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Willingness to Use Personal Health Record Systems: A Mixed-Methods Study Among Multi-Ethnic Civil Servants in an Upper-Middle-Income Country

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Abstract

Background

Electronic personal health record (PHR) systems allow individuals to access and manage their medical records seamlessly across healthcare providers to enhance service delivery and health outcomes. The success of the PHR systems depends on people's willingness to use (WTU) them. Despite the increasing implementation of this technology in Malaysia, there is a lack of official documentation regarding its acceptance or adoption. Given its high implementation costs, it is essential to gauge the public's WTU, assess the findings, and take appropriate measures to improve it.

Methods

This study aimed to determine the WTU as well as understand its predictors and insights among multi-ethnic civil servants from 15 ministries in Putrajaya, Malaysia, using a convergent mixed-methods study. The cross-sectional study was based on the Unified Theory of Acceptance and Use of Technology with linear regression analysis. Meanwhile, the generic qualitative study was based on semi-structured interviews with thematic analysis.

Results

The majority of respondents were willing to use the PHR system both currently and in the future. Significant predictors of performance expectancy (PE), facilitating conditions (FC), and social influence (SI) were integrated with the six themes of PE, FC, SI, effort expectancy (EE), human factors (HF), and perceived risk (PR). PE influenced WTU through health status, convenience, administrative efficiency, and incentives, while FC encompassed accessibility, self-efficacy, and assistance. SI depended on the impact of the healthcare provider, social connections, social media figure, promotion, stranger, and sense of autonomy. As for EE, informants underscored the importance of system integration, stability, and user interface. Additionally, HF extended beyond age, gender, and experience to include race, education, income, and employment. Meanwhile, PR was in regard to security, privacy, information credibility, and legal instruments.

Conclusion

Addressing these domains through tailored strategies can fulfil population needs, enhance system optimization, increase user acceptance, and support sustainable nationwide PHR system adoption.

Highlights

• broader practical aspects related to willingness to use personal health record systems beyond their technical features.

• Enhances understanding by integrating quantitative and qualitative evidence to provide a broader and deeper interpretation of the findings.

• Supports the development of inclusive policies and equitable implementation to improve system acceptance and adoption across diverse populations.

• Provides a foundation for future comparative studies and tailored interventions in similar settings.

Introduction

With advancements in mobile health technology, there has been a growing demand for accessible medical records anywhere at any time [1–4]. Electronic personal health record (PHR) systems address this need by allowing people to effortlessly access, share, and organise their health information digitally from any mobile device in real-time, regardless of changes in healthcare providers [3–12]. These systems often include additional features like reminders, self-monitoring tools, secure communication/messaging platforms, as well as privacy and security measures, further enhancing their benefits [7, 13–15]. This centralised access point bridges information gaps, complements provider-maintained electronic health records, and addresses limitations in health information exchange platforms [7, 14, 16]. By providing comprehensive, transparent, and updated health information, the PHR system enhances communication between patients and providers, particularly for those with lower health literacy levels or memory challenges [7]. Reliable health information supports better clinical decision-making and helps providers evaluate the effectiveness of current health management strategies [7, 14, 16, 17]. This PHR system can empower patients, particularly those with chronic illnesses, to take an active role in managing their health and engaging with providers [7, 14, 16, 18]. Informed patients are more likely to adopt necessary behavioural changes, leading to reduced hospital readmissions, fewer medical errors, lower healthcare costs, and improved compliance with medication and appointments [16, 19]. Aggregated data from PHR systems can support public health initiatives such as disease monitoring, outbreak management, and research [16, 17]. Ultimately, the PHR system enhances healthcare service delivery, individual clinical outcomes, and population health [7, 14, 16–18].

Despite these PHR systems' advantages, their adoption rates remain low globally [7, 16, 17, 20–26]. While there are increasing implementations of PHR systems in Malaysia [27–34], public opinion and their willingness to use (WTU) them remain largely unexplored. Limited research has been conducted on this topic in middle-income countries, particularly Southeast Asia, with multi-ethnic populations [35]. Understanding these factors is crucial due to the high costs associated with PHR system development and implementation [36]. Even though these costs may not directly impact people's WTU, failure to adopt such systems can have devastating consequences for stakeholders, particularly the Ministry of Health, given the healthcare sector's often limited financial resources. The estimated cost for developing an application prototype alone averages around USD 450 thousand, while the total cost for a fully functional

application can range from USD 2.8 million to USD 6.6 billion [36]. As this cost model was last estimated in 2008 and has yet to be officially updated, actual current costs are likely even higher.

The PHR system can be utilized by any individual regardless of their health status. However, those with chronic illnesses, particularly non-communicable diseases (NCDs), are anticipated to derive the greatest benefits. They frequently visit healthcare facilities for health management, have extensive medical histories and medication regimens, and should input at-home self-monitoring data to optimise health outcomes [18, 37]. In Malaysia, the National Health and Morbidity Survey 2019 reported that civil servants were one of the occupations with a high prevalence of NCDs such as diabetes, hypertension, hypercholesterolemia, and obesity [38]. Therefore, civil servants will likely benefit significantly from the PHR system due to their higher susceptibility to NCDs. Putrajaya, as Malaysia's primary administrative centre, hosts a substantial number of civil servants [39, 40]. Additionally, the infrastructures essential for PHR system usage are well established in this region, with internet usage of 100%, mobile phone usage of nearly 100%, and computer usage of 97% [41].

For PHR systems to be effective, widespread adoption should be made across the population to prevent disparities in healthcare services access and quality [19]. However, adoption of this technology relies on individuals' perceptions, which can vary significantly due to differing expectations or requirements and are influenced by the unique context of each country [19, 20]. Hence, it is vital to understand the factors influencing the WTU of these systems and individuals' distinctive insights on the matter in the respective country. As of 2023, only four studies have explored the PHR systems in Malaysia. Three studies focused on developing functional PHR mobile application prototypes but did not progress beyond the research phase into production [42–44]. The fourth study was a pilot test for a behavioural model development, integrating the Unified Theory of Acceptance and Use of Technology (UTAUT) and Protection Motivation Theory to assess the intention to use PHR systems within a single university setting [45]. No study has focused on understanding Malaysians' perceptions, opinions, and WTU PHR systems using a well-established behavioural theory and a mixed-methods design to identify key factors and insights for improving PHR system acceptance and adoption. To address the gap, this study systematically investigates the factors and insights influencing the WTU of a PHR system among civil servants in Putrajaya, Malaysia, using UTAUT, one of the most extensively tested frameworks for PHR systems research. It integrates eight frameworks, explains the highest variance, and overcomes limitations in other frameworks [26, 46, 55–61, 47–54]. The evidence-based findings will assist stakeholders in enhancing existing or future PHR systems, thereby improving healthcare service delivery and population health outcomes [7, 14, 16, 17], as well as provide a foundation for future research in similar contexts.

Materials and methods

Study design, setting, and sample

This convergent mixed methods study was a combination of a cross-sectional study with a self-administered questionnaire grounded in the UTAUT [47] and a generic qualitative study with semi-structured in-depth interviews (IDI).

Malaysia is an upper-middle-income country, and Putrajaya is an urban region with a multi-ethnic population [39] and a substantial prevalence of NCDs, particularly diabetes, hypercholesterolemia, and obesity among adults [38]. Civil servants are among the occupations most affected by NCDs [38], and Putrajaya is the primary administrative centre for government ministries [39, 40]. The PHR system can be utilised by anyone regardless of their health condition, but it is especially beneficial for individuals with NCDs. Therefore, Putrajaya was deemed an ideal location for this study, which was conducted at the headquarters of 15 government ministries. The headquarters consisted of a diverse range of civil servants, representing the broader demographic characteristics of Malaysia's civil service. This selection allowed for efficient access to a consolidated population, reducing logistical and resource challenges associated with data collection. Additionally, the readily available lists of eligible participants from the headquarters' Human Resource departments facilitated obtaining permissions and conducting random sampling effectively at the study sites.

The data collection period for both quantitative and qualitative studies was conducted concurrently from 1 October 2022 to 31 March 2023.

The sample size calculation for the quantitative study was done based on a formula for multiple regression studies by Milton [62]. After considering the adjustment for non-response of 20% [63], the final sample size calculated was 212. A total of 207 respondents participated, while another five declined to take part. Meanwhile, there was no predetermined sample size for the qualitative study, with data collection continuing until the saturation point.

For the quantitative study, a stratified random sampling method with probability proportional to size was used. After receiving ethical approval and permission to collect data at the study sites, lists of all civil servants in each ministry were requested from the respective Human Resource departments. These 15 lists were compiled, and the proportion of civil servants in each ministry was calculated. After applying the inclusion and exclusion criteria, 212 eligible civil servants were randomly selected using Microsoft Excel's random number generator, based on the required number of respondents from each ministry. The formula used to determine the proportionate number of respondents from each ministry was [(sample size/population size) x stratum size]. The population size refers to the total number of civil servants across the 15 ministries, which was 9,238. Meanwhile, the stratum size refers to the number of civil servants in each ministry, which ranged from 220 to 1,446. Inclusion criteria were civil servants working at the ministry headquarters in Putrajaya. Exclusion criteria were contract civil servants and those absent, on leave during data collection, or involved in the pre-test study. Contract civil servants are typically employed for a limited duration. Given the extended timeline required for data collection and analysis in a mixed-methods study, their availability throughout the study, particularly for member checking, could not be guaranteed.

