



Original

Use of Mobile Applications for Magnetic Resonance Imaging (MRI) Safety Screening: An Acceptability Study Utilizing Technology Acceptance Model (TAM)

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Abstract

Background: This study evaluates the acceptability for Magneto Safe mobile application as a digital solution in MRI safety screening procedures using TAM Model.

Methods: A cross-sectional survey included 257 medical doctors from two tertiary hospitals located on the east coast of Malaysia who had prior experience using the traditional paper form in MRI safety screening when requesting MRI procedures. The modified TAM questionnaire was used to evaluate users' acceptability of the mobile application. This study measured the Perceived Usefulness (PU), Perceived Ease of Use (PEOU), and Behavioural Intention to Use (IU) the Magneto Safe mobile application, and identify the factors associated to IU.

Results: Most respondents scored more than 80% in the 5-point Likert scale for 14 questions in PU, PEOU, and IU. After regression analysis, PU and PEOU both significantly associated with IU. The majority (86.4%) of respondents favour mobile applications over traditional paper-based pre-screening forms.

Conclusion: These findings conclude that the acceptability of Magneto Safe as an alternative to traditional paper form in the era of information technology in clinical settings.

Keywords: MRI safety, Technology Acceptance Model, mobile application, Perceived Usefulness, Perceived Ease of Use, Behavioural Intention to Use, acceptability



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INTRODUCTION

Magnetic Resonance Imaging (MRI) is essential in contemporary diagnostic medicine; yet it is a rigorous pre-procedural safety screening due to the powerful magnetic fields.^{1,2} Failure to adhere to safety protocols in the MRI setting can result in significant dangers, particularly related to the machine's powerful magnetic field. This intense magnetic force can draw ferromagnetic items, causing them to be pulled rapidly towards the magnet's core. Such accidents can be perilous, as these objects may traverse at high speed, potentially hurting patients and personnel or damaging the equipment. The risks are significant, and various safety events have been documented worldwide, including lethal consequences. There were occurrences in which a patient with a brain aneurysm clip succumbed during an MRI procedure, and a patient with a cardiac pacemaker experienced a fatal episode upon entering the MRI room.

A significant concern is that the MRI pre-screening process is usually performed either on the day of the appointment or on the day of the scan, especially for outpatient situations. If contraindications are discovered just during the scan, or if a patient's medical history is inaccessible or ambiguous, the MRI treatment must be aborted. Last-minute cancellations waste the scanning slots and create rescheduling of the cases. These challenges lead to workflow interruptions and extended MRI waiting periods, particularly in busy hospitals, where the waiting time for an MRI appointment may vary from six to twelve months, and the overall backlog in radiology departments is substantial.^{3,4} Conducting the pre-screening process early and obtaining clear answers on a patient's MRI eligibility would prevent cancellations due to unresolved safety issues. The proposed mobile application aims to resolve this issue by offering an early, automated screening tool capable of precisely assessing a patient's eligibility for MRI, hence enhancing scheduling efficiency and minimising procedure delays.

Currently, MRI safety screening is generally performed using a printed form that includes a checklist or a series of questions for the patient to complete. These enquiries often encompass personal details, established medical history, prior surgical procedures, and the existence of any metallic substances, including implants. The content and layout of pre-screening checklists may change among various healthcare organisations. Certain

institutions adopt standardized checklists developed from established online safety resources, such as those available on MRI-safety.com, to guide the development of their screening forms.⁵ Upon completion of the checklist, it is evaluated by a medical officer, physician, or MRI technologist to ascertain any possible contraindications. The patient will be asked about any prior surgeries and provided with a list of implants to indicate with a checkmark. The form does not highlight the details of the body implant, such as its types and contents, and whether it is MRI compatible, MRI conditional, or composed of ferromagnetic material. The form solely contains the checklist and lacks any conclusion and decision whether the MRI procedure can be done or not. The advancement of mobile application technologies in healthcare has generated increased interest in utilising digital tools to enhance clinical decision-making, minimise documentation errors, and elevate patient safety.

In response to these issues, the Magneto Safe mobile application was created as a digital substitute for paper-based MRI screening. Magneto Safe operates on the Android platform and is specifically designed as a pre-screening tool for MRI procedure. The application includes a checklist that must be finalised before referring a patient for an MRI scan. The Magneto Safe MRI mobile application for pre-screening process has incorporated a comprehensive database of implant names, types, and compositions, enabling the requesting physician to ascertain the specific type of implant in the patient prior to granting an MRI appointment. Consequently, it will prevent the annulment of proceedings without comprehensive information.

