Health Workers Readiness for Implementation of a Mobile Pregnancy Monitoring System in Primary Health Care: A Cross-Sectional Study

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Abstract

The study aims to describe factors related to the readiness of health workers with respect to implementation of a mobile Pregnancy Monitoring System in Primary Health Care (PHC) sites of the South Tangerang District in Banten Province, Indonesia using a socio-technical approach. A cross-sectional survey design was used among respondents who were involved during the antenatal care process. The participants (n=210) completed the questionnaire that measured information needs regarding the socio-technical aspect of readiness and factors affecting the readiness. The data was analysed using logistic regression analysis. The findings of this study showed that the majority of the health workers who were involved in the antenatal care process were ready to implement the mobile pregnancy monitoring system. Having social media (p= .013) and willingness (p= .007) to be involved in IT implementation are associated with IT readiness, while there is no significant association between demographic factors to the readiness of the health workers. Since there is no connectivity between the demographic factors to readiness, thus the supportive factors such as having a social media and willingness are associated to the level of health workers readiness in implementing mobile pregnancy monitoring system.

Keywords: Pregnancy Monitoring System; Mobile health; Women health workers; Antenatal care; Readiness

Introduction

As Primary Health Care Information Systems move forward using electronic devices in developing countries, its implementation has found many challenges and barriers to readiness which may prevent successful adoption (Afrizal et al. 2019b; Handayani et al. 2018). According to recent studies, the

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assessment of the readiness of organisational members is considered essential as a approach to a successful implementation of new technology (Ajami et al. 2011; Ghazisaeidi et al. 2014; Stock and Groß 2016). The aspect of readiness assessment aims to evaluate the preparedness of each component, provides a proper image of the existing conditions and gives valuable input to the healthcare organisation to infer the factors (Melas et al. 2013). A recent study showed that the impact of the socio-technical aspect of readiness has increased innovative work behaviour among the workers (Stock and Groß 2016).

In line with the implementation of a health information system in Indonesia, the introduction of a Sustainable Development Goals (SDGs) era still suffers from unresolved problems in that the preventable morbidity and mortality among pregnant mothers still remains high where the maternal mortality ratio is 14 times higher compared to those in the developed regions (United Nations 2015). Monitoring by the health providers during the pregnancy period such as to provide accurate real-time data on how many pregnant women are enrolled in antenatal care (ANC), the characteristics of pregnant women, interventions, and the outcome approaches would improve the ANC information systems which may reduce the maternal mortality cases (Harries et al. 2014). The current studies from Indonesia show that the ANC documentation is often poorly recorded in some primary care facilities due to several factors such as a lack of a monitoring system and having to write entries in multiple record books (Afrizal et al. 2020).

Previous research has determined that documentation during the ANC services in the community should be well-documented by the CHW through collection, collation and use of the health data in routine activities by use of electronic health (e-Health) solutions to ensure adequate reporting and supervision (World Health Organization 2018). Electronic health procedures such as the Electronic Health Record (EHR) are designed to provide information about an the health status of an individual and the health care given by multiple health providers (Mykkänen et al. 2016). Based on previous research in Palestine, the implementation of electronic records using mobile phones or m-Health for maternal and child health has enhanced the effectiveness and access for the monitoring system through an interactive checklist and clinical decision support which resulted in improvement of the quality of care for pregnant women (Venkateswaran et al. 2018). The implementation of e-Health in Indonesia currently is still dominated by hospitals (Handayani et al. 2016).

Before introducing an innovation such as the mobile pregnancy monitoring system in Primary Health Care, there is a need to evaluate the readiness of health workers to implement such a system (Holt et al. 2010). A previous review paper concluded that there are two enabling factors of readiness: individual readiness and organisational readiness. Both are influenced by psychological and structural aspects (Afrizal et al. 2019b). Individuals and organisations can be classified in terms of social readiness. Other research using the socio-technical methods has been discussed and used in the adoption of new technologies although there is little evidence that socio-technical methods as such have become a part of the language related to the readiness for change (Land 2000). A holistic approach, taking likewise individuals, technology and organisations into account is necessary (Noehring et al. 2019).

