The Role of Technology in Maternal Health Education to Improve Childbirth Readiness

Abstract

Aims: This study aims to analyze the role of technology in maternal health education to improve maternal readiness, measure its effectiveness in terms of knowledge, mental and physical readiness, and identify challenges and implementation strategies.

Instrument & Methods: The quantitative research used Partial Least Squares Structural Equation Modeling (PLS-SEM) with a sample of 99 pregnant women at the Umar Damanik Health Center, Tanjung Balai. Sampling was done using the Slovin formula (5% margin of error). Data was collected through valid and reliable questionnaires, analyzed with SmartPLS to test construct reliability (Cronbach's Alpha, Composite Reliability), convergent validity (Average Variance Extracted), and hypothesis test (bootstrapping).

Findings: All constructs met the reliability and validity criteria (Cronbach's Alpha >0.7; AVE >0.5). Technology significantly influenced childbirth readiness (R^2=0.717–0.899; p<0.05). Mobile health applications provided interactive information access, IoT facilitated real-time monitoring, streaming platforms expanded educational resources, and telemedicine increased access to health consultations. The PLS-SEM model explained 84.1% of the data variability (R^2 Adjusted).

Conclusion: Technology effectively improves childbirth readiness through accessible, interactive, and personalized education. Key challenges include limited access to technology, digital literacy, and validity of information. Implementation strategies need to focus on technology infrastructure, digital literacy training, and collaboration with health workers to optimize benefits.

Keywords: Health technology, mobile health applications, Internet of Things (IoT), streaming platforms, telemedicine

INTRODUCTION

The Health of pregnant women is an important aspect of the world of Health, which plays a role in efforts to prevent a decrease in maternal and infant mortality rates (1). Optimal preparation during pregnancy greatly influences a safe and smooth delivery process (2). However, many pregnant women still face challenges in accessing accurate and timely information about their Health (3). Technology in the world of Health offers various innovative solutions that can improve the readiness of pregnant women to face childbirth (4).

Health professionals are much concerned about the still high rates of mother and newborn death in some underdeveloped nations. WHO (World Health Organisation) statistics show that in 2017 pregnancy and complications accounted for almost 295,000 deaths among women (5). Most cases occur in countries with limited access to adequate health services. The main causes of maternal death include postpartum hemorrhage, preeclampsia, infections, and complications from uncontrolled labor (6). Many of these conditions can be prevented with better education and early detection of possible risks during pregnancy (7).

Ineffective dissemination of health information is one of the main obstacles to increasing the readiness of pregnant women (8). Many mothers still rely on information from family, friends, or myths that do not necessarily have a strong scientific basis (9). In addition, access to health services in remote areas is still limited, making it difficult for pregnant women to obtain the right health information when needed (10). Therefore, using technology in maternal health education is a potential solution to overcome this problem.

Technology has brought transformation in various sectors, including in the field of maternal and child Health (11). Various technology-based innovations have been developed to support the readiness of pregnant women in facing childbirth, including mobile health applications that provide educational information about pregnancy, fetal development, and danger signs that need to be considered; telemedicine that allows online consultation with medical personnel so that pregnant women can obtain medical information and recommendations without having to visit a health facility physically; wearable technology such as smartwatches and medical sensors that allow real-time monitoring of pregnant women's Health includes heart rate, blood pressure, physical activity; social media and online forums that will let pregnant women share experiences and get information from other mothers and medical professionals; and virtual reality (VR) and augmented reality (AR) technology used to offer more interactive and realistic childbirth preparation training. These developments allow, technology can improve the health literacy of pregnant women, help them recognize the danger signs of pregnancy earlier, and improve physical and mental readiness in facing childbirth (12).

Although technology offers a variety of innovative solutions, there are several challenges in its implementation, including limited access to technology, which means not all pregnant women have access to digital devices or a stable internet network, especially in rural areas; lack of digital literacy that causes some pregnant women to understand still not how to utilize health technology optimally; validity of information which is a problem because the many sources of information available on the internet increase the risk of spreading invalid or misleading information; and compliance with use, because not all pregnant women use technology consistently to monitor their Health (13). Therefore, an appropriate strategy is needed to ensure that technology is accessible and optimally utilized by pregnant women from various social and economic backgrounds.