The target users include medical doctors, specifically those initiating MRI requests for diagnostic purposes. Upon submission of the checklist, the system generates a response indicating the patient's eligibility for MRI examination. Access to the program is secured via a login procedure requiring a username and password. Upon successful authentication, the users are navigated to the subsequent screen, where they must enter pertinent patient information. The application provides a uniform, intuitive platform for executing safety evaluations before MRI procedures.

This study aimed to assess the PU, PEOU, and IU of the Magneto Safe using TAM, to identify the factors

associated to IU and to discover the preference of respondents whether to use the Magneto Safe or paper forms.

The TAM model is among the most widely utilised frameworks in research concerning the determinants of information technology adoption. This paradigm, empirically validated for its robustness, has been utilised

and further developed in numerous prior studies.⁶⁻¹⁰ The TAM is proven being utilised to evaluate the acceptance of information systems and has demonstrated efficacy within the Malaysian environment.¹¹ The Technology Acceptance Model evaluates technology adoption by analysing users' perceptions of a system's usefulness and ease of use, as well as their intention to use it. **Figure 1** illustrates the framework of the TAM model.

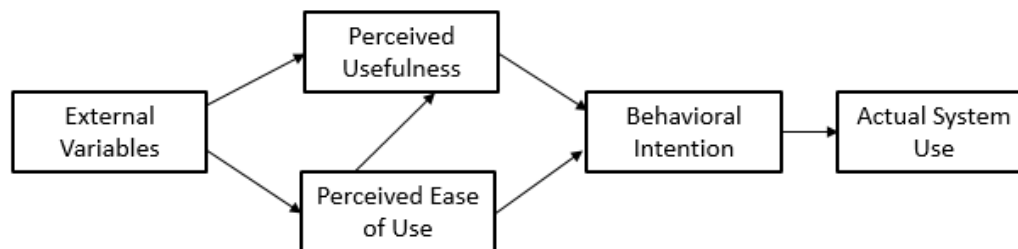


Figure 1. Framework of Technology Acceptance Model (Davis, 1989)¹²

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional quantitative study was performed at two tertiary government hospitals located on the east coast of Malaysia: Hospital Pakar Universiti Sains Malaysia (HPUSM) and Hospital Sultanah Nur Zahirah (HSNZ). Eligible participants were medical practitioners from various clinical specialties who were already acquainted with the traditional paper-based MRI pre-screening forms. Ethics approval was obtained from the ethics committee of Universiti Sultan Zainal Abidin (UniSZA), Hospital Universiti Sains Malaysia (HUSM), and the National Medical Research Register (NMRR) under the Ministry of Health Malaysia.

Study Tool and Data Collection

Participants were initially informed and introduced to the Magneto Safe as the alternative to a traditional printed form which they already had the experience using it in their hospitals. Only the medical doctors who had experience using the traditional paper form were included in this study.

The first part of the study was to assess the validity and reliability of the questionnaire, which was completed during the pilot study. The findings of the pilot study by our team researcher of the adapted TAM questionnaire exhibited robust internal consistency. These findings

have been published, and this study used the validated questionnaire from the pilot study.¹³

The TAM model was used to evaluate the study objectives. Participants were informed to use the Magneto Safe mobile application using simulated patient data and a mock medical history scenario. Upon finishing a simulated MRI safety screening session using Magneto Safe, participants were to complete an online questionnaire. The patient's information includes their name, age, weight, identification card number, registration number, date of request, examination part, indication, consultant-in-charge, kidney profile, medical illness, allergy, general condition, operation, external device, foreign body.

Variables and Analysis

The dependent variable is the acceptability, which is contributed by IU as shown in Table 1.

Table 1. Dependent variable and the type of variable.

Variable	Definition	Type of variable
Acceptability	It is the behavioural intention to use (IU) which will be assessed by using 3 questions.	Numerical

The independent variables include age, gender, educational level, clinical discipline, years of service, experience of using mobile applications, PU, and PEOU. The independent variable and the type of variable in this study as shown in Appendix.

A total of 14 questions was used in this study. The first objective is to assess the three domains in the questionnaire regarding PU, PEOU and IU which has 7 questions, 4 questions and 3 questions respectively. Descriptive statistics were calculated to summarize participant characteristics. Mean domain scores for PU, PEOU and IU were calculated.

