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The Simulation Model of the Resistance Factors Affecting the Adoption of Healthcare Robot Technology in Tertiary Care Center of Thailand

Paniti Vichitkraivin¹ and Thanakorn Naenna¹

¹Department of Industrial Engineering, Faculty of Engineering, Mahidol University, Thailand

Paniti.v.z.2535@gmail.com, thanakorn.nae@mahidol.ac.th

Abstract. Healthcare robot technology has become the important tool and it has extremely important role in the healthcare field. In spite of its great potential, gaps exist in our grasp of how users will assess change related to the healthcare robot. Previously research shows that when the new technology is used, the user may make decision to accept or resist technology. According to barrier theories this study develops a modified resistance model to describe the factors which resist the medical staffs' intention to use healthcare robot. The participants were selected from medical staffs (physician, nurse, and staffs) in Tertiary care center located in Thailand. We collected data using questionnaire to test a research model. The research model is analyzed by confirmatory factor analysis (CFA). The empirical results confirm that technological barrier, time barrier and change barrier have negative effect on medicals' behavioral intention to use healthcare robots. This study is discussed several practical and theoretical implications.

1. Introduction

Healthcare technology is developed and researched widely in healthcare service at present [1] such healthcare information system. When healthcare technology is developed alongside the need of patient are increasing, the healthcare robot has used in healthcare service. Healthcare robots initiative have been promise broadly [2]. They have become the important tool in healthcare service and they have had important role in healthcare since they can improve the healthcare service quality [3, 4]. Moreover, the healthcare robot market is growing fast and the highest value per unit sold [5].

Although healthcare robot can reduce healthcare cost and error from medical staffs, however the success of the healthcare robot initiative is dependent not only on robot designers, but also on medical staffs' willingness to adopt these healthcare robots because medical staffs are the user of healthcare robot to provide services to patients. Corporate executives or decision makers and robot designers, so, need an understanding of the adoption and barrier factors which have affected facilitate the adoption and using of healthcare robot by medical staffs [6].

The healthcare robot literature has focused on the technical using and design of healthcare robot [7-9], the adoption study area is the new topic in healthcare service. Previous researches on healthcare robot adoption have applied the technology acceptance model for suitable healthcare robot context, they have recommended the critical factor of healthcare robot adoption such as Alaiad A and Zhou L research [3]. However, user resistance is unavoidable for management and it may result in lower performance than



expected. As a result, organizations often get less of performance than they expect when they invest in new technology [10]. So, there is a need to check the critical resistance factors that affect technology adoption.

The previous researches on healthcare robot usage have been limited and most of them don't care problem about the resistance factors of users [11]. So, this research is the determinants of resistance factors which effect healthcare robot adoption of medical staffs. This study was motivated by observation that extant theories of technology usage, such as Unified Theory of Acceptance and Use Technology (UTAUT) have focused almost exclusively on users' positive (enabling) perceptions in relation to technology usage while ignoring negative (inhibiting) perceptions that may prevent technology usage, according to Cenfetelli's study [12]. Although Cenfetelli did not identify specific inhibitors of technology usage. Based on our literature review, resistance factors model of this research is created by using of resistance theory is main and adaptation with obstacles factors for suitable healthcare robot context.

2. Background and Theoretical

2.1. Healthcare Technology

Now healthcare institutes attempt to improve their services and increase the quality as much as possible. The quality improving in the hospitals can't be accomplished without healthcare technologies using and the other facilities since healthcare technologies have the potential to reduce diagnosis error, reduce process time and increase safety and quality. So, technology is playing an important role in the healthcare industry. Before, healthcare institutes began installing information and communication technology system in various ways; from the very simple format as using basic computer software putting the data in till the complex format as using healthcare robot [6] which can reduce 100% error [13]. The usage express IT in the healthcare section is very important to create competitive advantage and increase business value [6].