Meanwhile, for the qualitative study, a criterion sampling method was used. Informants were selected from respondents who demonstrated clear willingness or unwillingness to use the PHR system, defined as those who answered "strongly agree", agree", "strongly disagree", or "disagree" to the statement "I intend to use a PHR system now". Three informants who were involved in the interview protocol pre-test were excluded. The selection process and interviews continued until the saturation point.

The date, time, and venue for distributing and collecting the questionnaires were arranged with the liaison officers from the Human Resources departments. These officers assisted in inviting the 212 respondents to take part in the data collection. On the day of data collection, the 212 respondents were briefed regarding the study, and written informed consent was obtained from the 207 respondents who agreed to participate before distributing the questionnaire physically, as five out of 212 respondents declined to participate. The questionnaires typically required approximately ten minutes to complete, with guidance provided for any queries or uncertainties. Upon completion, the 207 questionnaires were collected.

Face-to-face IDIs were conducted in private rooms on the ministry premises to ensure confidentiality. Interviews were scheduled following verbal consent from informants, and written informed consent was obtained prior to the IDI. Only the informant, the researcher, and the enumerator were present. The interviews were audio-recorded with permission and supplemented with field notes. Each session typically lasted approximately 30 to 60 minutes. All informants participated in a follow-up session for member checking.

Study variables and operational definitions

The quantitative study included four independent variables, three moderating variables, and one dependent variable based on the UTAUT. The independent variables were PE, EE, SI, and FC. The moderating variables were age, gender, and experience. The dependent variable was the WTU of a PHR system.

“PE” refers to the extent to which an individual believes using a PHR system will benefit them. “EE” refers to the extent to which an individual believes using a PHR system will be easy. “SI” refers to the extent to which an individual perceives that significant people in their lives believe they should use a PHR system. “FC” refers to the extent to which an individual believes that there are organisational and technical infrastructures supporting the use of a PHR system [26, 58]. “Age” refers to the respondent’s age as of 2022. “Gender” refers to either male or female. “Experience” refers to the respondent’s experience using a PHR system or similar technologies like mobile health applications. “WTU” refers to the extent to which an individual intends or does not intend to use a PHR system [26].

Data collection instruments

The self-administered questionnaire consisted of 21 questions divided into six sections. The respondent information section included eight questions on age, gender, ethnicity, service grade, workplace (name of ministry), awareness of the PHR system, experience using a PHR system, and place of experience. The respondents chose one of two options for gender, awareness, and experience; one of four options for ethnicity and place of experience; and stated their current age, service grade, and workplace. The other five sections focused on PE, EE, SI, FC, and WTU of a PHR system, adapted from a study by Zhang et al. (2019) [58]. Each section contained questions rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The higher the score, the higher the respondent’s agreement on that particular aspect or WTU of the PHR system. There were three questions to measure PE, two for EE, three for SI, three for FC, and two for WTU of a PHR system. The questionnaire is attached as the Additional File 1.

The original questionnaires were in English and were translated into Malay, the official language of Malaysia. Malay is taught in schools to all ethnic groups in the country, and fluency in the language is a requirement for individuals seeking employment as civil servants. As for English, although it is not the official language of Malaysia, it is widely used among citizens and has the third-highest proficiency in Asia [64]. The adaptation to the Malaysian context was conducted based on the World Health Organization guidelines [65]. The questionnaires in both languages were revised based on pre-tests by both respondents and experts. The forward-backward translation from English to Malay was validated by two public health medicine specialists and two language experts at Universiti Putra Malaysia. Meanwhile, the relevancy and clarity of the questionnaire were validated independently by four information system experts from the Ministry of Health Malaysia using the item-content validity index based on a 4-point Likert scale, with relevancy ranging from 1 (not relevant) to 4 (very relevant) while clarity ranging from 1 (not clear) to 4 (very clear) [66]. For face validity and reliability, the questionnaire was distributed to 30 unselected samples chosen randomly from one of the 15 ministries [67]. The questionnaire’s internal consistency was assessed using Cronbach’s alpha, with the values ranging from 0.720 to 0.951, indicating reliability [68].

For the qualitative study, a semi-structured interview protocol was developed following a review of factors influencing WTU a PHR system. It had been validated by peer review and pre-tested with three informants to assess clarity, flow, and appropriateness. As all informants preferred to speak predominantly in Malay during pre-test, the protocol was developed in Malay. Subsequent IDIs were also conducted primarily in Malay, which began by addressing the informants’ questions, then proceeded with three open-ended questions on their WTU and factors that may encourage or discourage it. Probing questions were used to elicit further clarification and depth. At the end of each interview, the researcher summarized the key points for preliminary validation and allowed the informants to verify, clarify, or elaborate as needed. To ensure the rigor of the study’s findings, reflexivity, field notes, memos, adequate engagement, member checks, peer review, rich and thick descriptions, a codebook, triangulation, and audit trails were conducted.

Data analysis

Statistical analyses were performed using SPSS version 26.0. All collected questionnaires were checked for missing data; none were identified. Normality tests on all numerical variables were conducted after data cleaning. For descriptive analysis, mean, standard deviation, median, interquartile range, frequency, and percentage were used as appropriate. For inferential analysis, simple linear regression was used to determine the significant associated factors and moderators of the WTU of a PHR system. Subsequently, multiple linear regression was used to identify predictors of the WTU of a PHR system, with all variables with p-value < 0.05 from the simple linear regression included in the preliminary models. Collinearity diagnostics and assumptions for linear regression were checked and fulfilled. The p-value < 0.05 and 95% confidence interval were applied to all tests.

For the qualitative study, each interview was transcribed verbatim, capturing all verbal and nonverbal utterances. This process was supplemented by memos and field notes, along with audio recordings from two devices placed in different locations. Transcripts were cross-checked repeatedly against audio recordings to ensure accuracy. Informants' identities were anonymised using reference numbers, and no names were recorded during interviews. Data were analyzed using both deductive and inductive thematic analysis [69, 70]. The deductive analysis was guided by the UTAUT, which provided an initial analytical framework based on the interview protocol. Simultaneously, the inductive analysis allowed additional codes and themes to emerge directly from the data, ensuring that meaningful patterns were captured while staying receptive to new discoveries [71, 72]. Analysis began with repeated readings of transcripts to achieve immersion. Initial (open) coding was performed using Nvivo 12 Pro and manually, supported by field notes and memos. Emerging codes were iteratively organized into categories, subthemes, and themes, guided by the codebook. Similar codes were merged, redundancies removed, and some quotes were split to reflect different codes. Codes, categories, subthemes, and themes were continuously refined through constant comparison with the data to ensure the findings accurately addressed the research question. Preliminary analysis was conducted after every interview to obtain an early understanding of the findings and refine subsequent sessions for richer and more focused data. Interviews were conducted predominantly in Malay. While codes were translated into English, the original quotes were kept as-is in the original Malay-English mix to ensure data rigor. However, quotations included in this article were translated into English to facilitate comprehension among international readers.

Results

Characteristics of respondents and informants

Table 1 presents the characteristics of participants in quantitative and qualitative studies. Out of 212 eligible respondents, 207 had participated (97.6% response rate), while five had declined. Meanwhile, 15 informants participated to achieve the saturation point. Normality tests for all numerical variables indicated normal distribution, except for the WTU.

Table 1
Characteristics of participants

Characteristics		Quantitative (N = 207)	Qualitative (N = 15)
Age (mean ± SD)		35.33 (6.64)	39.67 (10.63)
Age group (years old)	20–29	39 (18.8%)	3 (20.0%)
	30–39	121 (58.5%)	4 (26.7%)
	40–49	41 (19.8%)	4 (26.7%)
	50–59	6 (2.9%)	4 (26.7%)
Gender	Male	59 (28.5%)	6 (40.0%)
	Female	148 (71.5%)	9 (60.0%)
Ethnicity	Malay	187 (90.3%)	8 (53.3%)
	Chinese	8 (3.9%)	3 (20.0%)
	Indian	11 (5.3%)	4 (26.7%)
	Other	1 (0.5%)	-
Occupation group (based on service grade)	Support	84 (40.6%)	5 (33.3%)
	Lower officer	99 (47.8%)	8 (53.3%)
	Upper officer	23 (11.1%)	2 (13.3%)
	Top management	1 (0.5%)	-
Awareness of a personal health record system	Aware	117 (56.5%)	-
	Not aware	90 (43.5%)	-
Experience in using a personal health record system	Have experience	59 (28.5%)	-
	No experience	148 (71.5%)	-
Place of experience using a personal health record system	Government healthcare facilities	46 (78.0%)	-
	Private healthcare facilities	7 (11.9%)	-
	Government and private healthcare facilities	6 (10.2%)	-

Willingness to use a personal health record system

The highest percentage of respondents believed that a PHR system is beneficial for monitoring, educating, and managing health; found it easy to use and learn; and had the necessary resources to use it; but had mixed perceptions regarding the social influence on its usage. They were mainly willing to use a

PHR system now (85.5%) and in the future (74.4%). The detailed results are provided in Table 2.