The normality of the PU and PEOU scores was assessed using the Shapiro–Wilk test and visual inspection of histograms and Q–Q plots. The results indicated that [both PU and PEOU scores were approximately normally distributed / there were slight deviations from normality, but within the acceptable range]. Therefore, the assumptions for linear regression were considered to be met.

The second objective is to study how the variables that encompass age, gender, educational level, clinical discipline, years of service, experience in using mobile applications for medical and non-medical, PU, and PEOU are associated with IU. Simple and multiple linear regression analyses were utilised to identify the factors associated with the IU. Statistical analysis was performed using SPSS version 22, with significance set at $p < 0.05$. The third objective was to assess medical doctors' preference for using Magneto Safe versus paper forms. The data was analyzed based on the answers to the question of "Do you prefer to use Magneto Safe or paper form?" in the questionnaire.

RESULTS

The study included 257 medical doctors from two tertiary hospitals in east coast Malaysia. The majority were female (65%), with an average age of 30.6 years and about 5 years of clinical service. Most respondents held a bachelor's degree (80.5%) and were nearly equally distributed across medical and surgical disciplines. This sample represents a young, relatively early-career cohort of doctors who are generally more open to adopting digital tools, which may have influenced the high acceptability rates. This result of participant characteristics is as shown in Table 1.

Table 1 Socio-demographic Characteristics of Respondents

Variables		Freq (%)	Mean (SD)
Age (years)			30.60 (4.27) *
Gender	Male	90 (35.0)	
	Female	167 (65.0)	
Disciplines	Medical based	143 (55.6)	
	Surgical based	114 (44.4)	
Education level	Degree	207 (80.5)	
	Master	50 (19.5)	
Years of services			5.21 (4.24) *

For the first objective, the average scores for each TAM domain were PU: 29.96 (SD $\pm$ 4.91), PEOU: 17.47 (SD $\pm$ 2.82), and IU: 13.02 (SD $\pm$ 2.21). The mean scores, minimum and maximum values of PU, PEOU, and IU is shown in Table 2.

Table 2. Mean Scores of PU, PEOU, and IU of Magneto Safe mobile application among respondents (n = 257)

Variables	Mean (SD)	Minimum	Maximum
PU	29.96 (4.91)	7.00	35.00
PEOU	17.47 (2.82)	4.00	20.00
IU	13.02 (2.21)	3.00	15.00

The outcomes reflect a favorable reception and readiness among physicians to utilize the Magneto Safe mobile application. The consistently high values for PU, PEOU and IU suggest that the application is both practical and easy to operate, thereby strengthening the likelihood of its adoption in clinical practice.

Regression Analysis: Factors associated with IU Assessment of Multicollinearity and Interaction Effects

The model was checked for multicollinearity using the Variance Inflation Factor (VIF). A VIF value exceeding 10 was considered indicative of multicollinearity issues [14]. Furthermore, plausible interaction terms were tested to determine whether the effect of one variable on acceptability was modified by the presence of another.

The multicollinearity checking is as shown in Table 3 in Appendix.

For objective 2, the analysis result of simple regression, PU and PEOU both significantly associated with IU, and for multiple regression both remained significant predictors. On the other hand, other factors such as age, discipline, educational level, duration of clinical service, and experience with mobile apps for non-medical or medical purposes showed no significant association with IU. This finding shows that personal and professional background factors were less influential compared to

perceptions about the application's acceptability and benefits.

For Model fit, adjusted R^2 equal to 0.773 shows that PU and PEOU together explained 77.3% of the variance in IU. This shows very strong explanatory power of TAM in this context. PU emerged as the dominant predictor, meaning doctors are more likely to adopt Magneto Safe if it is perceived as clinically useful, rather than just easy to use. The result of associated factors on IU as shown in Table 4.

Table 4 Associated factors on behavioural intention to use (IU) of the Magneto Safe mobile application among respondents (n =257)

Variables	SLR ^a		MLR ^b		
	Crude β (95% CI)	P Value*	Adj. β^d (95% CI)	t statistic	P Value*
PU	0.38 (0.34, 0.41)	<0.001	0.46 (0.37, 0.56)	9.50	<0.001
PEOU	0.68 (0.63, 0.73)	<0.001	0.14 (0.09, 0.20)	5.14	<0.001

^aSimple linear regression; ^bMultiple linear regression.

