

# Modeling the intention and usage of medicine vending machine: Using partial least squares-structural equation modelling and necessary condition analysis

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## Abstract

**Objective:** This study aimed to investigate the factors influencing the intention to use and actual usage of medicine vending machines (MVMs) in China and to close the existing literature gap by examining the relationship between perceived convenience (PC), perceived trust, performance expectancy, effort expectancy, and social influence, on the intention to use MVM in a comprehensive manner. The impact of facilitating conditions on MVM adoption was also examined. Finally, customer age was tested as a moderator.

**Methods:** This was a cross-sectional study that used data collected through a self-administered questionnaire. A combination of partial least squares-structural equation modeling (PLS-SEM) and necessary condition analysis (NCA) technique was used to analyze and discuss the 308 valid questionnaires, test the hypotheses, and conduct an in-depth analysis.

**Results:** The results showed that PC, perceived trust, and performance expectancy were significantly related to the intention to use MVM. Effort expectancy was a non-significant predictor of intention to use MVM. Social influence was a significant negative predictor of the intention to use MVM. More importantly, performance expectancy was found to be a necessary factor for MVM intention, providing new marketing ideas for MVM owners. Age had a significant moderating effect on the facilitating conditions and intention to use vending machines. The relatively young population is more conscious of the facilitating conditions.

**Conclusions:** The findings of this study are of considerable importance as a guide for the main user group of vending machines. The combined analysis and discussion of PLS-SEM and NCA provide a sound theoretical basis for the practical implications of this study. In the future, we will attempt to use this technique in other areas of study. In terms of theoretical implications, this study provides technical references for future research.

## Keywords

Consumer participation, decision making, computer-assisted instruction, computerized self-Instruction program, supply and distribution

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## Introduction

The healthcare industry is an important field closely related to people's quality of life and is growing and expanding with technological innovation.<sup>1</sup> At the same time, technological innovations, including the emergence of technological

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healthcare services products such as wearable medical devices, online healthcare platforms, online pharmacies, and medicine vending machines (MVMs), have also accelerated the expansion of the overall medical and health industries.<sup>1,2</sup> However, the infrastructure in healthcare is still not up-to-mark in many areas. The paucity of healthcare professionals and medicines has resulted in many people not being able to access treatment and purchase medicines in a timely manner. In addition, people cannot reach hospitals easily and in a timely manner because of the lack of transportation facilities in many places. Medical facilities are more accessible in metropolitan areas and towns than in rural areas and villages.<sup>3</sup> Therefore, the emergence of automated medical products and services, such as MVMs, has solved some urgent problems for people in different areas regarding access to and purchase of medicines.

Medical technologies and products have improved tremendously over the past few decades.<sup>3</sup> At the same time, China has become a global leader in the development of some technologies and products in the medical field, and the Chinese government has begun paying more attention to the physical and mental health of the Chinese citizens and ensuring the widespread availability of medical facilities, such as building hospitals and 24-h pharmacies in various regions and towns to provide 24/7 medical services to the local population.<sup>4</sup> Since ensuring social distancing and no-touch behavior is the best infection prevention measure during COVID-19, various manual laborers are being replaced by automated technological innovations, such as automated delivery vehicles, grocery vending machines, and MVMs.<sup>5</sup> In particular, MVMs are an emerging technology-based healthcare service product that can provide consumers with a convenient, fast, and safe channel to purchase medicines; they also solve the problem of difficult to recycle and reuse medicines, and increase the sales and marketing channels for overproduced medicines during COVID-19, thus reducing the waste of resources and contamination of expired medicines.<sup>2,5</sup> In China, MVMs are still in their infancy, but have great market potential and social value, especially during COVID-19 when the demand for medicines has increased and traditional pharmacies are restricted.<sup>4</sup> However, with the widespread availability of COVID-19 vaccine and the end of the epidemic era, whether there is a change in the Chinese population's emphasis on their health and their need for medication remains to be explored and studied.

With the increase in the standard of living, increasing numbers of consumers are paying attention to their health management issues, which in turn has led to a boost in shopping behaviors in favor of items such as medicines and healthy snacks.<sup>5,6</sup> The emergence of COVID-19 has accelerated the demand for medicines and health-related products among consumers, which in turn, has contributed to the emergence and introduction of MVMs in the market. Given the specificity of pharmaceuticals and the changes in consumer perceptions

after COVID-19, many consumers and users will differ in their acceptance of new technologies relating to healthcare services, as well as in their intentions and behaviors (e.g. trust).<sup>5</sup> Thus, these developments have led to a research gap which this study aims to fill by investigating the effects of customer performance expectancy, effort expectancy, social influence, perceived trust, perceived convenience (PC), and facilitating conditions on the Chinese customers' intentions to use MVMs and on their actual usage.