Table 2
Respondents' responses for each variable

Variable	Item	*n* (%) Strongly agree & agree	Mean ± SD or Median (IQR)
Performance Expectancy	Beneficial for monitoring health status	189 (91.3)	4.36 ± 0.65
	Beneficial for self-education	188 (90.8)	4.35 ± 0.64
	Beneficial for managing health	188 (90.8)	4.34 ± 0.68
	Overall	-	4.35 ± 0.60
Effort Expectancy	Easy to use proficiently	139 (67.1)	3.88 ± 0.68
	Easy to learn to use	150 (72.4)	3.99 ± 0.76
	Overall	-	3.94 ± 0.77
Social Influence	Colleagues and superiors' influence	81 (39.1)	3.36 ± 0.81
	Family & friends' influence	84 (40.6)	3.39 ± 0.86
	Doctors' influence	95 (45.9)	3.51 ± 0.82
	Overall	-	3.42 ± 0.74
Facilitating Conditions	Access to electronic device and internet	197 (95.2)	4.51 ± 0.69
	Have necessary knowledge	150 (72.4)	3.98 ± 0.94
	Someone to explain usage	88 (42.5)	3.22 ± 1.15
	Overall	-	3.90 ± 0.70
Willingness To Use	Willingness to use a personal health record system now	177 (85.5)	4.00 (1.00)
	Willingness to use a personal health record system in the future	154 (74.4)	4.00 (2.00)
	Overall	-	4.00 (1.00)

Predictors of willingness to use a personal health record system

Age, gender, and experience had no statistically significant association with the WTU of a PHR system and no statistically significant moderating effects on PE, EE, SI, and FC ($p > 0.05$). Meanwhile, PE ($p < 0.001$), FC ($p < 0.001$), EE ($p < 0.001$), and SI ($p < 0.001$) had a statistically significant association with the WTU of a PHR system. The results are simplified in Table 3.

Table 3
Association and interaction effects analysis using simple linear regression

Variable Type	Variable/ Interaction Term	R^2	Unstandardized *B*	95% CI	Pearson's correlation/ Standardized Beta	*p*-value
Main Effect	**Age**	0.000	-0.001	-0.016, 0.014	-0.009	0.899
	Gender					
	Male	Ref				
	Female	0.000	-0.002	-0.229, 0.226	-0.001	0.987
	Experience					
	No	Ref				
	Yes	0.001	-0.045	-0.273, 0.182	-0.028	0.694
	PE	0.236	0.605	0.455, 0.755	0.486	**< 0.001**
	EE	0.123	0.341	0.215, 0.466	0.350	**< 0.001**
	SI	0.102	0.324	0.192, 0.457	0.320	**< 0.001**
	FC	0.136	0.394	0.257, 0.531	0.368	**< 0.001**
Interaction Effect	**PE*Age**	0.238	-0.001	-0.004, 0.002	-0.057	0.464
	PE*Gender	0.236	-0.002	-0.048, 0.043	-0.007	0.916
	EE*Age	0.123	0.000	-0.004, 0.004	0.006	0.948
	EE*Gender	0.124	0.013	-0.041, 0.066	0.032	0.642
	EE*Experience	0.123	-0.009	-0.062, 0.043	-0.023	0.728
	SI*Age	0.103	-0.001	-0.005, 0.003	-0.038	0.713
	SI*Gender	0.103	0.008	-0.053, 0.070	0.019	0.787
	SI*Experience	0.103	-0.008	-0.069, 0.053	-0.018	0.796
	FC*Age	0.136	0.000	-0.004, 0.004	-0.008	0.930
	FC*Experience	0.138	-0.019	-0.072, 0.034	-0.047	0.476

p-value significant at < 0.05, PE=performance expectancy, EE=effort expectancy, SI=social influence, FC=facilitating conditions

All four independent variables with *p*-values of < 0.05 were included for further analysis. All assumptions were met. The scatterplot of residuals and predicted values, the Durbin-Watson value of 2.092, VIF values less than 10, and tolerance values greater than 0.1 all supported these assumptions, while outliers identified from Mahalanobis distance and Cook's distance did not significantly influence the model [73–77]. A parsimonious regression model was chosen using the Stepwise method. In the final model, PE ($p < 0.001$), FC ($p = 0.003$), and SI ($p = 0.007$) were found to be predictors, while EE was not ($p > 0.05$), explaining 29.8% of the variance (aR^2=0.298, $p = 0.007$). The final model demonstrated a good overall fit, indicated by the residual analysis and non-significant outliers, increasing adjusted R^2 values with each added variable, significant *F*-test values, and all predictors being statistically significant [78, 79]. All models and results are as in Table 4.

Table 4
Predictors analysis using multiple linear regression

***p*-value**		**< 0.001**			**< 0.001**				**0.007**				
F Change		63.406			13.134				7.532				
Adjusted R^2		0.233			0.275				0.298				
R^2		0.236			0.282				0.308				
95% CI	**Upper bound**		2.102	0.755		1.615	0.662	0.378		1.363	0.625	0.338	0.29
	Lower bound		0.787	0.455		0.213	0.353	0.111		-0.069	0.315	0.070	0.04
p-value			**< 0.001**	**< 0.001**		**0.011**	**< 0.001**	**< 0.001**		0.076	**< 0.001**	**0.003**	**0.00**
t			4.333	7.963		2.571	6.459	3.624		1.781	5.983	2.998	2.74
Standardised Coefficients	**Beta**			0.486			0.408	0.229			0.378	0.191	0.17
Unstandardised Coefficients	**SE**		0.333	0.076		0.356	0.079	0.067		0.363	0.079	0.068	0.06
	B		1.445	0.605		0.914	0.507	0.245		0.647	0.470	0.204	0.17
Variable		**Model 1**	Constant	PE	**Model 2**	Constant	PE	FC	**Model 3**	Constant	PE	FC	SI

p-value significant at < 0.05, PE=Performance expectancy, EE=Effort expectancy, SI=Social influence, FC=Facilitating conditions, CI=Confidence interval, Stepwise method applied

Insights for willingness to use a personal health record system

Analysis generated 452 codes with six themes, 22 subthemes, and 50 categories. Saturation point was achieved by the 13th interview, and two additional interviews were conducted to confirm saturation.

Theme	Subtheme	Category
1. Performance expectancy	a) Better health status	• Increase health awareness
		• Easier to manage disease/health
		• Improve health information-seeking behavior
		• More comprehensive and accurate health information
	b) Convenience	• Device is easier to carry
		• Faster information retrieval or sharing
		• Easier access to family information
		• Easier to access and receive treatment at different locations
	c) Administrative efficiency	• Provide evidence to superior
	d) Incentives	• Gain meaningful incentives by utilization
		• Unnecessary to gain incentives
5. Effort expectancy	a) Integration	• One system containing all health information
		• Need to input too much information
	b) System stability	• System stability is imperative
	c) User interface	• Not too many clicks or steps
		• Annoying difficult sign-in
		• Effortless sign-in
6. Social influence	a) Influential impact	• Healthcare provider
		• Close social connection
		• Social media figure
		• Promotion
	b) No influential impact	• Stranger
		• Autonomy
8. Facilitating conditions	a) Accessibility	• Availability is satisfactory
		• Availability is unsatisfactory
		• Affordability considerations
	b) Self-efficacy	• Digital literacy is essential
		• Health literacy is essential
	c) Assistance	• Assistance is not required
		• Require assistance
10. Human factors	a) Age	• Growing older
	b) Gender	• Women's reproductive health management, gender roles in family, and better health awareness
		• Men's passivity in health management, and time availability
		• No gender disparity
	c) Experience using similar technologies	• Positive experience
		• Negative experience
		• No experience needed
	d) Race	• All races are similar
	e) Education level	• Not dependent on education level
		• Probable dependency on higher education level
		• Dependent on higher education level
	f) Income level	• Income level is irrelevant
		• Income level plays a role

Theme	Subtheme	Category
	g) Employment opportunity	• Effect of certain employment
16. Perceived risk	a) Security and privacy	• Security and privacy concerns
		• Assurance against potential risks
		• Risks acceptance
		• Conditional on risks encounter
	b) Information credibility	• Low trustworthiness in information credibility
	c) Legal instrument	• Stringent legal repercussions

Performance expectancy

Many informants describe multiple perceived benefits that influence their WTU a PHR system. They noted that using this technology could improve health awareness and promote better overall well-being. Access to personal health information could facilitate healthcare provider make informed decisions for their disease and medication management.

"When we use a health app, we become more aware of our health. So, in a way, it can make us healthier. For me, that alone is already sufficient. It would be much easier to manage our medications and our illnesses. When we go to the hospital, the doctor already knows what condition we have and what medications we are taking." (Informant 01).