^cCrude regression coefficient; ^dRegression coefficient, $R^2=77.3\%$

For objective 3, study results revealed significant levels of acceptability among respondents. A majority (86.4%) expressed a preference for the Magneto Safe compared to paper-based forms. This finding indicates a high preference towards the utilisation of digital tools and willingness to use Magneto Safe in their clinical routine

DISCUSSION

The results revealed that most respondents exhibited positive attitudes toward all three constructs, indicating a substantial potential for the application to be embraced within clinical settings, particularly for improving the MRI consent process. These findings are in line with the research of Holzinger et al., and Ventola whom observed that mobile health applications improve healthcare delivery by increasing efficiency and supporting clinical decision-making.^{15,16}

While limited studies specifically focus on mobile applications for MRI consent, Bates et al. and Thomair et al. highlighted that mobile technologies ease hospital operations and patient management supporting that

Magneto Safe could play a crucial role in improving MRI procedures.^{17,18} Pande et al. conducted a study on mobile applications of different aspects, where they found that 95.8% of clinicians were comfortable with and accepted using a mobile application for managing tuberculosis care [19]. This finding resonates with our study, where most respondents showed readiness to adopt Magneto Safe.

According to Davis, the PEOU of a technology strongly influences its acceptance, particularly when users face limited time to adapt to new systems¹². Additionally, Bates et al. and Thomair et al. also emphasized the importance of ease of use in mobile health applications, noting that healthcare professionals are more likely to adopt tools that do not complicate their already demanding workflows.^{18,20}

Positive IU aligns with the TAM which posits that PU and PEOU significantly influence an individual's behavioural intention to use a technology.²¹⁻²³ The positive perception of Magneto Safe's usefulness and ease of use in our study led to a strong intention to adopt the application. This finding is consistent with findings

from Pande et al. who found that clinicians in India were very likely to use a mobile health application for tuberculosis management.¹⁹

The findings also align with prior research investigating mobile health devices. Previous research has also highlighted the positive effects of mobile health applications on healthcare efficiency and clinical decision-making.^{15, 16} Similarly, other studies have demonstrated that mobile technologies improved hospital workflows and better patient outcomes,^{18,20,24} which is consistent with the potential of Magneto Safe to optimise the MRI consent procedure in this study.

In conclusion, the study confirms that positive PU and PEOU are key factors in the intention to adopt Magneto Safe. These findings highlight the importance of designing mobile health applications that are intuitive, useful, and user-centered to promote successful adoption among healthcare professionals [25].

This study also revealed significant levels of acceptability among participants. A substantial majority (86.4%) expressed a preference for the Magneto Safe app compared to paper-based forms. This finding indicates a high preference towards the utilisation of digital tools to improve healthcare delivery, consistent with prior research that shows healthcare professionals are progressively integrating mobile applications in clinical environments, particularly when these tools are believed to enhance workflow efficiency and strengthen clinical decision-making, while also facilitating adherence to clinical procedures.^{26, 27} The strong preference for Magneto Safe may be attributed to its ease of use, compatibility with existing clinical practices, and the potential to enhance the MRI pre-screening and consent procedure.

The Magneto Safe program was perceived as more efficient than paper forms, providing healthcare workers with a faster and more precise method for managing MRI preparatory procedures. Prior studies on mobile health applications for tuberculosis management indicated that healthcare professionals predominantly endorsed the use of such applications, with 95.8% of participants reporting comfort and readiness to adopt the technology.²⁵

This study reinforces previous research demonstrating that utility and usability are fundamental determinants of

digital technology adoption, particularly in healthcare. Magneto Safe's capacity to streamline the MRI pre-screening procedure and diminish paper-related inefficiencies undoubtedly influenced its favourable reception. These findings correspond with recent research that endorses the significance of PU and PEOU in the adoption of technology within healthcare.¹⁹

Previous studies corroborate this finding by indicating that mobile health technologies can optimise healthcare workflows, enhance communication, and alleviate administrative burdens, thereby reinforcing the trend and underscoring a positive shift towards the integration of digital technology in healthcare practices.^{16,28}