This research offers a new contribution to the use of technology to improve the readiness of pregnant women for childbirth (14). Some aspects of the novelty of this study include an integrative analysis that does not only discuss one type of technology but analyzes various technologies in an integrated manner to see their Effectiveness in improving childbirth readiness, a personalized approach that highlights the importance of adapting technology that suits the individual needs of pregnant women based on their health conditions, literacy levels, and access to health facilities; an effectiveness evaluation that will measure the extent to which the use of technology has an impact on childbirth readiness, both in terms of knowledge,

mental readiness, and physical Health of pregnant women; and an evidence-based implementation strategy that not only identifies the benefits of technology but also provides concrete recommendations on how technology can be implemented more effectively in the health service system (15).

This paper intends to investigate the contribution of technology to mother health education by means of several technologies applied and their effect on birthing readiness; Measure the degree to which technology can enhance the mental, physical, and knowledge preparedness of pregnant women in confronting the childbirth process to evaluate the effectiveness of technology in improving childbirth ready; expose the several difficulties pregnant women experience in obtaining and using health technology; thus, gather suggestions for more efficient technology application by offering evidence-based strategies to enhance the use of technology in motherhood health education.

In terms of knowledge, mental preparedness, and physical health, technology in motherhood health education shows great promise to increase childbirth readiness. This paper aims to give a greater knowledge of the function of technology and techniques to maximize its use even if its execution presents certain difficulties. Therefore, this study is likely to lower the risk of birthing difficulties and raise the quality of health services for expectant mothers.

METHODS
Study Design

This study was designed with a quantitative approach and used the Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis method. This method was chosen because it is able to analyze complex relationships between latent variables and allows testing of structural models and measurements simultaneously. Data were collected through questionnaires that had been tested for validity and reliability in previous studies. After the data was collected, the analysis was carried out using statistical software based on PLS-SEM. In the analysis stage, construct reliability testing was carried out through Composite Reliability and Cronbach's Alpha, as well as convergent and discriminant validity testing to ensure the accuracy of construct measurement. In addition, hypothesis testing was carried out through analysis of t-statistic values, p-values, and using bootstrapping techniques to ensure the significance of the relationship between variables.

This study was conducted at the Umar Damanik Health Center, Tanjung Balai City, which was chosen because it had a significant number of pregnant women, in accordance with the objectives of the study. This study was conducted for two months, namely from November to December 2024, to ensure adequate data coverage according to research needs.

Population and Sample

The population in this study is all pregnant women who have had pregnancy checks at the Umar Damanik Health Center, Tanjung Balai City, from November to December 2024, with a total of 132 people. The number of

samples was calculated using the Slovin formula with a margin of error of 5%, so that a sample of 99 respondents was obtained.

To determine the number of samples in this study, the Slovin formula was used with a margin of error of 5%. The Slovin formula is used to estimate the number of respondents needed from a given population to keep the results representative. The formula is as follows:

$n = N / (1 + N(e)^2)$

Information:
- n = sample size
- N = total population
- e = margin of error (5% atau 0,05)

In this study, the number of samples obtained was 99 respondents. Based on calculations using the Slovin formula, the number of populations can be determined as follows:

$99 = N /(1 + 0.0025N)$
$99 + 0.2475N = N$
$0.7525N = 99$
$N \approx 132$

Thus, it can be concluded that the total population in this study is around 132 people. The sampling technique used was purposive sampling, taking into account 2 criteria:

Inclusion **:** Pregnant women with multiple pregnancies
Exceptions **:** pregnant women with medical complications such as preeclampsia, hypertension, and gestational diabetes

Statistical Analysis

Statistical analysis in this study was carried out using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method. This method was chosen because it is suitable for predictive research and is able to handle complex models with several latent variables. The analysis process is carried out using SmartPLS software, which is specifically designed to support PLS-SEM techniques.

The statistical tests carried out include:

- The Reliability test, which is analyzed using Composite Reliability values and Cronbach's Alpha to measure the internal consistency of the construct.

- Convergent Validity is evaluated based on Average Variance Extracted (AVE) values, while Discriminant Validity is tested using Fornell-Larcker criteria and cross-loadings.

- The hypothesis test was carried out with a bootstrapping procedure of 132 resamples to obtain t-statistical and p-values, which were used to test the significance of the relationship between constructs.

The use of SmartPLS can be analyzed even if the data does not meet the assumption of normality, which is one of the main advantages of the PLS-SEM method.