Earlier research investigated mHealth readiness which more discussed to the user perceptions in view of motivation and technological aspect (Handayani et al. 2021). Little information is available concerning evaluation of the socio-technical aspect of readiness and factors affecting readiness with respect to m-Health implementation amongst the health workers. Thus, the objective of this research is to assess the socio-technical readiness and factors influencing readiness before implementing an electronic monitoring system for ANC services among health workers in Primary Health Care. Consequently, there are two research questions in the preparation for IT implementation:

1. What factors influence the readiness to implement a mobile pregnancy monitoring system?
2. What are the recommendations in implementing a mobile pregnancy monitoring system?

The structure of this paper is organised as follows. In Section 2, a theoretical background is presented as substance for the research variables that have subsequently been developed into the conceptual

framework (Section 3). The methodological approach is detailed in Section 4 while the results are presented subsequently (Section 5). Section 6 concludes with a discussion of the theoretical and practical implications of the findings.

Theoretical Background

Role of Health workers in the ANC process in PHC

WHO defines health workers to be all people engaged in actions whose primary goal is to improve health (World Health Organization 2006). In view of the professional health workforce (such as Medical Doctors, nurses, midwives) facing shortages, maldistribution and performance challenges for health progress including access to healthcare a recommendation has been made to provide qualified employment opportunities among the community. This is named a community health service, and it is necessary to strengthen primary health care and the health workforce by delivering preventive, promotive and curative health services (World Health Organization 2018). In Indonesia, the term for a community health worker (CHW) is *Kader* in the Indonesian Language. The role of the CHWs in the community service such as a site clinic is very important because they provide health information for the community as well as a regular monitoring process for mother and child including ANC service, nutritional status, immunisation, and birth planning (Indonesia Ministry of Health 2012).

As the first level of care for pregnant women, a PHC in Indonesia does not only provide in-house ANC services in the clinic but also community services such as a site clinic and home visits (Mahendradhata et al. 2017). To improve the ANC services, the Ministry of Health has released regulations for integrated ANC implementation which has 2 (two) main activities, namely pregnancy registration and pregnancy monitoring. For the in-house ANC service, both activities are documented in the Cohort ANC register while ANC in the community is still recorded separately using paper-based forms and the community midwives submit their report regularly at the end of the month (Afrizal et al. 2020). This practice enables communication and care-coordination between the different health-care providers involved in the care of women during pregnancy and childbirth (Kemenkes RI 2015; Pattinson 2007).

Socio-technical Context of Health Information System Readiness

A Health Information System is a collection of interrelated components that aim to work together to achieve common goals. A system can include software, mechanics, electricity, and electronic hardware (Sommerville, 2004). Individuals and organisations where they are situated are responsible for the entire system development process. Health information systems that are interrelated, can cause the system to become complex. This is the biggest challenge faced by an organisation that seeks to develop, utilise and control a new technology to improve the quality of the performance of the organisation.

Based on previous research, a model that integrates social aspects in technology development is also an important component in the development of information technology-based health information systems, namely (1) individual characteristics (people); (2) the nature or complexity of the work or task performed (task process); (3) workplace environment and organisational characteristics namely social, environmental and management (structure); and (4) User interface or technology used (technology) (Bogh et al. 2015). The socio-technical model in the implementation of technology was first introduced by Bostrom and Heinen (1977) as seen in Figure 1. Socio-Technical Analysis in the development of Information Systems placed by applying a user-centred approach which is more focused on the needs and satisfaction of the users of the system.