2.2. Robot

Now, robots have been widely used such as automotive industry (this robot is used in automotive production), researching industry (this robot can co-work on scientific research and surveying with human) and healthcare industry (this robot can use mechanical-armed robot for taking part in the operation because it is able to do accuracy required work better than human can do) since each company wants to reduce labor costs and human error. Though the definition of robot is currently no clear for adoption by the general public and there is no unanimous opinion that what qualified to be a robot [14]. Each country has the difference robot standard for consideration. So, to understanding that match about the Thailand standard of robot, the robot standard in this research is identified by multiple theories. First, robot is the machine that is able to work, some of them can work by itself meanwhile the others need instructor, according to NASA [3, 6]; second, robot should be able to do one or more of the following: 2.1. move around 2.2. operate a mechanical limb 2.3. sense and manipulate their environment 2.4. exhibit intelligent behavior, following from Thailand Center of Excellence for Life Sciences (TCELS), [14]; and third, robot is the mechanical tools and mechanisms inside can be many things together with a human or a human agent and can rearrange work process, according to Saranukromthai book 36 [15].

2.3. Healthcare Robot

Robot is the machine which can be used in the work. Some of the robots can work by themselves but the other robots need controller, the command must be entered or programmed to make it work, according to NASA [3, 6]. When these tasks mean to healthcare, these robots are called healthcare robot. Healthcare robots have an important role in improving the healthcare system and assistance the medical staff in every stage of the healthcare process [4]. They include drug manufacturing, nursing, drug medication management, dispensing drugs to patients, monitoring patient vital signs and carrying out surgeries and telemedicine [16]. Healthcare robots have been recently used by Thailand hospital such as Siriraj hospital, Bangkok and Ramathibodi hospital, Bangkok. According to the literature, Thailand healthcare robot can be dividing into three major categories include: treatment robot, support robot and

medical service robot [4]. This classification of robot has difference applications and tasks characteristics depend on the role of robots and the appropriateness of the responsible service.

The Healthcare robot in Thailand hospital include surgery robot, telemedicine robot, nurse healthcare robot, pharmacy robots, physical robot, CT scan, MRI and specific healthcare robot such as robot helps develop children. These healthcare robots are considered in this research and they have characteristics that match with robot standard.

2.4. Technology Acceptance Barrier for Healthcare Robot

The resistance or barrier factor is the reason that humans don't show any behavior. The diffusion research theory barrier has related to explaining the different between innovators and early adopters and other ideal types of adoption behavior, such as the early and late majority and laggards [17]. These barriers are closely associated to all type problem issues. Each barrier factors have very significant for the problem of equipment used in every work which make technology acceptance barrier is specified into various methods and theories is suitable for work. Now, there are many barrier research theorists such as: Pagani (2004) [18] and Kleijnen et al. (2004) [19].

From literature review, this research is applying the Pagani barrier model because it accentuates to the main in characteristics of the technology and most of its factors is suitable of healthcare robot context. These barrier factors include: technological barrier ((Lack of) Ease of use Barrier factor and Functional Usability Barrier factor), security barrier, Time barrier (Long time training and setting barrier) and change barrier.

2.5. Technology Acceptance and Resistance

When the new technology is used, the user may make decision to accept or resist technology. It depends on assessing changes related to the new system [20]. Although healthcare technology has great potential to improve the healthcare quality but this benefit may not receive the attention. Due to many healthcare technology efforts are experiencing problems or failures. Several failures, and these issues can be checked from the resistance of the user [21]. Bhattacharjee A and Hikmet N said the resistance isn't equivalent to not use because not using may mean that the users who use that technology don't know about new technology or continue to assess the technology before adoption. But resistance means that technology was considered and was rejected by users [22]. However, the ability to accept and resistance the technology must be examined in conjunction with the theoretical model of the common due to the resistance of the users is an important barrier to use new technology [12]. So, this research determined the resistance of the user. It is the conflict of the user to the changes associated with the use of new technologies.

Hsieh and Pi-Jung research showed barrier factors of acceptance healthcare technology have negative effected with behavioral intention to use [11, 23].

This research aims to answer the following the two mains research question: 1) What are the barrier factors influencing the medical staffs' behavioral intention to use healthcare robots? 2) What is the barrier factors which have strong effect of healthcare robot adoption?