The system could also improve health information-seeking behaviour and enable active health monitoring, especially because they could have direct access to information that was not always fully communicated during a clinical visit.

"When the doctor enters health information, I have the desire to learn and understand what the system actually is, how it works, and where we can check our health status. I can monitor where I actually stand. Otherwise, I would be left wondering, because sometimes not everything the doctor records is conveyed to the patient; it's just entered into the system." (Informant 08).

Beyond individuals with chronic conditions, some informants believed the PHR system could benefit healthy individuals by establishing baseline health status and tracking disease progression. It allowed for more comprehensive and accurate health information without having to rely on memory.

"Even healthy people would want to know their baseline health status. We think everything is okay when we go to a clinic, but we may not realise that something is progressing towards a disease. It is not only for chronic disease but for everyone. One more thing, it depends on our recall. We cannot always remember all our past health information. Having complete records would make subsequent treatments easier and more efficient." (Informant 11)

Numerous informants also highlighted the portability and accessibility of the PHR. As smartphones are widely owned, medical records were considered more practical and faster than physical documents, useful for the whole family. The system was perceived as facilitating continuity of care across facilities without the need to repeat procedures.

"Nowadays, everyone has a smartphone, so there is no need to carry many booklets. It's easier to access health information, like me, who is caring for elderly parents, my own, and my whole family, including my children. I prefer to use the system compared to manual records because it saves time. We no longer depend on one healthcare facility, and treatment can continue elsewhere without repeating the entire process." (Informant 11)

One informant further described administrative benefits within the workplace, as appointment records in the PHR system could serve as credible documentation.

"If we need to explain to our superior about frequent appointments, we can show the records in the PHR system. It proves that we are not being dishonest. Since the app is from the hospital, it is valid and can serve as supporting evidence." (Informant 10)

Half of the informants expressed greater WTU the PHR system if meaningful incentives were provided. Suggested incentives included free comprehensive health check-ups, shorter waiting times, lucky draws, cash, tax deductions, coupons, subsidies for medications, discounts at healthy food establishments, free treatment, access to premium wards, gifts, and redeemable points or gifts. Examples included:

"Maybe free comprehensive medical check-up, no queuing, or lucky draw." (Informant 02)

"Easy one would be cash. I think everyone likes tax deductions. You could give coupons related to health too, like gym memberships, Zumba classes, or consultations with a dietician." (Informant 14)

"Discounts for medications at pharmacies, maybe five or ten percent. Or discounts at healthy food outlets." (Informant 04)

"Maybe free treatment, for some duration. We can stay in premium wards." (Informant 08).

"Maybe Tupperware; gifts; things like points, then we can redeem." (Informant 03)

However, the other half of the informants expressed that incentives would not influence their WTU. They emphasised personal responsibility for maintaining health and believed that awareness of one's health status was inherently rewarding:

"If we want to be healthy, we should know our health status. Don't wait for the government to offer rewards before we take care of our health." (Informant 08).

"No need for rewards. Because this is for ourselves. If I am healthy, that itself is my reward." (Informant 07)

Some informants also raised concerns regarding financial sustainability, cautioning that incentives could impose unnecessary costs on the government and threaten long-term system maintenance:

"We need to think long term, which is maintenance, that is more important. If many people are attracted initially, but then there are insufficient funds to sustain the system, it will eventually be wasted." (Informant 14)

"I do not think incentives are necessary. Because I worry that it may burden the government." (Informant 13)

Effort expectancy

Integration was one of the most strongly emphasised aspects of perceived ease of use. Numerous informants identified it as a key factor influencing their WTU a PHR system. The PHR system should consolidate all health information within a single platform to be more efficient and less burdensome. Integration was believed to reduce repetitive data entry and facilitate easier reference for both patients and healthcare providers.

"It would be more efficient. All data is gathered in one place. It's easier for doctors and us to refer to. It would be troublesome if it's not integrated. There would be too much information to enter if we had to update everything ourselves." (Informant 12)

One informant suggested that the PHR system should be integrated with insurance panels and have location-based features that would allow users to identify nearby healthcare facilities that accept their insurance coverage.

"It should connect with insurance companies and hospitals. If someone is travelling and becomes unwell, they can check which nearby hospital accepts their insurance. So they do not need to call each hospital to ask." (Informant 06)

Most informants highlighted system stability as a fundamental expectation, where technical issues like lagging, crashes, and software "bugs" are major deterrents to continued use. Regular updates were perceived as necessary to maintain reliability. The system should be stable and compatible across devices, or else it will discourage use.

"The minimum expectation is that the system does not lag or crash easily. Many apps are not fully stable. If there are too many bugs, I will lose interest in using it. The system should always be updated to ensure stability." (Informant 06)

"As long as the system is not stable, it will discourage us from using it. Maybe it is too heavy, or some phones cannot support it. The application must be usable across devices." (Informant 11)

Most informants also want immediate responsiveness and the ability to obtain desired information quickly with minimal effort. Systems requiring excessive clicks, multiple steps, and difficult to log in were viewed negatively, which were common with government systems.

"When I click, I expect the information to appear immediately. I do not want delays. When we click, we can easily get the information we want. Sometimes we click, but we cannot find what we need. Even logging in can be difficult; it makes people frustrated." (Informant 08)

"When there are too many steps, it becomes difficult to use. Government systems are sometimes overloaded, you have to refresh many times, log in again, forget ID, too many authentication steps." (Informant 05)

The system should be easy to log in to, and the authentication processes could be streamlined, such as biometric login, over passwords or PINs:

"The system should be easy to sign in. The easiest way is when we open the app, we can just use our fingerprint. No need to enter ID numbers and passwords." (Informant 15)

Social influence

The WTU the PHR system was found to vary according to the source of influence. Numerous informants reported a strong tendency to follow their healthcare providers' positive or negative recommendations, especially when there is an established relationship.

"Doctors are one of the main sources of influence. If I regularly see the same doctor and the doctor says, 'This system is not very good for you,' then as the patient, I would automatically stop using it. We really depend on doctors. When they say something is good, we will follow." (Informant 06)

Without recommendations from healthcare providers, several informants indicated that they would not have been aware of the system or considered using it.

"The healthcare workers informed me about it. They didn't force me, they just suggested it. I tried it and found the app quite good, so I continued using the PHR system. If it hadn't been promoted, I wouldn't have known about it and wouldn't have used it." (Informant 10)

Close social connections, such as family members, friends, and colleagues, were also highlighted as influential. Informants were more inclined to try the system when recommendations came from trusted individuals who had positive user experiences:

"If someone recommends it and they had good results from using it, I think I would try it. Especially people I trust, friends, office colleagues, family." (Informant 12)

One informant identified social media figures as her primary source of influence compared to close social connections since the former often provided detailed, experience-based explanations. Although she acknowledged the importance of healthcare professionals, she perceived their recommendations as potentially biased.

"Colleagues and family are important. But most of the influence comes from social media influencers. Doctors and nurses are important too, but I feel there may be a bit of bias regarding the apps. Usually when social media influencers introduce a new app, they already have experience using it. They explain the process in detail, why they use it, the benefits, and the disadvantages." (Informant 03)

Promotion and marketing were repeatedly mentioned as influential factors. Multiple informants suggested that a lack of advertising reduced awareness, perceived benefits, and interest, ultimately affecting WTU. Social media platforms were proposed as effective channels for outreach due to their broad user base.

"We may not use the system because there is no marketing or advertisement encouraging us to install the app. There is no exposure. We can use social media like Instagram or Facebook, where there are many users. That's where the system can be marketed and its benefits explained." (Informant 06)

Another informant noted that continuous updates and improvements to the system often go unnoticed, which may contribute to low adoption rates.

"I see that the PHR system has added many new features and improvements. But people don't realise it. Sometimes I check what has been improved, and when I see the updates, I think, 'Oh, this is quite good. Why aren't we using it?' So maybe people don't use it because they don't know." (Informant 13)

In contrast, recommendations from strangers were perceived as significantly less influential. Trust and familiarity were considered essential determinants of persuasive impact.

"If a stranger encourages me to use it, it wouldn't carry the same weight as if my doctor or a trusted friend suggested it. If I'm walking outside and a stranger says, 'Use this,' I would probably just ignore it." (Informant 01)

Additionally, some informants emphasised personal autonomy, and for them, others' opinions did not meaningfully influence their WTU.

"Other people's opinions are not important. My health is my private matter. If I am willing to share it with the government, that is my personal decision. Whether others agree or not does not make a difference." (Informant 05)

Facilitating conditions

Facilitating conditions, including accessibility, self-efficacy, and external assistance, could either positively or negatively influence the WTU a PHR system. Informants expressed mixed views regarding the availability of Malaysia's technical infrastructure to support system adoption. Several informants perceived that device ownership and internet penetration were adequate, suggesting that the fundamental infrastructure required to support PHR usage is largely in place.

"It's already 2023. If you look at surveys, ninety percent of people are using smartphones and ninety percent have their own internet access. So the PHR system is very accessible. For me, everyone can access it." (Informant 06)

However, a larger proportion of informants reported that internet connectivity remains inconsistent, with some highlighted slow connection speeds and connectivity challenges in rural areas, albeit improvements have been observed.