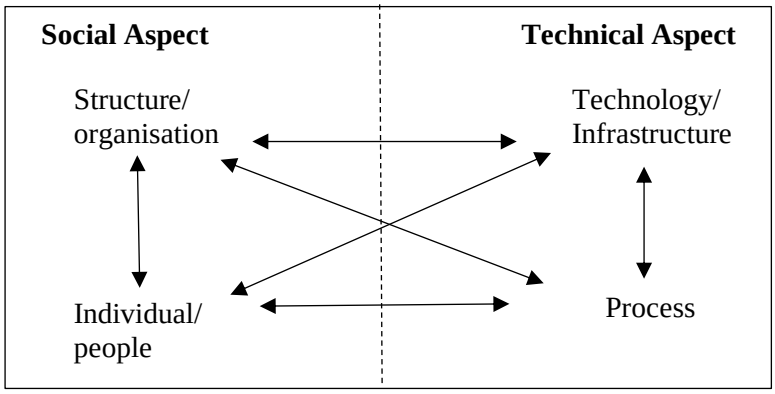

Figure 1. Socio-technical Model for Technology Adoption (Bostrom and Heinen 1977)

Methodology

A quantitative survey method was conducted from February to June 2019 in six Public Primary Health Care centres in South Tangerang to assess the readiness of health workers to accept the mobile pregnancy monitoring system among those who are involved in the antenatal care process. South Tangerang District was chosen as the research location because the district has already adopted the health information system especially for Primary Health Care for 5 years and currently the District Major encourages the implementation of mobile technology in all government sectors including health sector.

Participants

The population of midwife and community health workers in Public Primary Health Care was estimated to be 5500 in the South Tangerang District (Dinkes Kota Tangsel 2017). The sample size was estimated using a sample size calculator ("Sample Size Calculator" n.d.) with a confidence level of 95 %. The sample size should be 169 participants accordingly. Hence, it was possible to distribute 250 questionnaires which were a number higher than the proposed number of respondents. The convenience sampling method was adopted for the field survey where the items were written using the Indonesian language to obtain the perspectives of the respondents. Altogether, around 250 ANC providers (100 midwives and 150 CHWs) were approached. After removal of some incomplete feed-back forms, the final data was collected for 210 respondents.

Instrumentation

The research instrument consisted of two parts as follows:

a. Part I included questions about the demographic variables (age, profession, level of education, working experience, and computer skills and associate factors (Having a social media, Internet access, monthly Internet budget, experience in HIS, coordination of care, smartphone ownership, and willingness)).
b. Part II contained 20 items from instruments adopted from (Aydin and Tasci 2005) which assess readiness for Information and Technology implementation using a socio-technical approach. The options were coded as 1, 2, 3, 4, and 5, as in a five-point Likert-scale. Based on the research, the 3.4 mean scores could be identified as the middle point level of readiness, while other responses enabled organisations to show higher or lower levels of readiness. The 3.4 mean average was determined after identifying the critical level: 4 intervals/5 categories = 0.8. As a result of this analysis, the levels of readiness were determined as depicted in Figure 2.

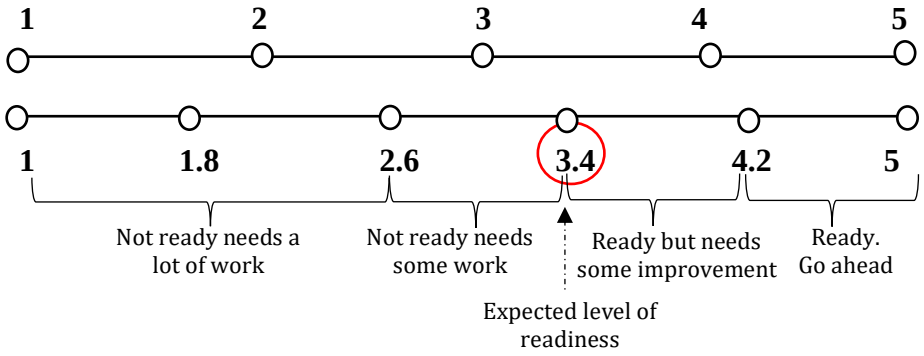

Figure 2. Level of Readiness Based on Mean Average of the Likert Score (Aydin and Tasci 2005)