3. Research Model and Hypotheses

In this study, the research model is presented in figure 1. The model base on Pagani barrier model and result of Hsieh and Pi-Jung research to examine the barrier factors effect of medical staffs' behavior toward adopting a healthcare robot. The barrier factors in this research model include technological barrier ((lack of) ease of use barrier factor and functional usability barrier factor), security barrier, time barrier (long time training and setting barrier), change barrier.

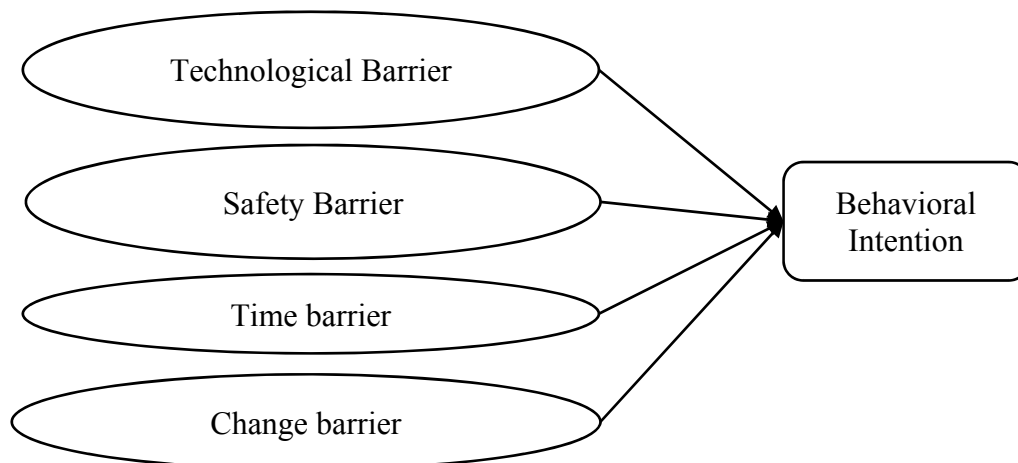


Figure 1. The barrier model in this research.

3.1. Technological Barrier ((Lack of) Ease of Use and Functional Usability Barrier Factor)

(Lack of) ease to use barriers means the each person's feeling that the technology was difficult for using when he must actual use. It was not flexible and study hard. There is the research show lack of ease of use causes medical staff refusing of using healthcare robot [24, 25]. In this research means the medical staffs found healthcare robot so complicated, difficult to use when it needs actually work and learning is difficult so they didn't want to use.

Functional usability barrier means the feelings of users that technology can't help their job effectively enough by itself or technology isn't response their work. The result of healthcare robot research show the lack of functions using is one of the barrier which causes the medical staffs don't accept using the healthcare robot [24, 25]. For this research means the medical staffs' feeling that healthcare robot can't response their job.

H1. Technological Barrier has a negative effect on users' behavioral intention.

3.2. Safety Barrier

Safety barrier means the users' feeling that using technology won't safe for users and patients. Safety barrier has influential for healthcare robot acceptance by the relevant concept, they have a wide range of ideas such as: BenMessaoud C. and group research (2011), Chen et al. (2007) and Stahl & Coeckelbergh, (2016) [24, 26, 27]. This research context means the medical staffs' feeling to use healthcare robot that isn't safe for them and patient when there is actual using.

H2. Safety Barrier has a negative effect on users' behavioral intention.

3.3. Time Barrier (Long Time Training and Setting Barrier)

Long time training barrier means the users' feeling that the time in training of using technology is spent too much, they feel waste of time in their work and bored with. Previous research results show that the long time too much training is the barrier that make the medical staffs against the adoption of healthcare technology. The researches support that content are follows Alaboudi et al., 2016, Treister, 1998 and BenMessaoud et al., 2011 [24, 25]. For this research context means the medical staffs' feeling, the training for using healthcare robot spends too much time and makes them wasting time and boredom.

Long time setting barrier means the users' feeling that they spend too much time for setting technology. BenMessaoud C. and group research said the spending too much time for setting surgery robot is the barrier factor of healthcare robot the because medical staffs will afraid that they can't help patient in time [24]. In this research context means the medical staffs feel that healthcare robot must spend too much time for setting so they can't help patient in time.