## Literature review

### *Theoretical foundation*

Considering that user intention and usage behavior towards MVM is a detailed domain related to technology acceptance and use, this study utilizes technology acceptance model (TAM), which was developed by Davis.<sup>7</sup> In previous studies, TAM has often been used to measure the determinants of technology use, where PC and perceived ease of use (PEU) have been shown to be important determinants that can influence usage intentions and behaviors for consumer and the transactional technology products.<sup>8-10</sup> Many scholars have used TAM to study technology usage and adoption intentions in e-commerce-related areas, such as in blockchain<sup>11</sup> and mobile banking.<sup>8,12</sup> It is evident from previous studies that TAM is not sufficient to measure users' intention and acceptance behavior towards new systems in more detail. Therefore, this study adds constructs, such as users' performance expectations, effort expectations, and social influence, to better explain users' acceptance, intention to use, and usage behavior towards MVM by combining TAM and unified theory of acceptance and use of technology (UTAUT).

The technology acceptance model (TAM) must be linked with essential situation-related aspects to get a deeper comprehension about the adoption of information technology.<sup>13</sup> TAM has been incorporated and utilized in the context of vending machines by researchers from various countries.<sup>14</sup> According to TAM, the actual usage of an MVM may impact a consumer's perception of the trustworthiness of a service or product as well as their perception regarding the convenience associated with using that service or product. The core structures of TAM must be improved and expanded because they do not represent the range of user task contexts adequately. As a result, the current research added another model, UTAUT, with additional constructs, such as the user's perceived trust and convenience, performance expectancy, effort expectancy, and social influence.

### *Hypotheses development*

**Perceived convenience.** With technological development, various technology-based products have started appearing and the convenience offered by them has motivated the

users and consumers to use them. This study explores the relationship between the perceived utility variable convenience by considering its effect on users' intention to use (ITU). Park et al.<sup>9</sup> confirmed that users' PC of portable technologies, such as mobile apps, can positively influence their attitudes towards technology use, which in turn can positively affect their intention to use and usage behavior. Shankar and Rishi<sup>15</sup> showed that users' PC depends on different factors, including search, operational, and transactional convenience, which can significantly affect users' ITU. Therefore, considering that the actual use of MVM will include search, operational, and transactional convenience, the following hypothesis is proposed for the relationship between PC and ITU.

**H<sub>1</sub>:** PC has a positive influence on the intention to use MVM

*Perceived trust.* The effect of trust on attitudes and intentions has been tested and found to be positive in previous studies.<sup>8,10</sup> Given the anonymity, temporal separation, and geographical dispersion that characterize the virtual world, conducting business online is fraught with a number of serious risks and uncertainties. Therefore, users need to establish trust to lower their perceived risk, and thus to make their transactions easier.<sup>16</sup> Kumar et al.<sup>8</sup> confirmed that users' perceived trust in a technology product, such as mobile wallets which involve money and transactions, can directly and positively influence their intention to use it, which in turn promotes their subsequent usage behavior. The risks associated with mobile transactions are similar to those associated with online shopping. Thus, to increase the likelihood of individuals utilizing a service, building trust among users is crucial. Trust is still receiving attention despite the abundance of studies on online vending machines.<sup>16</sup> Gao and Waechter<sup>17</sup> showed that factors related to the technology of the vending machine as well as the vendor of the device have an impact on the level of trust people place on the machine. Therefore, the following hypothesis is proposed:

**H<sub>2</sub>:** *Perceived trust has a positive influence on the intention to use MVM*

*Performance expectancy, effort expectancy, social influence, and intention.* Technology is used in many different fields, and it has only recently become integrated into everyday life. Several studies have shed light on the factors that influence people's attitudes toward new technologies. The researchers who conducted this study concluded that customers' opinions on the usefulness of a technology impact its adoption. In this study, performance expectancy, effort expectancy, and social influence in UTAUT were considered to explore their effects on customers' and users' intention to use MVM.

Performance expectancy generally represents the extent to which individuals feel that using technology and systems will help them in their work, and that advances in technology will ease their performance of daily duties.<sup>18</sup> According to previous findings, an individual's anticipation of a device's performance is crucial in determining how long they will continue to use it. According to studies conducted in the field of financial technology, performance expectancy is an essential factor that drives consumer interest in new technologies.<sup>19,20</sup> In case of insufficient availability of physical health facilities, technological advancements will help make medical services more accessible to patients. Customers have access to a variety of benefits as a result of this technology, including shorter waiting times when consulting medical professionals, and ease in obtaining information and help for their health needs.

More consumers adopt technologies with user-friendly properties. The ease with which technology may be utilized defines the expected level of effort. The technology users are relieved when it demands a small amount of time. Previous studies have shown that an individual's perception of the amount of effort required to complete a task is a factor that influences behavioral intention.<sup>21,22</sup> People are more likely to believe that a technology product helps and, as a result, improves their day-to-day activities if they sense that using the product lessens their effort. This is also true for technological applications in the field of medical care. According to Cheung et al.,<sup>23</sup> the simplicity of use that consumers of health technology enjoy will lead them to a more favorable perception of the benefits that the technology provides and motivate them to use such technology in the long run. In addition, previous research by Farah et al.<sup>24</sup> showed that individuals' expectation of their level of effort is a good predictor of their future performance and behaviors.