The internal consistency reliability for the instrument was estimated using the Cronbach alpha coefficient. According to the Cronbach Alpha analysis, the reliability of the instrument was found overall to be 0.72 (>0.7). Data was analysed by logistic regression to test for associations between variables. Like all regression analyses, logistic regression is a predictive analysis where a model is tested to find out whether the value of one variable, or the combination of values of multiple variables, can predict the value of another variable (Frey 2018).

Results

A total of 210 health workers participated in this study. Of that number, 70 of the participants (33 %) were midwives and the other 67 % were community health workers. More than one-third (39.5 %) were at an age above 45 years old. With regard to the working experience, about 38.5 % of participants have been doing ANC monitoring for between 6 to 10 years, and 27.6 % were between 11 and 20 years. The participants were asked if they have skills related to computer applications where 58.5 % of them indicated that they have good computer skills. The majority (90 %) of the respondents indicated that they have a Social Media application on their mobile phone. Almost 82 % of the respondents claimed to have a monthly Internet budget. With regard to HIS experience, 57 % of the respondents claimed that their experience in HIS implementation was still inadequate. However, 98 % of the respondents had a smartphone using the Android Operating System and 67 % of the participants used the phone for care-coordination amongst the health workers and other health professions. Finally, more than 64 % of the respondents were willing to implement innovation such as the mobile pregnancy monitoring system (see Table 1).

As seen in Table 2, the socio-technical aspect of readiness was divided into four categories: innovation to organisation, people, technology infrastructure, and process improvement among the health workers was found ready to implement the innovation with a few improvements (Mean = 3.77). The result showed that the process improvement that supported the technical aspect has the highest mean score (Mean = 3.84, S.D. = 0.62). The result also implied that the technology infrastructure was very useful to improve the technical readiness as the mean for the category was (Mean = 3.77, S.D. = 0.62). The highest mean of the items answered by respondents for the technical aspect of readiness was item 10 which stated “Internet access is available at the PHC to support the implementation of a mobile Pregnancy Registration-Monitoring System” (Mean= 4.10, S.D. = 0.72).

Table 1 Distribution of Demography and Associate Factors amongst Health Workers (N=210)

Variable	CHW n (%)	Midwife n (%)
Age		
<=25	3 (23.1)	10 (76.9)
26 to 35	8 (18.6)	35 (81.4)
36 to 45	58 (81.7)	13 (18.3)
≥ 46	71 (85.5)	12 (14.5)
Education Level		
Primary & Secondary	121 (100.0)	0 (0.0)
Diploma	19 (26.8)	52 (73.2)
Degree & Post Grad	0 (0.0)	18 (100.0)
Computer Application Knowledge		
Good	59 (48.0)	64 (52.0)
Limited	81 (93.1)	6 (6.9)
Working Experience		
<= 5 years	28 (62.2)	17 (37.8)
6 to 10 years	55 (67.9)	26 (32.1)
11 to 20 years	43 (74.1)	15 (25.9)
≥ 21 years	14 (53.8)	12 (46.2)
Android ownership		
Yes	137 (66.2)	70 (33.8)
No	3 (100.0)	0 (0.0)
Experience in HIS implementation		
Yes	48 (53.9)	41 (46.1)
No	92 (76)	29 (24)
Internet Access		
Good	10 (18.9)	43 (81.1)
Limited	130 (82.8)	27 (17.2)
Social Media Apps in Handphone		
Yes	123 (64.7)	67 (35.3)
No	17 (85.0)	3 (15.0)
Monthly Internet Budget		
Yes	116 (67.4)	56 (32.6)
No	24 (63.2)	14 (36.8)
Use Handphone for care-coordination		
Yes	87 (61.3)	55(38.7)
No	53 (77.9)	15 (22.1)
Willingness to use e-Health for pregnancy monitoring system		
Yes	92 (67.6)	44 (32.4)
No	48 (64.9)	26 (35.1)