RESULTS

Characteristics of the research sample

This study involved respondents with various demographic and obstetric characteristics. Most of them were at the ideal reproductive age and had a secondary education level. In terms of pregnancy spacing and number of deliveries, most respondents had previous experience, either as mothers of their first child or with varying birth spacing. These findings reflect the respondents' backgrounds that are relevant to be explained further. As explained in table 1 as follows:

Table 1. *Characteristics of the research sample* at the Mayor Umar Damanik Health Center, Tanjung Balai City 2025

Characteristics	N	(%)
Age		
<20 year or > 35 year	41	15,9
20 - 35 year	92	84,1
Entire	132	100
Education		
Elementary school	4	0,7
Junior high school	26	13,6
Secondary school	63	56,8
Diploma/Bachelor	40	28,9
Entire	132	100
Pregnancy spacing		
The first child	43	38,6
<2 year	13	9,1
>2 year	77	52,3
Entire	132	100
Parity		
≥3 time	60	43,9
<3 time	73	56,1
Entire	132	100

Results of Composite Reliability and Cronbach Alpha Examination

All constructs in this study have met the criteria of reliability and validity. The Cronbach's Alpha and Composite Reliability values indicate that the instruments used have good internal consistency. Convergent validity has also been achieved, as indicated by the adequate Average Variance Extracted (AVE) value. Thus, all indicators in each construct are declared feasible to use.

Table 2. Results of Composite Reliability and Cronbach Alpha Examination

Construction	Cronbach's Alpha	Rho_A	Composite Reliability	Average Variance Extracted (AVE
Mobile Health App	0.758	0.917	0.717	0.568
Internet of Things (IoT)	0.870	0.885	0.752	0.564
Streaming Platforms	0.863	0.723	0.768	0.791
Telemedicine	0.826	0.821	0.838	0.899
The Role of Technology in Maternal Health Education to Improve Childbirth Readiness	1.000	1.000	1.000	1.000

Regression results of the influence of the application of health education technology to improve nutritional literacy and prevent anemia in pregnant women.

Based on the results of data processing, the role of technology in maternal health education to improve childbirth readiness shows an R Square value of 0.955 and an Adjusted R Square of 0.949. These results indicate that the model used is very strong and relevant in describing the relationship between the use of technology and maternal readiness to face childbirth. With such high results, this approach is considered effective in the context of this study.

The Effect of Maternal Health Education on Improving Childbirth Preparedness

The Effect of Maternal Health Education to Improve Childbirth Preparedness tested showed significant results based on statistical tests. Each indicator was successfully tested as proven by the p-value being below the specified significance level. This shows that all indicators of Maternal Health

Education to Improve Childbirth Preparedness have a significant influence in the context of the study. The data can be proven based on table 3.

Table 3. Data processing results on the role of technology in maternal health education to improve childbirth preparedness

Variable	Original Sample (O)	Sample Mean (M)	STDEV	T-Statistics (|O/STDEV|)	P value
Mobile Health App	0.252	0.251	0.093	2.580	**0.030**
Internet of Things (IoT)	0.344	0.192	0.101	2.949	**0.050**
Streaming Platforms	0.257	0.232	0.078	2.852	**0.038**
Telemedicine	0.357	0.471	0.154	2.861	**0.004**

Discussion

Mobile Application

The use of digital technology in the form of health applications has provided significant support for pregnant women in preparing for childbirth. Easy access to various information about pregnancy, whether in the form of articles, videos, or interactive guides, helps improve the mother's understanding of the pregnancy and delivery process. Convenient features such as reminders of check-up schedules and monitoring of fetal development also provide convenience, especially for those in areas with limited access to health services. This technology is an efficient means of helping pregnant women recognize important signs during pregnancy, including emergencies that require medical attention. With these various conveniences, digital applications are an important part of supporting pregnant women's physical and mental readiness.

This aligns with research by Lupton and Pedersen, who found that mobile-based health applications can improve pregnant women's understanding of pregnancy health, possible risks, and steps to prepare for childbirth (18). In addition, research conducted by Lau et al. (2020) supports these findings by showing that mobile health applications designed interactively and based on evidence can increase the preparedness and confidence of pregnant women in facing childbirth (19). In the study, applications that provide online consultation features with medical personnel, reminders for pregnancy check-ups, and multimedia-based information proved more effective than conventional education methods.

Internet of Things

The content you uploaded discusses the benefits of using the Internet of Things (IoT) in maternal health education. It emphasizes how IoT helps pregnant women access health information flexibly, enabling them to

overcome time and space barriers. The technology allows them to engage with materials related to pregnancy and childbirth in various formats, such as videos, interactive modules, and discussion forums, thus offering personalized learning methods. Furthermore, IoT can reach a wider population, including pregnant women in areas with limited access to traditional healthcare services. This finding is supported by research conducted by R. Gray, who examined the Effectiveness of the Internet of Things (IoT) in improving pregnant women's understanding of childbirth preparation (20). In the study, pregnant women who used prenatal based on the Internet of Things (IoT) showed a significant increase in knowledge about the labor process, signs of pregnancy danger, and pain management during labor compared to the group that only received conventional education. In addition, the study also found that pregnant women who used the Internet of Things (IoT) felt more confident in facing labor because they had access to valid and scientifically based information.