In addition, the process of social influence occurs whenever social groups affect customer attitudes and behaviors.<sup>9</sup> In a study on the Chinese consumers' acceptance of autonomous vehicles, Zhang et al.<sup>25</sup> found that social influence was a key influence on whether users would accept new technologies and be willing to use them. Park et al.<sup>9</sup> found that social influence positively influences users' intention and behavior to use new technologies such as mobile payment; it thus hypothesizes that social influence has a direct and positive impact on the intention to use autopilot services. Therefore, the following hypotheses were proposed:

**H<sub>3</sub>:** *Performance expectancy has a positive effect on intention to use MVM*

**H<sub>4</sub>:** *Effort expectancy has a positive influence on intention to use MVM*

**H<sub>5</sub>:** *Social influence has a positive influence on intention to use MVM*

*Facilitating condition and actual usage of MVM.* Facilitating conditions were first used to refer to the objective

environmental elements that, according to the consensus of observers, make a certain activity relatively simple to perform. It is hypothesized that these external elements directly influence one's intention to use vending machines. In the context of virtual lectures, the persons directly participating in the process, technological infrastructure, and technical assistance for the usage of vending machines, can all be considered facilitating conditions.<sup>19</sup> In Almazroa and Gulliver's<sup>26</sup> study, the desire to use mobile payment systems on a continuing basis may be accurately predicted by supporting conditions having a substantial impact. The long-term preservation of the intention to utilize online banking is substantially influenced by favorable conditions.<sup>19</sup> Bervell and Arkorful<sup>27</sup> found that facilitating conditions significantly impacted users' propensity to continue using new technology. Facilitating conditions can save consumers' time and money while purchasing goods in many ways, thus further enhancing their purchase intention.<sup>16</sup> It has been shown that facilitating conditions are the most important aspect influencing technology acceptance and consumer satisfaction.<sup>26,27</sup> This led us to formulate the following hypothesis.

**H<sub>6</sub>:** *Facilitating condition has a positive influence on actual usage of MVM.*

**Intention to use MVM and actual usage of MVM.** Considering that medicine vending is subject to very strict regulations and policies in China, MVM exists only in some cities in China; therefore, studies related to users' use of MVM are scarce.<sup>4</sup> However, consumer and user demand for medication and MVM are not diminishing, and thus it is necessary to explore and study the demand and use of MVM by Chinese users and consumers. Fernando et al.<sup>28</sup> confirmed that users' intentions to use self-service technology can be positively influenced by their own perceptions, which in turn lead to subsequent usage behavior. In theoretical studies related to TAM and UTAUT, both intentions to use and usage behavior have been identified; here, intention to use refers to an individual's intention to try or make an effort to perform certain behaviors.<sup>1</sup> Tongnamtiang and Leelasantitham<sup>29</sup> also found in their study of usage intention and behavior of self-service technologies that users' usage behavior for self-service technologies, such as vending machines, can be influenced by their personal intentions. Therefore, considering MVM as a self-service technology, there is a positive relationship between users' intention to use it and their usage behavior, which leads to the following hypothesis.

**H<sub>7</sub>:** *Intention to use of MVM has a positive influence on actual usage of MVM.*

**The moderating role of age.** Most studies on the intention to use information communication technologies have

confirmed the moderating effect of some personal attributes on the core variables in these models by using the TAM model and its extension model, UTAUT, where common personal attributes include age and gender.<sup>10,18,20,30</sup> Each person is primarily responsible for his or her own health, regardless of gender, in the face of common health problems such as dyslipidemia, overweight, and fatty liver, individuals are equal.<sup>31</sup> Additionally, studies have shown that compared to younger individuals, middle-aged and elderly individuals pay more attention to their health status.<sup>32,33</sup> As new technologies are introduced into the market, their understanding and acceptance vary across age groups of users and consumers; therefore, it is an interesting and worthwhile perspective for this study to examine the effect of age as a moderator on users' intention to use them. Terblanche and Kidd<sup>34</sup> argued that the relationship between performance expectancy and effort expectancy and users' behavioral intention to use new technologies is influenced by the moderating effect of the age factor, and the relationship between expectations and intentions tends to be negatively correlated with age. In a study of mobile payment services, Sobti<sup>35</sup> found that age can be used as a moderating variable to influence users' intention to use mobile payment services and that younger users place more importance on the easy interface of mobile payment services as well as peer and social influences. In a study on the adoption of mobile apps for ordering in restaurants, Okumus et al.<sup>36</sup> emphasized gender and age as moderating variables in the relationship between social influence, effort expectancy, performance expectancy, and users' intention to adopt the technology. We found that, in articles emphasizing the acceptance or use of new technologies, age is typically not considered a significant influencing factor or is often presented as having a negative moderating effect.