Table 2 Means and Standard Deviations of Four Aspects of Readiness among Health Workers in Primary Health Care (N = 210)

Aspect of Readiness	Category	Mean	Standard Deviation
Social Aspect	Innovation to organisation	3.72	0.39
	People	3.76	0.55
Technical Aspect	Infrastructure/Technology	3.77	0.62
	Process of Improvement	3.84	0.62
Mean		3.77	

The other aspect of readiness is the social aspect which was divided into two categories: innovation to organisation and people. The highest score for this aspect was for the people category (Mean=3.76, S.D.=0.55). The result showed that the highest mean score for the people category was for question #12 which stated: "Officers who can facilitate the technology implementation will help you to implement the mobile Pregnancy Monitoring System". For the innovation to organisation category (M=3.72, S.D.=0.39), the highest score was for question #9 (M=4.12, S.D.=0.75) which stated: "Reward can increase the adoption of an innovation in the organisation". The detailed score for each question is described in Table 3.

Based on these scores, it shows that the majority of the respondents had a low perception of innovation within the organisation with respect to IT implementation. Moreover, the majority of respondents felt the existing computer facilities were not adequate enough to be used since they do not have access to use a computer individually at work. Further, most respondents disagreed with punishment regulation to enhance IT implementation.

To evaluate the factors related to the readiness of health workers, a multivariate analysis using logistic regression was used (see Table 4). The current result shows that having a social media in HP and willingness for IT implementation are associated with readiness ($P \leqq .05$). It also shows that there is no significant association between demographic factors such as age, education level, working experience etc. on the readiness of health workers.

Table 3 List of Questions and Statistics for Items Related to Socio-Technical Aspects Of Readiness

Question	Mean	Std. Deviation
1. Most of the employees are experienced in using an m-Health system (People)	3.76	.893
2. The management of the PHC organisation has declared to use a health information system in daily tasks (innovation to organisation)	3.82	.749
3. IT officer assistance for m-Health system is available in the organisation (People)	3.74	.881
4. Previous experience in implementing a health information system in the organisation has improved the efficiency in monitoring system (innovation to organisation)	3.76	.891
5. Most of the health workers are willing to implement the mobile Pregnancy Monitoring System (People)	3.60	.819
6. Based on previous experience, health information system is able to improve the process of coordination of care between professions (Process of improvement)	3.55	.933
7. Monitoring from the organisation management is carried out during the adoption of an innovation (such as the mobile Pregnancy Monitoring System) (innovation to organisation)	3.93	.677
8. Legal issues such as punishment is able to reduce the barrier of the adoption of an innovation in the organisation (such as the mobile Pregnancy Monitoring System) (innovation to organisation)	2.96	1.057
9. A reward is able to increase the adoption of an innovation in the organisation (innovation to organisation)	4.12	.751
10. Internet access is available at the PHC to support the implementation of a mobile Pregnancy Monitoring System (Technology & Infrastructure)	4.10	.726
11. The PHC has achieved the organisational change target (such as total quality indicators) after an innovation implementation such as a Health Information System (innovation to organisation)	3.89	.665
12. Officers who can facilitate the technology implementation will help you to implement a mobile Pregnancy Monitoring System (People)	3.85	.887
13. You have access to use a computer individually at work (Technology & Infrastructure)	2.93	1.119
14. Based on previous experience, health information system is able to save the patient personal data securely (innovation to organisation)	3.83	.873
15. Your computer has the ability to create, save, delete and protect files (Technology & Infrastructure)	4.10	.907
16. You can follow the directions on a computer screen to accomplish a task in an application (Technology & Infrastructure)	3.97	.917
17. The Mobile Pregnancy Monitoring System as an innovation that will integrate the health care service for community and personal health care (Process of improvement)	3.97	.735
18. The Mobile Pregnancy Monitoring System as an innovation will improve the record completeness and ease of access (Process of improvement)	3.96	.741
19. The Mobile Pregnancy Monitoring System as an innovation will improve the timely antenatal care visits for pregnant mothers (Process of improvement)	3.86	.846
20. The Mobile Pregnancy Monitoring System as an innovation meets the needs of the organisation to change the previous manual monitoring system (Process of improvement)	3.88	.827
Total	3.77	