"I can't say accessibility is one hundred percent good. Sometimes the connection is slow." (Informant 08)

"I think internet access is quite good. In rural areas it may be limited. But now it's getting better. I don't think it's a major problem." (Informant 09)

Similarly, informants expressed mixed views regarding the affordability of the technical infrastructure. Several informants mentioned the financial constraints related to smartphone ownership and mobile data subscriptions as potential barriers to access. They noted that not everyone owns a smartphone, and even among those who do, not all can afford consistent data plans.

"It can be difficult because not everyone uses a smartphone. Even if they have one, they may not have mobile data. Data plans require a financial commitment." (Informant 04)

Conversely, one informant asserted that internet subscription costs were affordable, citing that there were low-cost plans available in the market, as low as RM 5.00 a month (equivalent to USD 1.28).

"I just heard on the radio that it's only five ringgit. Just five ringgit; it's considered cheap." (Informant 15)

Therefore, to address the affordability issue, one informant suggested stronger governmental or regulatory oversight of the telecommunications market. Increased competition and price regulation were viewed as potential mechanisms to ensure more affordable prices and improve accessibility to the broader population.

"Internet is expensive now. If you have money, you can buy data; if not, it's a problem. The government should control the market. I'm not sure how the telcos operate now, but there should be someone to control the price. It seems like there's limited competition. With more competition, prices might decrease. Supposed there should not be any problems browsing the internet anymore. Prices should be reasonable so that everyone can afford internet access." (Informant 08)

More than half of the informants recommended implementing universal free access, subsidies especially targeted for vulnerable groups, or free access at designated sites like healthcare facilities, to improve system use.

"The government needs to help. Provide free internet, or subsidies." (Informant 07)

"Free internet for rural populations or elderly groups. Not for everyone, based on income level and location." (Informant 13)

"Wi-Fi should be open, especially in places like hospitals, where it should be free to use." (Informant 04)

In contrast, one informant raised concerns regarding the economic sustainability of large-scale free or subsidised internet provision, as the financial burden associated with building and maintaining broadband infrastructure could outweigh potential economic returns:

"The government could go bankrupt. The infrastructure, especially broadband, is costly to build and maintain. I don't think the government can bear the cost. It may not provide good economic returns." (Informant 15)

Another informant proposed multi-sectoral collaboration as a potential solution. Partnerships between village leaders, district officers, telecommunications companies, and other agencies were suggested as a means to expand community-level internet access to attract more users. In return, they could receive incentives such as tax waivers as mutually beneficial arrangements.

"Village heads or district officers could be required to provide free Wi-Fi to local communities as a way to encourage people to use the app. We could collaborate with other departments or agencies. For example, the government could offer tax waivers to telcos that provide support. That would create a win-win situation." (Informant 11)

To effectively utilize the PHR system, a certain level of self-efficacy is required, particularly in terms of digital literacy and health literacy. Informants indicated that variations in self-efficacy could either positively or negatively influence the WTU the PHR system. Informants mentioned that digital literacy is a requisite for the WTU the PHR system, as individuals without the ability to navigate the system are unlikely to use it.

"If I don't know how to use an app, I won't open it. If I don't know how to access it, how to input information, how to make an appointment, or even how to read the news in it, then I won't be able to use it." (Informant 03)

Similar to digital literacy, informants also highlighted that health literacy is a requisite for the WTU the PHR system, as individuals who do not perceive the value of understanding their health status are unlikely to use it.

"We will be willing to use it if we first think it is beneficial. If someone feels there is no need to know about their health, then they won't use the PHR system." (Informant 04)

The availability of assistance was perceived as a facilitating condition that could positively influence WTU, although views were mixed. Some informants mentioned that assistance was not necessary for them, provided the system was useful.

"For most apps, I don't need training. Even if a doctor says, 'Use this app,' but doesn't provide any assistance, as long as I think it's useful, I will use it." (Informant 01)

Meanwhile, others acknowledged that assistance would be helpful but still not necessary.

"It would be helpful if assistance is available. But if there isn't, it wouldn't stop me from using it." (Informant 02)

The perceived need for assistance also appeared to vary by age. One informant explained that while he could independently navigate the system if step-by-step guidance were embedded within the app, older family members might require external support:

"For me, I don't need assistance if there are instructions within the app. How to log in, what to do next, what information to input. I can manage on my own. But for my mother, I would need to help her." (Informant 12)

This perspective was echoed by older informants in their 50s, who expressed a need for support from more technologically skilled individuals, such as friends or family members, due to their limited digital proficiency.

"If someone is already familiar with the PHR system and more skilled in IT or digital matters, they should provide assistance. I am less proficient in digital matters, so I would need help from friends or family members who are more skilled." (Informant 09)

When asked about preferred forms of assistance, informants recommended both digital and face-to-face approaches.

"When people come for appointments, someone could introduce the app and teach them while they are waiting. Or if we want everyone to use it, not only patients, we could show short demonstration videos on TV explaining how to use it." (Informant 14)

However, one informant argued that a system requiring extensive tutorials may indicate poor design. Ideally, the system should be intuitive and user-friendly.

"If a system needs a tutorial, that means it is too complicated for everyone. It should be intuitive." (Informant 05)

Human factors

Under this theme, seven human factors were discovered as having the potential to positively or negatively influence the WTU a PHR system: age, gender, prior experience using similar technologies, race, education level, income level, and employment opportunity.

Older informants (in their 50s) acknowledged that age may facilitate their WTU a PHR system. One informant explained that advancing age is often accompanied by multiple chronic conditions requiring frequent hospital visits; therefore, a PHR application would simplify medication and disease management.

"When people get older, they start to have various illnesses. When we have to go to the hospital many times, it becomes easier to manage medications and diseases if there is an app like this. If we go to another hospital, the doctor already knows what illness we have. It makes things easier for older people with multiple conditions to manage their health." (Informant 01)

Meanwhile, many informants have mixed views regarding the influence of gender on WTU. Approximately half of the female informants perceived that women may be more willing to use a PHR system. One informant attributed this to women's familiarity with health applications to track their reproductive health, such as menstrual cycle apps, which reduces hesitation towards adopting other health-related applications.

"Women usually track their menstrual cycle online. So the possibility of using other health apps is not a problem because we are already used to it." (Informant 02)

Many informants also linked this tendency to socially constructed gender roles in Malaysia, where women are commonly expected to manage family health matters. One informant further shared how she routinely records and reminds her husband about health-related issues, not because he is incapable, but because he is less accustomed to doing so.

"I would use it because my husband usually asks me to record and remind him everything about health matters. It's not that he cannot do it, but he is not trained to manage these things. For children's immunisation and appointments, we as women are the ones who usually remember and handle them. It's not that man doesn't know." (Informant 04)

Additionally, women were more commonly perceived to have better health awareness.

"I think most users will be women because women tend to know more about health matters." (Informant 07)

Men were also perceived to be less proactive in health management, with some informants believing that men might only use health applications when necessary, such as when already unwell.

"I would say women are more likely to use it. Men tend to think health apps are unnecessary. Usually, they will only use them when they really have to, for example, when they are already sick." (Informant 14)

However, one female informant believed the opposite possibility that men might use such applications more because they have more available time.

"Maybe men would use the app more because they have more time." (Informant 03)

The rest of the informants of both genders claimed that gender does not meaningfully influence WTU and emphasised that individual health awareness is more important.

"I do not think gender matters. It depends on the individual's health awareness." (Informant 13)

Furthermore, another informant stated that both fathers and mothers share responsibility for managing children's health records.

"I do not think there is any difference between men and women. This system can be used generally. Men can use it, women can use it. Fathers also need to keep their children's health records, not only mothers." (Informant 09)

There were also mixed views regarding the role of prior experience. Several informants expressed that positive previous experiences with health applications increased their WTU the PHR system due to a sense of familiarity and perceived efficiency.

"I strongly want to use it. If we have used something similar before and know it is efficient, we will use it." (Informant 02)

Conversely, negative past experiences were described as a challenge, although their perceptions could be reversed through effective reassurance and system credibility. One informant also elaborated that even those positive past experiences could change their mind if problems arose.

"Experience definitely impacts everyone. If someone has had a bad experience, they may feel traumatised to use it again. But if you can convince me as a user that the system is good and highly secure, I can change my mind. Even those with good experiences may change their mind if they encounter problems." (Informant 14)

Nevertheless, one informant mentioned that prior experience is not essential, as users can learn through initial exposure.

"Experience is not important. For any app, we start without experience, but we still begin using it." (Informant 01)

As per race, many informant across different racial backgrounds asserted that race does not influence their WTU the PHR system. A Chinese informant expressed that health is universally important.

"Race does not play a role. I think healthcare is equal for everyone." (Informant 05)

Meanwhile, a Malay informant indicated that usage depends more on a person's digital literacy.

"I do not think so. It depends on the person's digital knowledge." (Informant 03)

Likewise, an Indian informant believed that usage depends more on a person's perceived usefulness.