However, in this study, MVMs were not only considered a new technology based on vending machines but also presented as a new type of point of sale for pharmaceutical and medical devices. The public is free to decide their acceptance of the technology, and they are not forced by the government to accept it. Considering that different age groups place different degrees of importance on health, this study infers that the age factor can act as a mediator to influence their intention to use and adopt MVM. To explore whether the age factor of an individual has a significantly different impact on the intention to use and adoption behavior of MVM, the following hypotheses are proposed.

**H<sub>8</sub>:** *Respondents age moderates the effect of performance expectancy on intention to use MVM*

**H<sub>9</sub>:** *Respondents age moderates the effect of effort expectancy on intention to use MVM*

**H<sub>10</sub>:** *Respondents age moderates the effect of social influence on intention to use MVM*

**H<sub>11</sub>:** *Respondents age moderates the effect of facilitating condition on adoption behavior of MVM*

## Research methodology

### Sample selection and data collection

To test the above hypotheses, a questionnaire survey was conducted in the city of Zhoukou, Henan Province, from 2 October 2022 to 25 November 2022. Considering the research background and the level of market penetration of the novel product, this study focuses on understanding individuals who are familiar with MVMs but have not used this particular product. The participants' level of trust in the questionnaire collection team can influence the completeness of questionnaire responses and the quality of collected data. Therefore, collaborating with the company responsible for deploying the MVMs is an effective approach. The data collection team contacted medical company that have installed MVMs in the city to determine the exact locations and the number of machines deployed prior to the start of data collection. The company provided the team with a list of 17 locations where the MVMs were deployed. From that list, we selected five locations for data investigation. These five selected locations have two common characteristics: firstly, they are all situated at the entrances of densely populated residential areas with a high volume of foot traffic; secondly, as part of the medical company's marketing strategy, there are employees of medical company in these areas who carry out certain promotional activities. The medical company that owns the vending machines introduces passersby to various functional details of the machines, including the types of drugs available, payment methods, the scope of health insurance card usage, placement locations, and the process for replacing expired medications in the MVMs. Simultaneously, the data collection team randomly selects respondents within the area and informs them about the purpose of the study, the data collection process, the specific flow of data, as well as their rights to participate and withdraw from the study at any time. Before full data collection began, the data collection team conducted a pretest and pilot test to ensure that the translated Chinese version of the questionnaire would not pose any reading difficulties or comprehension issues arising from translation. Specifically, the pretest occurred during the early stages of questionnaire translation, where two professional language experts were invited to perform English-to-Chinese translation of the original questionnaire and provide their feedback. After incorporating the suggestions from the two experts, we used the revised questionnaire to randomly select 20 users near the MVMs to participate in the pilot test. Members of the data survey team carefully observed the respondents' state while they filling out the questionnaire and solicited feedback from the participants involved in the pilot test. Based on this feedback, the questionnaire was further refined. Written informed consent for participation was obtained from respondents who participated in the

survey. After excluding incomplete responses, 308 participants were selected as the final sample for the study. This sample size met the minimum sample size required for this study, as suggested by Faul et al.<sup>37</sup> (calculated using G\*Power: Effect size  $f^2=0.15$ ,  $\alpha=0.05$ , Power=0.80, Number of Predictors=7; Minimum sample size 103).

### Instrument

In quantitative research, self-administered questionnaires are widely employed as a highly efficient and low-cost approach of data collection.<sup>38</sup> The study employed self-administered questionnaires for data collection, which primarily consisted of two parts: Part A collected the demographic characteristics of the respondents and Table 2 details the respondent demographics; Part B contained all the measures of the constructs used in this study. All endogenous and exogenous constructs were measured using the 7-point Likert scale, ranging from "1 - strongly disagree" to "7 - strongly agree." To ensure content validity and usability, all measurement items for the variables in this study were adapted from existing literature, and the wording was revised according to the contextual needs of and applicability to this study. All sources of these measurement models were listed in **Supporting Material 1. Survey Instrument**. Specifically, the items for performance expectancy, effort expectancy, and social influence were adapted from Lin<sup>39</sup> and Rahi et al.<sup>40</sup> Perceived trust was adapted from Gao and Bai.<sup>41</sup> The item on PC was adapted from Bansah and Agyei,<sup>42</sup> and Lin.<sup>39</sup> The item on facilitating condition was adapted from Widayat et al.<sup>43</sup> In addition, the items from Chen et al.<sup>20</sup> were used to measure users' intentions to use MVM. Finally, the actual usage of MVM was constructed by adapting the items from Kimiagari and Baeib.<sup>44</sup> Since all the original items of the construct were written in English, the scale (questionnaire) in this study was translated and evaluated by Chinese language experts before it was put into use. This ensured that the meaning of all the measured items could be accurately understood, and that the accuracy and validity of each questionnaire item were guaranteed.