Table 4 Determinant Factors Related to the Readiness of Health Workers

Variable	Category	Readiness		Total (%)	Sig.	Odds Ratio (95 % CI)
		Ready n (%)	Not Ready n (%)			
Age	≤ 25 years	13 (100)	-	13 (6.2)		Not Eligible
	26 to 35	40 (93)	3 (7)	43 (20.5)		
	36 to 45	61 (85.9)	10 (14.1)	71 (33.8)		
	≥ 46	74 (89.2)	9 (10.8)	83 (39.5)		
Education Level	Primary & Secondary	103 (85.1)	18 (14.9)	121 (57.6)		1
	Higher Education	85 (95.5)	4 (4.5)	89 (42.4)	.179	0.4(0.108 to 1.515)
Working experience	≤ 5 years	41 (91.1)	4 (8.9)	45 (21.4)		1
	6 to 10	68 (84)	13 (16)	81 (38.6)	.276	2.05(0.56 to 7.49)
	11 to 20	56 (96.6)	2 (3.4)	58 (27.6)	.282	0.36(0.59 to 2.28)
	≥ 21	23 (88.5)	3 (11.5)	26 (12.4)	.857	1.17(0.202 to 6.85)
Smartphone ownership	Yes	185 (89.4)	22 (10.6)	207 (98.6)		Not Eligible
	No	3 (100)	-	3 (1.4)		
Experience in HIS adoption	Yes	82 (92.1)	7 (7.9)	89 (42.4)		Not Eligible
	No	106 (87.6)	15 (12.4)	121 (57.6)		
Computer Application Knowledge	Good	115 (93.5)	8 (6.5)	123 (58.6)	.298	1.81(0.59 to 5.54)
	Limited	73 (83.9)	14 (16.1)	87 (41.4)		1
Access to Internet	Good	47 (88.7)	6 (11.3)	53 (25.2)		Not Eligible
	Limited	141 (89.8)	16 (10.2)	157 (74.8)		
Social Media Apps in Handphone	Yes	175 (92.1)	15 (7.9)	190 (90.5)	.013	4.6(1.39 to 15.61)
	No	13 (65)	7 (35)	20 (9.5)		1
Monthly Internet Budget	Yes	154 (89.5)	18 (10.5)	172 (81.9)		Not Eligible
	No	34 (89.5)	4 (10.5)	38 (18.1)		
Use of HP for coordination	Yes	130 (91.5)	12 (8.5)	142 (67.6)		Not Eligible
	No	58 (85.3)	10 (14.7)	68 (32.4)		
Willingness to use App	Yes	129 (94.9)	7 (5.1)	136 (64.8)	.007	4.1(1.4 to 11.39)
	No	59 (79.7)	15 (20.3)	74 (35.2)		1
Job Title	Midwife	66 (94.3)	4 (5.7)	70 (33.3)		Not Eligible
	CHW	122 (87.1)	18 (12.9)	140 (66.7)		

Discussion

Previous studies have concluded that the implementation of e-Health has caused an impact by increasing efficiency and quality in health services (Burton et al. 2004; Evans 2016). Factors that influence the successful implementation of e-Health are the acceptance and readiness of health service providers (Fritz et al. 2015). To the knowledge of the authors, there has been no research conducted in Indonesia to assess the readiness among health workers, especially ANC services and the readiness of service recipients (pregnant women) in e-Health implementation. This research has found that most of

the health workers in the PHCs who are involved during the ANC process of an urban area in Indonesia are ready to implement an electronic monitoring system. However, based on the level of readiness previously developed by Aydin & Tasci (2005), the mean score of readiness was 3.77 which need a few enhancements. Based on previous research, the implementation of e-Health in Primary Health care facilities especially in a developing country still has many constraints which result from limited information about e-Health implementation in terms of readiness which in turn brings barriers to IT adoption (Afrizal et al. 2019a).