Strength

This study specifically focused on MRI mobile applications, which have not been reported in any literature or report, and contributes to the increasing evidence that mobile technology can enhance clinical workflows and patient safety. This conclusion closely aligns with our study objective, which revealed that healthcare workers demonstrated significant acceptance of a mobile application, hence validating the notion that Magneto Safe mobile application can be effectively integrated into a hospital environment as reported in previous studies.¹⁹ These findings indicate robust user confidence in the Magneto Safe usability and ease of use, consistent with previous research on the uptake of digital tools in clinical settings.²⁵

The Magneto Safe mobile application presents an innovative solution to improve safety in medical imaging environments, addressing this deficiency. Unlike other mobile applications that mainly provide instructional or ancillary functions, Magneto Safe is specifically engineered to digitise and standardise the MRI safety screening procedure, replacing conventional paper-based forms. The application's user-friendly interface enables rapid data entry and provides immediate feedback on MRI safety, enhancing clinical management. Integrating established MRI safety standards into the Magneto Safe mobile application converts it from a passive resource into an active decision-support system.

Barrier and challenges

It is also important to identify barriers to mobile health technology acceptability. Many healthcare professionals

acknowledged the benefits of mobile health applications. Still, some were hesitant to adopt them due to concerns about the reliability of the technology and the comfort stage of existing paper-based systems.²⁹ This situation aligns with this study's finding that 13.6% of respondents preferred paper forms, suggesting that while there is a clear preference for digital solutions, resistance may still exist among some healthcare professionals, which may be due to a lack of familiarity or concerns about the technology's reliability. In addition, another study highlighted significant concerns regarding issues related to patient privacy and confidentiality [30]. There is also a need for regulatory frameworks to protect healthcare professionals from legal liabilities associated with the use of smartphones in medical settings.

Limitations

Even though this study offers meaningful insights into the acceptability of the Magneto Safe application within a radiology context, some limitations are unavoidable. When designing such mobile applications or IT technology for medical use, it is also essential to consider user capabilities and concerns to suit the specific needs of healthcare professionals [31]. A recent study in the investigation of digital technologies found that factors like digital literacy and basic computer skills had a substantial impact on users' willingness to adopt information technology (IT) applications [32, 33]. However, it was found that the associated factors, such as technology savviness and previous experience in using the mobile application, were not statistically significant in our study, meaning that the digital literacy and technology savviness factors were not significantly associated with the acceptability of Magneto Safe.

Furthermore, the research was confined to two public tertiary hospitals in Malaysia's east coast region, which may limit the broader applicability of the findings to other healthcare environments, such as private facilities or institutions with different levels of digital readiness. The use of a cross-sectional design also restricts the ability to draw causal inferences between key constructs, and reliance on self-administered questionnaires introduces potential bias, particularly the possibility of respondents providing answers that reflect socially desirable views rather than their true perceptions.

Implications of the study

Magneto Safe represents a pioneering advancement in the use of mobile technology within radiology. It moves beyond existing educational or viewing tools by providing a practical, protocol-driven application for pre-MRI screening. Its implementation can improve patient safety, operational workflows, and hospital decision-making processes. As healthcare increasingly prioritizes digital innovation, Magneto Safe stands as a model for how mobile applications can be meaningfully embedded into everyday clinical practice and policy frameworks. Future investigations are recommended to adopt longitudinal study designs, investigate its long-term usability, integration and compatibility with existing digital infrastructures such as hospital information systems (HIS) or electronic medical records (EMR), cost-effectiveness and evaluate clinical performance indicators to provide more substantial evidence for the sustained implementation of Magneto Safe in healthcare settings.

CONCLUSIONS

This study concludes that the Magneto Safe mobile application is highly acceptable among medical doctors. The acceptability of the Magneto Safe mobile application is significantly associated with PU and PEOU, with PU being the more dominant factor. These insights emphasize the importance of aligning technological innovations with clinical needs to ensure successful implementation. Overall, this study indicated that Magneto Safe has the potential to enhance healthcare workflows, particularly in improving the MRI consent process and could play a crucial role in increasing clinical efficiency and ensuring patient safety. These results suggest Magneto Safe is well-suited for broader implementation, offering a viable digital alternative to paper-based pre-screening method.

Conflicting Interest: The authors declare that there are no conflicts of interest related to this study.

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The authors employed ChatGPT, an AI language model created by OpenAI, to assist in the preparation of this manuscript. The support encompassed enhancing language, organising content, and conforming the article to journal formatting standards. All AI-generated content underwent meticulous examination, revision, and approval by the authors, who assume complete responsibility for the accuracy and integrity of the final manuscript

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