### Common method bias

To avoid common method biases (CMB) resulting from the data collection approach, this study considered and implemented procedural (ex-ante) remedies recommended by Rodríguez-Ardura and Meseguer-Artola<sup>45</sup> and Yang et al.<sup>46</sup> Specific procedural remedies included: (a) the study utilized self-administered questionnaires, reducing the influence of researcher-respondent interaction on respondents. This approach mitigated potential effects resulting from researcher-induced cues during the data collection process; (b) providing advance notice of the purpose of the data collection to reduce sensitivity and discomfort

among respondents during the data collection process; (c) collaborating with medical companies to provide detailed information about the functionality of the MVMs, thereby enhancing respondents' understanding of the topic and improving the completeness of questionnaire responses and data quality; (d) conducting pretest and pilot test. Incorporating expert opinions as well as feedback and suggestions from pilot test participants to refine the final questionnaire. Meanwhile, this study used post hoc diagnosis of the still possible existing CMB, prior to the partial least square-structural equation modeling (PLS-SEM) analysis, the CMB evaluation was conducted using Harman's single-factor test and Kock's full-collinearity test.<sup>47</sup> First, the results of Harman's single-factor test showed that the first and largest factor explained at 28.805% (<40%), as CMB was negligible in this study.<sup>48</sup> Furthermore, the study examined the variance inflation factor (VIF) for all structural pathways and found that they were all below the threshold of 3.3, indicating that there was little to no CMB problem in this study, with all the data presented in Table 1.

### Data analysis method

This study focused on a PLS-SEM analysis using SmartPLS 4. The PLS-SEM method is suitable for optimizing the interpretation of the endogenous structure and variance of the prediction model, and it has fewer constraints on the multivariate normal distribution than other research methods.<sup>49</sup> After passing the multivariate normality test, an exploratory study using PLS-SEM was found to be the appropriate technique for this study.  $p < 0.05$  in Mardia's Multivariate Normality test indicated that the data distribution violates the normality study. Under these conditions, PLS-SEM was well-suited for this study. However, while the advantages of PLS-SEM are evident, the disadvantages of PLS-SEM are equally evident. PLS-SEM usually provides only a standard linear model, which is not sufficient for social sciences.<sup>1</sup> To ensure that the study can provide sufficient practical implications and contributions, it incorporated necessary condition analysis (NCA) to complement PLS-SEM. In this study, the NCA complemented the causal and data analysis of the constructs from the perspective of the logic of necessity. Previous reports using NCA indicated that outcomes can only be achieved if the necessary causes were attained, at least, at a certain level.<sup>50</sup> Other

exogenous constructs cannot compensate for endogenous constructs when the necessary conditions are not met. This allowed the study to (a) analyze in more detail the specific impact of the potential variables under this analysis, (b) provide a basis for further theoretical development, and (c) discuss in more practical terms how best to facilitate an increase in the modification problem. This helped to provide greater precision in the results of this study and to identify the best factors to provide greater practical value.

## Findings

### Data analyses and results

The demographics of the respondents are presented in Table 2. The descriptive data analysis showed that close to 80% of the respondents were between the age of 25 and 42 years. Of the respondents, 10.4% had chronic diseases. Health insurance, as mentioned in the study, is a health insurance system specific to China. According to publicly available data from the Chinese National Healthcare Security Administration, as of the end of 2022, the number of people covered by China's basic medical insurance reached 1345.7 million, with coverage stability exceeding 95%.<sup>51</sup> The results in Table 2 indicate that 94.5% of the respondents in this study had health insurance coverage. Regarding the level of education, 35.1% of respondents had a college degree and 36% had a degree. The data also showed that the majority of respondents had a monthly income of more than RMB 3000. After being reimbursed by health insurance, 75% respondents spent less than RMB 200 per month on medicines, while only 25% spent more than RMB 200 on medicines.

### Measurement model

After evaluating the CMB, multivariate hypothesis, and normality distribution, the quality of the model was evaluated using SmartPLS 4. The data in Table 3 show that the values of average variance extracted (AVE) were all greater than 0.5, validating convergent validity; on the other hand, the values of Cronbach's Alpha, Composite reliability, and Dijkstra-Henseler's rho were all greater than 0.7 for all constructs in the model, thus validating internal consistency.<sup>49</sup> In terms of discriminant validity (presented in *Supporting Material 2. Discriminant Validity*), an examination of the Fornell-Larcker

**Table 1.** Full-collinearity test.

Variables	PE	EE	SI	PT	PC	FC	ITU	ADT
VIF	1.338	1.294	1.387	1.384	1.415	1.446	1.427	2.534

**Note:** PE: performance expectancy; EE: effort expectancy; SI: social influence; PT: perceived trust; PC: perceived convenience; FC: facilitating condition; ITU: intention to use MVM; ADT: actual usage of MVM.