This study has tried to explore the socio-technical readiness of midwives and community health workers to implement a mobile Pregnancy Monitoring System in the Primary Health Care of an urban area in Banten Province, Indonesia. The socio-technical aspect of readiness was divided into four categories: 1) innovation to the organisation and 2) people for the social aspect of readiness, 3) technology infrastructure and 4) process of improvement for the technical aspect of readiness. The result showed that the process improvement that supported the technical aspect was found to have the highest mean score. The highest mean of items answered by respondents for the technical aspect of readiness was item 10 which stated: "Internet access is available at the PHC to support the implementation of a mobile Pregnancy Monitoring System". The local government has committed to improve the public service by accelerating the installation of the internet network which has been more focused on the public primary health carers since 2016 (Kabar6 2016).

However, the majority of respondents felt the existing computer facilities were not comfortable enough to be used since they do not have access to use a computer individually at work. This may cause barriers to the e-Health adoption since implementing e-Health requires infrastructure such as Internet connection, software and hardware i.e. a computer and mobile phone. Previous study has shown that technical support and computer availability brought a positive influence on the readiness of students with respect to IT implementation (Kabonoki 2008). It also concluded that access to a computer has a positive influence on attitudes toward computers.

The current result shows that having social media on a HP, and willingness for IT implementation are both associated with the social aspect of readiness. These results are similar to a previous study which concluded that working experience and the ICT knowledge level are found to have a significant contribution on the innovativeness of teachers (Noh et al. 2016). Similar to that study, personal innovativeness is also related to the willingness of an individual to try out any new information technology (Agarwal and Prasad 1998).

Finally, there is no significant association between demographic factors among the health workers to IT readiness. A readiness assessment is an important step in change management, and including this step is a planning process that increases the chances of successful e-Health implementation (Li et al. 2012). Previous research concluded that supportive factors such as technological and infrastructure require attention before a new technology can be implemented in an institution (Coopasami et al. 2017). The research also acknowledged that IT users require the proper infrastructure to make optimum use of technology and to support them with the hardware facilities to enhance the innovation initiative.

Implication

The background of the study that some of the prior studies related to IT readiness were more focused on the barriers and drivers such as optimism, innovativeness, discomfort, and insecurity. This study measured readiness in adopting a mobile pregnancy monitoring system in an urban area which has less technical constraints and to analyse the association of demographic and supportive factors of the health workers. The findings are very useful to give information to the regulators as well as the Primary Health Care organisations before implementing any innovation in technology. Applying a socio-technical model during the assessment of readiness from the perspective of health workers and to evaluate the factors related to readiness gives strategic recommendations and specific actions that should be taken for improving IT readiness. The study was performed with a formal clearance number 783/UN2.F10/PPM.00.02/2018 received from the ethical board of Universitas Indonesia.

Conclusion

This study measures the association of demographic characteristics and associated factors of health workers to readiness. The findings of this study show that the majority of the health workers who are involved in the ANC process are ready to implement a mobile pregnancy monitoring system. Based on statistical analysis, this study has indicated that there was no significant association of the demographic factors to the readiness of m-Health implementation. The supportive factors such as having social media on a HP and willingness for IT implementation are associated with readiness.

Even though a readiness assessment before adopting a mobile pregnancy monitoring system is important, this research has only highlighted two aspects of the socio-technical model to measure IT readiness among health workers. Further research is recommended to evaluate another aspect of readiness in terms of the psychological aspect.

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