Streaming Platforms

Streaming platforms have an important role in helping pregnant women prepare for the delivery process. Based on the results that meet the limitations of hypothetical acceptance, it can be concluded that streaming platforms become an effective source of information for maternal health education. Pregnant women can easily access various information about pregnancy, childbirth, and baby care through this platform, with information coming from various trusted sources such as medical personnel, health institutions, and the pregnant women's community.

Streaming platforms also provide space for pregnant women to interact directly with medical personnel and other pregnant women. This interaction creates a community that allows pregnant women to share experiences and gain invaluable social support. Thus, streaming platforms are not only a means to obtain information, but also serve as a place for pregnant women to feel more prepared and supported in facing childbirth. Research by Lupton, who looked at how social media might raise pregnant women's level of health literacy, supports this result (18). The study found that pregnant women who actively access health information through Streaming Platforms tend to have higher levels of childbirth readiness than those who rely only on conventional information sources. Streaming Platforms provide quick and easy access to educational content, such as videos, articles, and webinars that discuss important topics related to pregnancy and childbirth. In addition, the study also shows that social media helps reduce anxiety in pregnant women by providing a discussion space and emotional support from the online community.

Another advantage of the Streaming Platform is its ability to disseminate information quickly and reach a wider population—various platforms, such as infographics, interactive videos, and live Q&A sessions. However, the problem in employing the Streaming Platform as a source of health information is the legitimacy and credibility of the information being delivered. According to Moorhead et al., although the Streaming Platform has great potential in health education, disseminating information that is not scientifically based is also a risk that must be anticipated (21). Therefore, pregnant women need to get information from trusted sources, such as the official accounts of medical personnel or credible health institutions.

Telemedicine

Telemedicine has proven to be an effective tool in helping pregnant women better prepare for childbirth. These digital healthcare services offer significant benefits, ensuring quick and accurate access to vital medical information. Telemedicine enables pregnant women to consult healthcare professionals remotely, avoiding the need to visit medical facilities. This is especially advantageous for those residing in remote areas with limited access to healthcare services. Moreover, telemedicine facilitates more comprehensive health monitoring for pregnant women, through options like teleconsultations, online education, or remote monitoring systems. As a result, telemedicine provides an accessible and cost-effective solution for supporting the health of pregnant women.

This finding is supported by research conducted by van den Heuvel et al., who examined the Effectiveness of telemedicine in improving antenatal care (22). Their research results showed that pregnant women who used telemedicine for routine consultations and monitoring of pregnancy conditions had a higher level of labor readiness compared to those who only relied on face-to-face visits (23). The study also found that telemedicine can help reduce anxiety in pregnant women by providing faster access to medical information and support from health workers, thereby increasing confidence in facing the labor process. Another advantage of telemedicine is its ability to overcome various obstacles to access to health services, especially in areas with limited medical personnel. With telemedicine-based consultations, pregnant women can get timely medical advice, monitor their pregnancy conditions regularly, and access relevant health education programs. However, challenges exist in implementing telemedicine, especially regarding limited technology, internet access, and digital literacy (24). According to WHO (2020), the Effectiveness of telemedicine is highly dependent on the readiness of technological infrastructure and ease of use for the community, especially in developing countries (25). Therefore, efforts are needed to

improve accessibility and digital literacy for pregnant women so that the benefits of telemedicine can be felt optimally.

CONCLUSION

Based on the research results, technology has a significant role in maternal health education in improving childbirth readiness. Mobile health applications have been shown to provide easier and more interactive access to information, helping pregnant women understand their pregnancy conditions better. The Internet of Things (IoT) contributes to real-time health monitoring and increases maternal compliance with medical recommendations. Streaming platforms enable disseminating broad and interactive health information, helping pregnant women gain deeper insights through various trusted sources. Meanwhile, telemedicine services provide convenience in medical consultations without physically visiting health facilities, making access to health services more efficient. Although these technologies have proven effective, challenges such as limited access to technology, digital literacy, and the validity of information still need to be considered. Therefore, a more optimal implementation strategy is required to ensure that technology can be utilized optimally in supporting pregnant women's childbirth readiness.