H3. Time Barrier has a negative effect on users' behavioral intention.

3.4. Change Barrier

Change barrier means the users don't want to change the traditional healthcare in order to use new healthcare technology because of personal reasons. Previous researches show the change barrier is the result from several human causes such as the lack of clear benefits, unknown technology phobia and not necessary to change. Many researchers said that the change is barrier of technology acceptance such as Panteleimonitis S and group (2017) [28], Marescaux J (2005) [29]. In this research means the medical staffs don't want to change their traditional healthcare to using healthcare robot in actual working because personal reason.

H4. Change Barrier has a negative effect on users' behavioral intention.

4. Methodology

This study focuses on medical staffs who use healthcare robot include physicians, nurses, and staffs. The participants were selected from Tertiary Care Center local in Thailand. To help participants understand about healthcare robot, we explain about robot standard, functions, and characteristics of healthcare robots in the introduction of the survey. We collected 225 responses, 189 returns and among which 171 were valid and used in this study and 18 were incomplete. Among the participants, 44.44% were male and 55.56% were female.

After creation the research model based on the sources mentioned earlier, we survey to collect the data about barrier factors effecting of medical staffs' perceptions of healthcare robots for testing the research model. The model is tested by using Lisrel program. The survey was conducted by using questionnaire. All the questions were adapted to the suitable of healthcare robot context, and measured on 5-point Likert scales.

5. Result

A reliability analysis was proceeded by using Cronbach's Alpha with 1-5 Likert scales. To test for validity, Item-Objective Congruence (IOC) testing technics has been done. All of scales of Cronbach's Alpha have nearly or exceed 0.70 for each factors group and for overall questionnaires. All questions get the IOC score greater than 0.50 which are declared to be "passed", according to the IOC concepts.

In this research, the confirmatory factor analysis (CFA) was taken to test the hypotheses and check the loading of barrier factors. First measurement model is analyzed; all data observed of latent variables are checked and specified the loading of each measurement items. Theoretically, the barrier factor of healthcare robot adoption by medical staffs in tertiary care center of Thailand should have 4 dimensions include technological barrier, safety barrier, time barrier and change barrier. But from the analysis of question, it was found that barrier factors consisting of technological barrier, time barrier and change barrier in latent variables have been accept, they have t-value more 1.96 (chi-square/df<2, GFI AGFI TLI NFI >0.95 and RMSEA<0.05).

The CFA was taken again to find the hypotheses and barrier factors loading for each barrier factor that have been accepted, the model for healthcare robot with barrier factor loading is shown in figure 2. Acceptable barrier factor items have been found to be negatively associated with behavioral intention to use healthcare robot, result of the factor analysis reported in table 1.

Table 1. Result of the 2nd order confirmatory factor analysis.

Factor	Factor loading	T-value	Percentage Approximation (%)	Result
Technological Barrier	0.92	3.29	32.5	Accept
Time Barrier	0.93	7.46	32.87	Accept
Change Barrier	0.98	9.19	34.63	Accept