"I do not think this is related to race. If someone wants to use it for their own benefit, they will use it." (Informant 07)

Views were mixed regarding whether educational level influenced the WTU the PHR system. Several informants across both higher and lower educational levels believed that it did not determine WTU. They asserted that individuals with a higher education level may still choose not to use the system, while those with a lower educational level may be equally willing to adopt it. One of them elaborated that it is because higher educational attainment does not automatically translate into prioritising one's health, and perceived usefulness remains more important.

"Not everyone with higher education takes care of their health. They need to understand the necessity and importance." (Informant 04)

Another expressed that formal education is not necessarily required to use the system, except in cases of illiteracy.

"Education is not necessary. But for those who never went to school and cannot read, that may be a real barrier." (Informant 15)

Similarly, one informant argued that facilitating conditions, rather than formal education, is a necessity. She highlighted that even very young children can navigate digital platforms.

"Education is not necessary if you already know how to use a smartphone or have any device with internet access. Nowadays, even two- or three-year-olds can use YouTube. So I don't think education is an issue for using the PHR system." (Informant 07)

However, another group of informants across both higher and lower educational levels believed that those with higher education levels are more likely to be willing to use the system. Some elaborated that they may have better perceived usefulness or better health and digital literacy.

"Education level plays a role. Because it also reflects one's level of understanding and awareness of the benefits." (Informant 14)

"People with higher knowledge tend to be more alert and more willing. Those with higher education usually know more about health and digital matters, so that plays an important role." (Informant 03)

Several believed that education may have some influence, but not as a dominant determinant, as awareness of health applications is increasingly widespread across educational levels.

"Education may play a role, but not a big one. People from various educational levels are already aware of health applications." (Informant 13)

Additionally, informants also expressed mixed views regarding the influence of income. A few informants from middle and lower income levels believed that it is irrelevant, as the medical expenses in Malaysia are subsidised by the government, and it is a matter of personal choice.

"Income does not play a role because the government already subsidises medical expenses." (Informant 05)

"It's not necessarily those with high salaries who will use it. Even those with lower salaries may use it. It depends on the person's personal choice." (Informant 09)

One informant further argued that income is subjective and does not necessarily reflect health literacy.

"Income is subjective. Someone may have a lower income but high health literacy." (Informant 02)

Nevertheless, some informants from middle and higher income levels expressed that income could influence the WTU the PHR system under certain conditions. One informant asserted that the presence of payment requirements would prompt reconsideration.

"Income plays a role, because I have to consider if there is a payment required to use this system. Even a one-off payment, I would think twice." (Informant 14)

On the other hand, another informant believed that higher income may increase exposure to information and digital tools, thereby indirectly influencing awareness and WTU.

"If someone has more money or is wealthier, it can influence whether they are aware of the app or system." (Informant 01)

Certain employment opportunities can also be a potential influencing factor for WTU. One informant described how certain jobs or workplaces, such as in educational institutions, may increase exposure to the healthcare system.

"Occupation can be a factor. Certain workplaces, like educational institutions, we are exposed to these kinds of things." (Informant 01)

Perceived risk

Perceived risk is a person's subjective perception of potential negative consequences associated with the decision to use the PHR system. Perceived security and privacy risks were found to both positively and negatively influence the WTU a PHR system. More than half of the informants expressed

concerns regarding potential data breaches and misuse of personal health information. Informants feared that leaked health information could be exploited by scammers, potentially leading to manipulation, fraud, safety threats, or extortion.

"Might be data leakage. For example, maybe we have heart disease, and then the information reaches a scammer. Then they call and say, 'Oh, this is a new medication, a new treatment.' So we might be influenced. Because when we are sick, we may not make very rational decisions. And more importantly, it might affect safety." (Informant 02)

"Information leaking out to other people. Personal information like addresses, phone numbers, spouse details, family members, IC numbers. They can access everything. There's a threat in terms of kidnapping or extortion, you never know." (Informant 15)

Concerns were also raised regarding system integration. While integration was previously viewed as beneficial, one informant cautioned that centralised systems could increase vulnerability to large-scale breaches, referencing recent data breach incidents in government and banking sectors.

"Recently, there have been many incidents of data breaches in government agencies and even banks. So, having one system, I think the government should think very carefully about that. It might be better to have multiple systems but one connection for users, from a technical perspective." (Informant 05)

Conversely, some informants emphasised that assurance of strong security measures would increase their WTU the PHR system. They viewed data privacy as a decisive factor.

"Personally, if I do not need to worry about my data privacy, I will use the PHR system. The most important point for me is data security. As long as I have to worry about my data security, I will not use the app." (Informant 01)

At the same time, a significant number of informants also perceived that security and privacy risks did not influence their WTU, demonstrating risk acceptance. Although they acknowledged potential security threats, they perceived such risks as inherent to all digital systems and considered them minimal relative to the system's benefits. They also believed that users bear personal responsibility for safeguarding their information.

"Every system is the same, it carries risks. Once you access the system, you must take care of yourself. You already know there are pros and cons. We know our data will eventually be shared, whether with private entities or the government. So I think I will still use it." (Informant 07)

Similarly, another informant asserted regarding the inevitability of data risks in the digital era and the need to adapt to technological advancement. She expressed optimism that system vulnerabilities could be improved over time.

"If we talk about data risks, it is not only health data. Many types of information can leak. I think we must move along with technological progress. Risks can be improved over time. Every system has advantages and disadvantages. Maybe initially there are leaks, but I believe it will be improved." (Informant 11)

Several informants stated that they would continue using the system, provided no evidence of data leakage emerged.

"As long as there is no proof of data leakage in the system, I will continue using it." (Informant 13)

To overcome the risks, some informants recommended system maintenance for continuous security management and incorporating additional authentication mechanisms, such as biometric access and password protection.

"It depends on how we manage the risk. What I can think of is maintenance of the system; it really plays an important role, especially in security." (Informant 14)

"Adding fingerprint access, like banking apps. Or passwords, patterns, whichever." (Informant 15)

Perceived information credibility could also negatively influence the WTU a PHR system. Concerns centred on the accuracy and reliability of health records within the system. One informant shared her experience in which missing medical records at a public hospital resulted in repeated postponements of a scheduled operation.

"I am worried because sometimes information goes missing. It happened to me in a government hospital. My operation was postponed from January until the end of the year because each time I went, the records were missing. I don't know how. If the hospital itself does not have my medical record, how can I have it? That's why people do not fully trust the system." (Informant 07)

To address this concern, one informant suggested that public education is necessary to reassure users that the data within the system are accurate and protected from unauthorised alterations.

"I think the barrier is that people do not trust the authenticity of the data in the system. Actually, the data cannot simply be altered. We need to educate them that the data are valid and cannot be manipulated. Educate and motivate them so they will continue to use the system." (Informant 09)

Legal instruments are laws, regulations, policies, and formal governance frameworks that establish standards and accountability mechanisms related to data protection and system management. The availability of these instruments could influence the WTU. One informant mentioned that stricter regulations and stronger legal consequences for data breaches or hacking incidents would increase his WTU. He perceived current regulatory frameworks as insufficiently stringent and lacking significant repercussions for misconduct.

"What would encourage me to use a system like this if policies or regulations become stricter. When data breaches happen, there must be serious consequences for the companies managing the system or those who hack the database. For the time being, government regulations seem to be at an early stage. When data

leakages occur, I do not see significant consequences for those involved." (Informant 01)

Discussion

Respondents showed a good WTU of the PHR system both presently and in the future. This finding was quite surprising, as many developed countries, including the United States, Australia, Denmark, Estonia, and the Netherlands, reported prevalences below 50% [20–25]. Despite high prevalences seen in countries such as Saudi Arabia, Luxembourg, Belgium, Germany, and France [59, 60], comparative formal documentation in other middle-income or Asian countries, particularly in Southeast Asia remain limited [35]. The difference in the prevalence could be attributed to the impact of the Coronavirus-19 pandemic. The pandemic may have heightened health awareness and emphasised the importance of accessing medical records, as evidenced by Sweden's doubling of PHR system users after the pandemic onset [80]. Additionally, the pandemic necessitated the wide use of various health applications for teleconsultation and contact tracing in Malaysia [81–84]. Continuous and rapid technological advancements equipped with artificial intelligence, potentially further improve digital literacy, foster trust, and create positive attitudes toward digital health solutions.

While current WTU is often driven by positive experiences, familiarity, and trust, future WTU may be influenced by uncertainty surrounding rapid technological change, including concerns about future reliability, security, external inputs from surrounding people, and the emergence of better or more burdensome alternatives. This is consistent with literature describing the dual nature of technology, which can improve daily life while also introducing burdens such as dependency, inefficiency, reduced real-world interaction, and new unmet needs (Csuka et al., 2019). Studies have also echoed similar concerns about future technological developments, while expanding on surveillance, privacy threats, anxiety from information overload, and stress from poor system design (Anderson & Rainie, 2018; Stansberry et al., 2019).