**Source:** Author's data analysis.

**Table 2.** Demographic characteristics.

	N	%		N	%
Gender			Education		
Male	158	51.3	High school level and below	53	17.2
Female	150	48.7	College	108	35.1
Total	308	100.0	Degree	111	36.0
			Postgraduate and above	36	11.7
Age			Total	308	100.0
18–24 years old	6	1.9			
25–30 years old	101	32.8	Monthly Income		
31–36 years old	83	26.9	RMB 1001–RMB 2000	3	1.0
37–42 years old	59	19.2	RMB 2001–RMB 3000	29	9.4
43–48 years old	44	14.3	RMB 3001–RMB 4000	154	50.0
49–54 years old	15	4.9	RMB 4001–RMB 5000	99	32.1
Total	308	100.0	Above RMB 5000	23	7.5
			Total	308	100.0
Chronic illness					
Yes	32	10.4	Spending on medicines		
No	276	89.6	Lower RMB100	95	30.8
Total	308	100.0	RMB 100–RMB 200	136	44.2
			RMB 201–RMB 300	41	13.3
Health insurance			RMB 301–RMB 400	30	9.7
Yes	291	94.5	RMB 401–RMB 500	4	1.3
No	17	5.5	More than RMB 500	2	0.6
Total	308	100.0	Total	308	100.0

Notes: CNY1000  $\approx$  USD 137.67 (Refer to the People's Bank of China RMB to USD exchange rate in June 2023)

Source: Author's data analysis

Criterion, the square root of AVE was greater than the other correlation coefficients. In the meanwhile, cross-loading was used as a basis for judgement, and all loads had a strong loading capacity on their respective structures (all greater than 0.70) and a weak loading effect on the other unrelated structures (all cross-loads were less than related loading). The highest value of heterotrait-monotrait (HTMT) ratio was 0.574, which is well

below the threshold value of 0.85. Therefore, the model had a good fit and was suitable for path analysis.

The model has two endogenous constructs, and the measurement model explains 27.5% of the intention to use and 37.5% of the actual usage. As these percentages are greater than 20%, the model has satisfactory predictive power. Sarstedt et al.<sup>52</sup> stated that  $f^2$  equal to 0.02, 0.15, and

**Table 3.** Reliability and validity.

Variables	No. items	Mean	Std. deviation	Cronbach's alpha	Dijkstra-Henseler's rho	Composite reliability	AVE	VIF
PC	5	5.190	1.167	0.855	0.859	0.896	0.633	1.296
PT	5	4.941	1.200	0.868	0.872	0.905	0.655	1.267
PE	5	5.319	1.211	0.894	0.896	0.922	0.702	1.289
EE	5	5.410	1.220	0.887	0.895	0.917	0.689	1.218
SI	5	2.933	1.212	0.878	0.886	0.911	0.671	1.162
FC	5	4.977	1.302	0.881	0.882	0.913	0.678	1.174
ITU	5	4.861	1.363	0.885	0.886	0.916	0.684	1.205
ADT	5	4.824	1.359	0.886	0.887	0.916	0.686	-

Note: PC: perceived convenience; PT: perceived trust; PE: performance expectancy; EE: effort expectancy; SI: social influence; FC: facilitating condition; ITU: intention to use MVM; ADT: actual usage of MVM; VIF: variance inflation factor; AVE: average variance extracted.

Source: Author's data analysis.

**Table 4.** Hypothesis testing.

Hypothesis	Beta	Confidence interval	t-values	p-values	R <sup>2</sup>	f <sup>2</sup>	Decision	
H1	PC → ITU	0.133	(0.034, 0.245)	2.068	0.019	0.276	0.019	Accept
H2	PT → ITU	0.180	(0.075, 0.288)	2.784	0.003		0.035	Accept
H3	PE → ITU	0.117	(0.017, 0.217)	1.936	0.026		0.015	Accept
H4	EE → ITU	0.077	(−0.029, 0.189)	1.155	0.124	0.373	0.007	Reject
H5	SI → ITU	−0.288	(−0.400, −0.178)	4.308	0.000		0.099	Reject
H6	FC → ADT	0.370	(0.274, 0.466)	6.378	0.000	0.373	0.186	Accept
H7	ITU → ADT	0.364	(0.269, 0.460)	6.250	0.000		0.176	Accept

Note: PC: perceived convenience; PT: perceived trust; PE: performance expectancy; EE: effort expectancy; SI: social influence; FC: facilitating condition; ITU: intention to use MVM; ADT: actual usage of MVM.

Source: Author's data analysis.

0.35 have small, moderate, and large effect sizes, respectively. The results in Table 4 show that PC (0.019), performance expectancy (0.015), and perceived trust (0.035) have small effect sizes for intention to use. The remaining exogenous constructs had small effect sizes on the intention to use. Meanwhile, PC and intention to use had large effect sizes on actual usage.