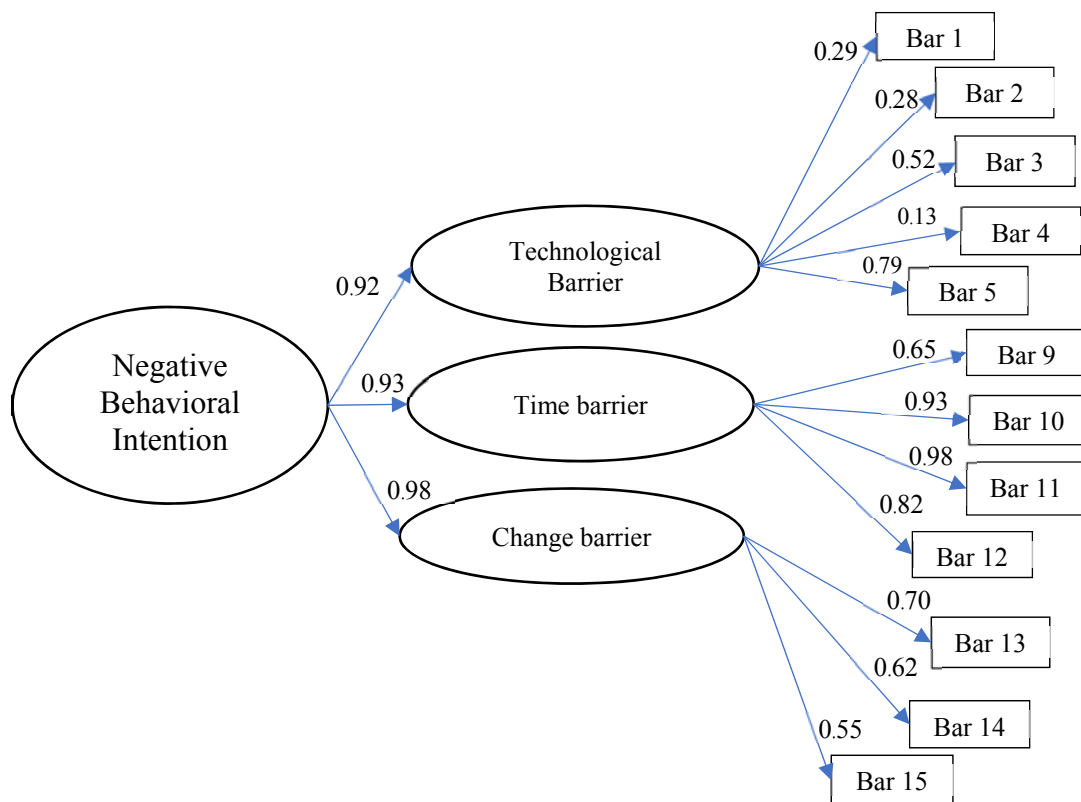


Figure 2. Result of barrier factor loading model.

The change barrier factor has the highest effect to resist of healthcare robot adoption, following with time barrier. The technological barrier has the least influence on healthcare robot adoption.

6. Discussion

In this study empirical study, we analyzed the medical staffs' resistance to healthcare robot adoption in tertiary care center of Thailand. This research model is analyzed by using the confirmatory factor analysis (CFA) for confirmation hypothesis and loading factors. Our study confirmed that medical staffs' resistance to healthcare robot adoption was caused by technological barrier, time barrier and change barrier. The change barrier has highest loading factor caused by the medical staffs don't know the clear benefits enough of robot, not necessary to change and uneasy due to fear. Previous research result shows the solutions include: first, offering strong, committed and positive leadership to lead the implementation process, this team should have implementation leader, engineers, training supervisors, and client support personnel [30] and second, education and training sessions to instruct the users [30]. The time barrier is the second loading factor because the training and preparing robot spend too much time. Resulting in the staff being bored, wasting time and not wanting to use. The solution is Healthcare robot should be designed the function to be similar to the original for reduce training and setting time [24, 31, 32]. The last barrier is technological barrier because some healthcare robot is hard both using and training, unable response their work, no staff teaches how to use and the result are not clear. Previous research suggested the solutions as follow: first, healthcare robot should design to be easy to use and to learn [24]; second, they need to be designed usage condition to be similar to the original [31, 32]; third, their function must response the work and better the original [24] and testing software performance and quality, prior to the using [33]. The safety barrier has influenced only some healthcare robot such as surgery robot [24, 29].

In practical, we consult with actual users in Thailand about the solution of barrier factors in healthcare robot adoption context. They suggest the solutions of these barrier as follows: first, healthcare robot must easy to use; second, the hospital should have training for using healthcare robot by expert in

suitable time; third, healthcare robot must response their job with the precise result; fourth, the hospital need to show the robot advantage and information for reducing staff anxiety and the last, the hospital should have public relations and support for the use of a full range of medical service robots. In pragmatic, the medical staffs said that the safety barrier has affected on executives and decision makers recruiting tools.

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