As expected, PE would propel a person's decision to use the PHR system over other factors. Consistent with prior literature, perceived benefits in terms of improving information management, preparedness for clinical visits, discussions with healthcare providers, understanding of disease, adherence to treatment, patient empowerment, as well as overall care coordination and control [3, 10, 12, 37, 85–89]. Despite a study finding that some participants were hesitant to read their health information in the system, expressing concerns that it could make their diseases feel more "real" and remind them of their health problems, potentially leading to increased stress and a poorer quality of life [10], similar sentiments were not echoed by the informants in this study. This may denote that they viewed the system as an empowering tool and appreciated transparency in accessing their health information. Additionally, the systems are more convenient, faster, and can be easily shared with others, providing reassurance on continuity of care without redundant procedures during travelling, emergencies, relocation, or healthcare provider change [11, 12, 90, 91]. This could contribute to smooth information exchange in a mixed public-private healthcare setting in Malaysia. Interestingly, despite a few references to the convenience of communication with healthcare providers via the online platform of the PHR system [9, 37, 85, 87, 92], none of the informants in this study mentioned this aspect. This may indicate that they either prefer face-to-face communication with healthcare providers or do not regard digital communication through the PHR system as an important feature. The PHR system could serve as a valuable tool for providing documentation in professional settings, similar to the NHS application, which offers options for patients to request sick notes to certify whether they were fit to work [93]. This suggests that the PHR system may hold broader practical and organisational relevance beyond its primary functions, which could be an interesting topic for further research. While incentives could support initial uptake [4, 35], they are unlikely to sustain long-term engagement without internalised value [26]. Any incentivisation strategy must therefore align with meaningful health behaviour change and avoid compromising fiscal sustainability. Public-private partnerships could be leveraged to complement expertise, resources, and innovation to enhance the effectiveness and reach of the incentivisation strategies.

The sentiment for FC was consistent with reports showing that smartphone and internet usage in Malaysia had exceeded 90% in both rural and urban areas [94, 95]. However, equitable access must continue to expand and be enhanced, preferably through a phased approach. Public areas such as community centers, healthcare facilities, and government buildings should be prioritized to bridge gaps. Fast and reliable internet access ideally should be provided for free and universally available, or more feasibly subsidised and targeted towards specific populations. To alleviate this financial burden, the Ministry of Health should not only collaborate with other related governmental ministries or agencies, but also with community leaders, politicians, local authorities, and partnerships with private entities, especially telecommunication companies. An economic evaluation is needed to determine the cost-benefit, as improved accessibility will not only enhance patients' connection to health systems but also generate social and financial advantage [96] and ultimately improve health outcomes. The telecommunications market should also be regulated to promote competitiveness. Some respondents were unsure whether they had sufficient knowledge and disagreed about having someone to explain how to use the PHR system, highlighting the subjective nature of perceived self-efficacy and system unfamiliarity to many people, as mentioned by the informants. Therefore, the PHR system should remain as simple and as least complex as possible to accommodate users across all digital and health literacy levels, as well as to reduce the need for assistance. Assisting requires workforce and time, increasing the burden on already overstretched staff, as hiring additional workers requires funding. Irregardless, adequate support should always be offered when needed. To minimize workload, assistance should be delivered through tutorials and educational materials via videos, pamphlets, or online links, as well as self-guided resources like FAQs and helpdesks. These resources should be easily accessible and comprehensible for users with varying digital and health literacy levels. Where necessary, personalized support can be offered through single or multiple sessions and extended to family members or caretakers, allowing them to collectively benefit, fostering a supportive learning environment, and increasing interaction within the family [12, 96].

Awareness can arise from various sources with different degrees of influential power, due to the complex and multifaceted nature of decision-making shaped by individuals' perspectives and societal roles [97]. Although some individuals are self-governed by autonomy [97], many are strongly influenced by healthcare providers and close social connections due to the effectiveness of interpersonal relationships [2]. Additionally, social media figures can be more appealing to the mass public, as social media has become a primary source of information for many people today [98]. A multifaceted and sustained promotion should integrate human engagement, involvement of community members and leaders, and use both traditional and digital marketing channels to highlight the system's benefits, ease of use, security features, and legal protections. These efforts should be intensified following system improvement. Opportunistic promotion during clinical visits is crucial, as individuals are more likely to appreciate the system's benefits in such settings. Healthcare

providers should be briefed to communicate this information effectively and positively to patients [99] and encourage users to share their positive experiences within their social networks. Social media figures' ability should be harnessed to endorse the system to extensive user bases [98]. Other platforms should include broadcast media, print media, outdoor advertising, official government websites, and community-based events or outreach programs. Messaging must be clear, concise, and easily understandable without avoiding technical jargon or complex language.

The contrasting findings for EE suggest that when PE, SI, and FC are perceived positively, WTU the system remains high irrespective of its perceived ease or difficulty to use, and that EE may reflect broader considerations. In this regard, integration has the appeal of a one-stop centre, which enhances user engagement, reduces cognitive load of remembering details, minimizes redundant data entry, supports regular updates, mitigates stress and burnout associated with electronic health record documentation [2, 3, 12, 90, 100–103], thereby enhancing overall efficiency and accuracy [104, 105]. However, achieving direct integration between various systems is challenging [106]. Health Information Exchange (HIE) can offer a viable pathway for interoperability, though technical and standardisation challenges may persist. If integration is not possible, it is recommended that the responsibility for data entry be appropriately shared among patients, healthcare, and non-healthcare personnel, which can also ensure data accuracy and completeness within the system, as well as promote patient empowerment and engagement in their health management. System stability was considered a fundamental expectation, aligning with a study that found that a significant number of users would uninstall or discontinue using an application if it frequently lagged, crashed, or showed errors [107, 108]. Optimal system performance must be ensured by conducting thorough trial runs before official rollouts, timely resolution of reported issues, and verification that all required infrastructure is fully operational to prevent system overload during peak usage. Formal feedback mechanisms should be established, such as a dedicated email support service, a helpdesk, and a FAQs section. Informal channels, like social media, should also be monitored to identify emerging complaints or issues. A designated team should oversee feedback management as well as conduct regular monitoring and maintenance. Although cross-collaboration with other projects may optimise workforce utilisation, careful workload planning is necessary to avoid overburden and potential compromise of service quality. The user interface intuitiveness substantially impacts perceptions of usability and trust in PHR systems [2, 4, 11]. Accordingly, the system design should prioritise simplified sign-in and identity verification processes, minimize procedural steps, provide a clear layout to reduce navigation difficulties, and ensure cross-platform compatibility. User feedback should continuously be incorporated into system updates [87], and emerging technologies such as artificial intelligence should be leveraged to further enhance functionality while reducing administrative burden. Design considerations should also address challenges such as appointment scheduling issues and non-adjustable display features, such as brightness and small font size, that can make information virtually illegible and thus not valuable [12, 85]. Although disabilities were not explicitly mentioned, embedding inclusive design features with visual symbols and adaptive accessibility functions is necessary to cater to diverse users with varying literacy levels and physical abilities.

The lack of statistically significant direct effects of age, gender, and experience may be attributed to the skewed distribution of respondents' characteristics, with a higher proportion of younger individuals, females, and those without prior experience. Additionally, the lack of statistically significant indirect effects of age, gender, and experience may be influenced by the COVID-19 pandemic. During this period, people from all walks of life were compelled to rely heavily on digital technology and health applications, contributing to people more readily accepting and using this technology. Nevertheless, the qualitative study discovered contrasting insights. Older informants perceived benefits from the PHR system specifically due to their advancing age, which is somewhat unexpected, as previous studies have generally reported that younger respondents showed higher WTU a PHR system [12, 60, 99, 109–112]. The mixed perspectives on gender were not surprising, as it is complex and influenced by various philosophical and epistemological points of view, with subjectivity, objectivity, and bias issues [113]. The social norms and traditional gender roles in Malaysia usually dictate that women are the primary family's caregivers [114]. Women also tend to show greater interest in health-related matters, actively seek and receive more health-related information from others, make more efforts to purchase healthier options, as well as engage more frequently in healthier lifestyles compared to men [115, 116]. At the same time, men were perceived to have more time to use the PHR system, as women spent more hours caring for children and family members compared to men [117]. Despite growing attention on men's health, men's participation in reproductive health initiatives remains relatively low [118]. For experience, a sense of familiarity can improve confidence and trust, subsequently more comfortable in adopting new technologies and use it independently [12, 119, 120].