### Structural model

The structural model (Figure 1 and Table 4) shows that six of the seven direct effect pathways were significant. The

results in Table 4 show that PC ( $\beta=0.133$ ,  $p<0.05$ ), perceived trust ( $\beta=0.180$ ,  $p<0.05$ ), and performance expectancy ( $\beta=0.117$ ,  $p<0.05$ ) had positive and significant effects on intention to use, which supports H<sub>1</sub>, H<sub>2</sub>, and H<sub>3</sub> respectively. Effort expectancy ( $\beta=0.077$ ,  $p>0.05$ ) had no significant effect on intention to use and H<sub>4</sub> is rejected. Social influence ( $\beta=-0.288$ ,  $p<0.05$ ) had a negative and significant effect on intention to use, and H<sub>5</sub> was also rejected. Facilitating conditions ( $\beta=0.370$ ,  $p<0.05$ ) and intention to use ( $\beta=0.364$ ,  $p<0.05$ ) had a significant and positive effect on actual usage, thus providing evidence to support H<sub>6</sub> and H<sub>7</sub>. In addition, the confidence intervals for H<sub>1</sub>, H<sub>2</sub>, H<sub>3</sub>, H<sub>6</sub>, and H<sub>7</sub> did not



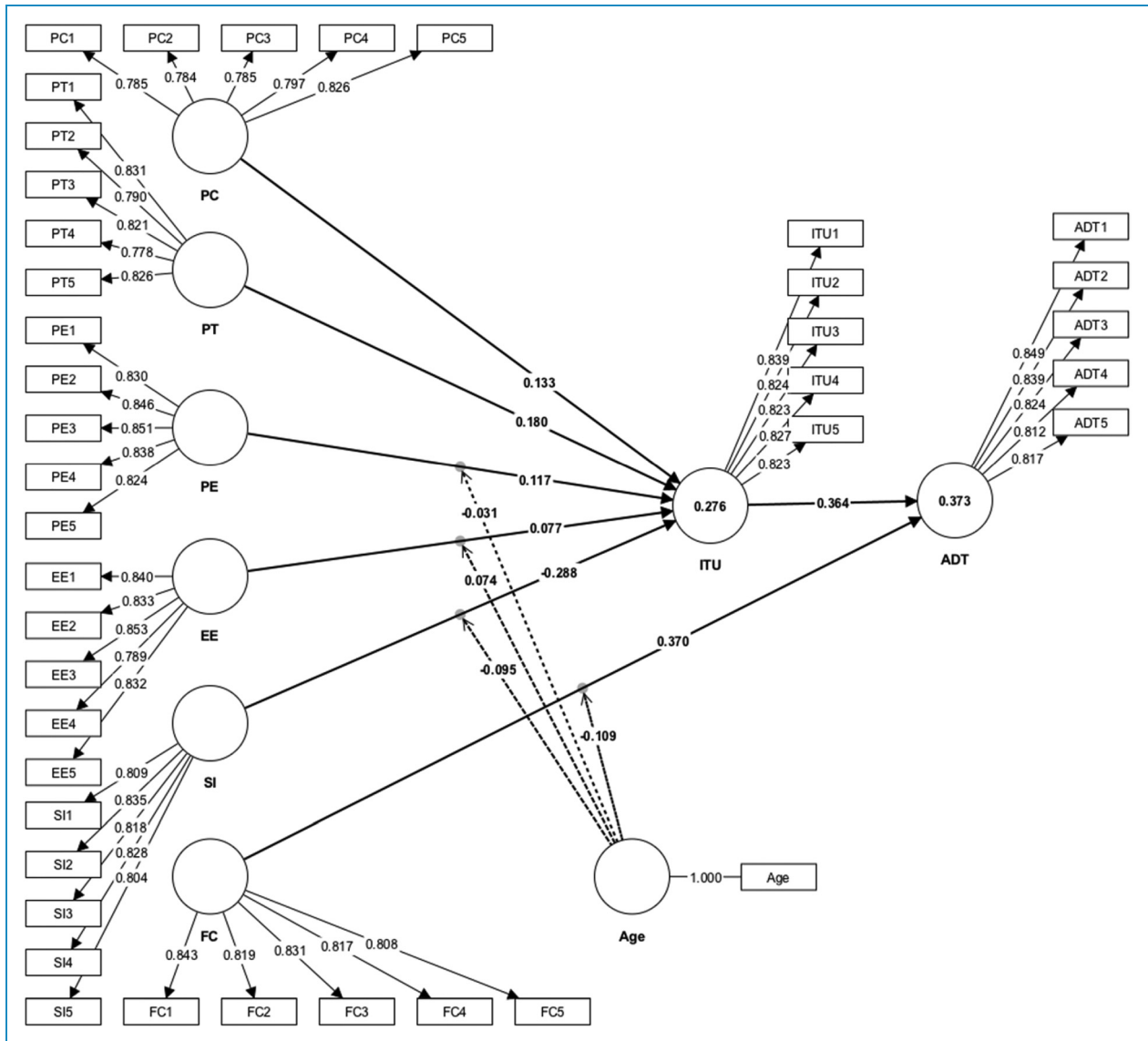


Figure 1. Measurement model.

contain zero between the minimum and maximum values, thus validating the hypotheses.

Age had no moderating effect on the relationship between performance expectancy ( $\beta = -0.031, p > 0.05$ ), effort expectancy ( $\beta = 0.074, p > 0.05$ ), and social influence ( $\beta = -0.095, p > 0.05$ ) on intention to use. There was a negative moderating effect of age between facilitating conditions ( $\beta = -0.109, p < 0.05$ ) and actual usage, supporting  $H_{11}$ . The effect of facilitating conditions on actual usage diminishes with age (Table 5).