Informants claimed that race did not influence WTU, contrasting with US-based studies, which discovered that Whites had better WTU than other races due to longstanding racial disparity [99, 112, 121, 122]. Malaysia's predominant tax-funded public healthcare system with Universal Health Coverage [123, 124] may attenuate the racial disparities in healthcare access, in contrast to the US, where greater reliance on private healthcare can create access barriers for marginalised communities [125]. Although higher education often provides greater exposure to information technology through employment [111], there is no evidence that it guarantees WTU the system. Similarly, illiteracy does not preclude WTU, as it may stem from lack of schooling or learning difficulties rather than low cognitive ability [126]. Nevertheless, Malaysia's literacy rate exceeded 94–95 in 2021 [127], indicating that literacy-related constraints are unlikely to pose a major concern. Additionally, widespread early exposure to digital devices in the contemporary "age of screens" may contribute to broader digital literacy across generations [128]. Income has similarly been associated with differential access to technology, with higher-income individuals typically having better exposure, while financial constraints may reduce engagement with PHR systems where user fees apply [111]. However, in the Malaysian context, income may exert less influence, given the country's established Universal Health Coverage [124], and the expectation that the government-implemented PHR system would be free or subsidised. Moreover, health literacy has not been consistently associated with income levels [129, 130]. Meanwhile, the aspect of occupational role on WTU remains underexplored in studies on PHR system acceptance or adoption. As human factors have mixed insights, the promotional efforts should be tailored to the specific needs and preferences of different demographic groups [131]. System-oriented awareness should particularly target older adults, women, individuals with prior positive experiences using similar technologies, and those with lower education or income levels. Conversely, health-oriented awareness and emphasis on practical benefits of the system should target younger adults, men, individuals with prior negative experiences using similar technologies, and those with lower education or income levels. Across all groups, promotion should highlight the system's ease of use, intuitive design, availability of user support, positive user experiences, cost-free access, compatibility with existing features that are most relevant to them, for example, medication and chronic disease management for older adults, and maternal and child healthcare management for

women. Focus for men to take a more active role in personal health management and organize events or outreach programs in collaboration with local community organizations, charities, or non-profits to reach populations with lower education or income levels.

Digital health data are susceptible to illicit activities like insurance fraud and commercial exploitation. Multiple vendors had reportedly sold deidentified patient data to third parties, despite such datasets can be reidentified when combined with publicly available external data sources [132]. Disclosure of these data may result in stigma and discrimination, particularly for individuals with conditions such as HIV infection, Acquired Immunodeficiency Syndrome (AIDS), and mental illness. In Malaysia, two PHR-related systems were allegedly experiencing breaches with data offered for sale [133, 134]. Although remediation measures were undertaken and the allegations were denied [135, 136], public discourse revealed frequent concerns regarding security and privacy of these kinds of systems [137–141], which may partly explain the marked decline in usage once they were no longer mandatory [142]. While both paper-based and electronic records inherently carry risks of missing information and potential alterations, including those arising from human errors [143, 144], electronic systems provide mitigation mechanisms through audit trails, routine system upgrades, and database backups that require lesser storage and efforts [144, 145], albeit with potential temporary inaccessibility during technical disruptions such as power outages or system failures [146]. To ensure robust security and privacy protection, system vendors must implement comprehensive safeguards, including strong but seamless authentication mechanisms, encryption and decryption protocols, pseudonymisation, secure servers, access controls, audit trails, as well as regular system backups, maintenance, and updates [13, 14, 17]. Regular security audits and prompt investigation of suspicious activities are obligatory to assess the safeguards' effectiveness and ensure information integrity. Privacy protection should prioritise patient autonomy by enabling individuals to control what information is shared and with whom [13]. Although two-factor authentication involving both patients and healthcare providers may strengthen protection, it requires more time and effort from patients [4], and the usability implications should be evaluated through user feedback prior to implementation. Technical measures alone are insufficient without transparent communication. Public education should clearly articulate the safeguards in place, patients' legal rights, and best practices to address concerns, emphasising that only necessary personal information is collected and that the system's benefits outweigh potential risks [3, 4, 10].

In Malaysia, the absence of comprehensive digital health–specific legislation creates uncertainty regarding permissible practices [147]. The Personal Data Protection Act (PDPA) 2010, although relevant, does not comprehensively address electronic medical records and applies only to the private sector, excluding federal and state governments [148–152]. This limitation may weaken accountability mechanisms in cases of misuse or breach involving public institutions. Such gaps are concerning, given the rising incidence of cyber threats affecting government agencies [153, 154]. Although similar legal challenges exist globally, developed countries often mitigate their impact through more robust regulatory frameworks that better support digital health solutions [147, 155]. It is imperative to establish a robust digital health data governance framework, including a dedicated oversight body and clear legal instruments addressing data security, privacy protection, interoperability, standardisation, transparency, consent, and accountability. Effective enforcement mechanisms are necessary to ensure compliance and ethical data use. Policymakers should prioritise the development or revision of relevant legal instruments to provide clarity for both healthcare providers and patients, particularly in light of the rapid expansion of digital health services. Ministry of Health must strengthen collaboration with relevant ministries and agencies responsible for communication, digital platform, cybersecurity, and legal affairs [156–158]. In the event of cybersecurity threats or incidents, reliance solely on system vendors may be insufficient, and coordinated engagement should be made with appropriate government authorities for effective emergency response and digital forensic investigation [156].

Limitations

The age distribution across all groups in this study was not balanced, with more respondents in the younger age groups, notably in their 30s; the fewest were in their 50s. Additionally, there were more females, those with no experience, predominantly Malay, with some Chinese and Indian, as well as very few from top management positions. The sociodemographic imbalance may affect the generalisability and statistical power of the findings. Nevertheless, rigorous sampling and data analysis methods were used to maximise the validity and reliability. This study's findings may only apply to other regions where civil servants have a similar sociodemographic distribution. As this study focused on civil servants, the age limit was between 18 and 59 years old. Future studies should consider balancing and broadening the demographic representation by involving individuals younger than 18 and older than 59. Future studies should explore beyond these populations, such as other groups like aborigines and ethnicities in Sabah Sarawak, as well as top management, particularly those with grades 56 and above. A broader sociodemographic representation will ensure better generalisability to a wider population across diverse individual characteristics. Other than that, this study also focused solely on civil servants working in the ministry headquarters in Putrajaya. Future studies should consider broadening the study population beyond this location, possibly covering the entire country, to identify potential differences between regions and populations.

There might be some degree of information bias due to self-reported responses in the questionnaire, but this was mitigated by using standardised questionnaires and ensuring respondent confidentiality and anonymity. The use of a cross-sectional study design cannot establish causal relationships and only captures prevalence at a specific point in time. Admittedly, experimental and traditional cohort studies are challenging to conduct on topics related to perceptions and emotions, which are influenced by numerous factors that are not easily controlled, especially regarding current technology that is rapidly changing. In recent years, a promising alternative is eCohorts, which leverages the internet and technology use throughout all study stages. This novel study design offers flexibility, scalability, interactivity, and patient-centeredness, but with challenges in generalisability, privacy concerns, and data quality [159]. Moreover, despite the increasing implementation of PHR systems in Malaysia, they are not yet well established. Therefore, eCohorts were considered not feasible for this current study, especially since they still require substantial resources compared to cross-sectional studies. The quantitative analysis would benefit from using structural equation modelling (SEM) to describe the reliability and validity of the constructs, as well as to test for moderating effects. However, due to the resource-intensive nature of a mixed-methods approach, this analysis was not performed. Future studies should consider using SEM instead of linear regression.

The variance explained in this study was 29.8%, possibly attributed to adhering strictly to UTAUT core constructs for theoretical consistency and avoiding model overfitting. Nevertheless, additional values from the qualitative study helped compensate for this limitation, maintaining the validity and reliability of

the findings. This study also identified several topics that have not been well addressed in current literature, including the roles of employment, organisational benefits of PHR systems, strategic promotional wordings, social media figures' specific impact on PHR system promotion, and legal instruments influence on WTU the PHR systems. Future studies should consider exploring these topics extensively and extending or revising the UTAUT model to better suit the evolved technology landscape and the changing technology usage pattern in contemporary times. In this regard, previous studies have proposed additional constructs within the theory [20, 54], and these extensions warrant validation in other populations or countries.

Conclusion

This study demonstrated a generally high willingness among multi-ethnic Malaysian civil servants to use a PHR system. The integration of quantitative and qualitative findings provided deep insights into the factors shaping WTU, highlighting the roles of system usefulness, ease of use, social influences, system support, human factors, and perceived risks. These findings underscore the importance of designing user-centred PHR systems, strengthening institutional support and policy, as well as addressing system awareness, security, privacy, and credibility to facilitate sustained usage.

Declarations

Ethics approval and consent to participate

This study has been approved by the Universiti Putra Malaysia Ethical Committee for Research Involving Human Subjects (Reference Number: JKEUPM-2022-555) and followed the ethical principles outlined in the Declaration of Helsinki. Voluntary written informed consent was obtained from all participants. To ensure confidentiality, their identities were anonymised, and they were identified using reference numbers. Any personal identifying information collected was securely stored.

Consent for publication

Not applicable.

Availability of data and materials

The quantitative and qualitative raw data are available at https://doi.org/10.5281/zenodo.19996822 or alternatively at https://doi.org/10.34740/kaggle/dsv/19623005.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Conceptualisation: NAA, AM, AAR, RD

Data curation: NAA, AM, AAR

Formal analysis: NAA

Funding acquisition: NAA, AM

Investigation: NAA

Methodology: NAA, AM, AAR, RD

Resources: NAA

Validation: NAA, AM, AAR, RD

Writing – original draft: NAA

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