**Necessary condition analysis results**

This study used NCA to complement the linear relationship in PLS-SEM. The results in Table 6 show that performance

expectancy ( $d > 0.1, p < 0.05$ ) is a meaningful, significant, and necessary condition for intention to use. PC and trust were relevant determinants of intention to use but were not necessary conditions. This inference is further supported by a detailed evaluation of the bottleneck table. Table 6 shows that, to reach 20% and 60% of intention to use, performance expectancy needs to satisfy the 0.649% and 1.623% bottlenecks, respectively. Until the performance expectancy breaks the 1.623% bottleneck, PC and trust are not recommended to be increased; at this stage, the increase in PC and trust is meaningless for intention to use. The results of PLS-SEM show that effort expectancy and social influence had no significant impact on intention to use; this is further supported by the results of the NCA, where an increase in effort

**Table 5.** Moderating effect.

Hypothesis	Beta	Confidence interval	t-values	p-values	f <sup>2</sup>	Decision
H8 Age x PE → ITU	−0.031	(−0.134, 0.073)	0.493	0.311	0.001	Reject
H9 Age x EE → ITU	0.074	(−0.037, 0.182)	1.116	0.132	0.007	Reject
H10 Age x SI → ITU	−0.095	(−0.202, 0.007)	1.485	0.069	0.012	Reject
H11 Age x FC → ADT	−0.109	(−0.179, −0.030)	2.414	0.008	0.020	Accept

Note: PC: perceived convenience; PT: perceived trust; PE: performance expectancy; EE: effort expectancy; SI: social influence; FC: facilitating condition; ITU: intention to use MVM; ADT: actual usage of MVM.  
Source: Author's data analysis.

**Table 6.** NCA effect size.

Construct	Intention to use		Actual usage	
	Effect size (d)	Permutation p-value	Effect size (d)	Permutation p-value
Perceived Convenience	0.043	0.133		
Perceived Trust	0.026	0.417		
Performance Expectancy	0.142	0.000		
Effort Expectancy	0.025	0.236		
Social Influence	0.001	0.722		
Facilitating Condition			0.066	0.048
Intention to Use			0.151	0.000

Note: PC: perceived convenience; PT: perceived trust; PE: performance expectancy; EE: effort expectancy; SI: social influence; FC: facilitating condition; ITU: intention to use MVM; ADT: actual usage of MVM.  
Source: Author's data analysis.

expectancy and social influence had no meaningful impact on intention to use.

Intention to use ( $d > 0.1$ ,  $p < 0.05$ ) was necessary for actual usage to be meaningful and significant. To achieve 30% actual usage, the intention to use needs to reach 2.922%; to achieve 60% actual usage, the intention to use needs to break the bottleneck of 3.896% (Table 7).

## Discussions

This study reveals that PC, perceived trust, and performance expectancy are important factors in the intention to use vending machines, and they can be used as a basis for targeted operational management by small- and medium-sized businesses that have vending machines. In conjunction with the findings of the NCA study, performance expectancy as a necessary factor influencing intention to use vending machines is an essential input in this direction. According to the results,

PC and trust have a significant and positive relationship with the intention to use vending machines. Convenience can help reduce the time and effort required by users to lock their perceptions during the use of vending machines. This can increase the perceived value of using a vending machine at a given cost, thus increasing the users' intention to use it. Research has also confirmed that trust encourages the intention to use an e-commerce system, which plays an important role in improving its usability.<sup>53</sup> This finding supports our hypothesis. When people think about making purchases online, trust is typically the first thing that comes to their minds. If customers do not have faith in the business that offers the e-commerce platform, they will not purchase the product from the said platform. The level of trust between the two parties is an essential component that has a direct and significant bearing on the desire to make a transaction. Several studies, including those conducted by Kim et al.,<sup>53</sup> Luyao et al.,<sup>54</sup> and Nawi et al.,<sup>16</sup> have shown that customers' trust beliefs

**Table 7.** Bottleneck table (percentages).

Percentage	Intention to use					Actual usage	
	EE	PC	PE	PT	SI	FC	ITU
0%	NN	NN	NN	NN	NN	NN	NN
10%	NN	NN	NN	NN	NN	NN	0.325
20%	0.325	NN	0.649	NN	NN	NN	0.325
30%	0.649	0.974	0.649	NN	NN	NN	2.922
40%	0.649	0.974	0.649	NN	NN	NN	2.922
50%	0.649	0.974	0.649	NN	NN	0.649	2.922
60%	0.649	1.299	1.623	NN	NN	0.649	3.896
70%	2.273	1.948	3.896	NN	NN	0.649	3.896
80%	2.273	1.948	5.519	NN	NN	6.494	16.234
90%	7.792	4.545	11.039	5.195	NN	11.364	22.078
100%	16.883	13.312	22.078	5.844	12.013	20.130	60.390

Note: PC: perceived convenience; PT: perceived trust; PE: performance expectancy; EE: effort expectancy; SI: social influence; FC: facilitating condition; ITU: intention to use MVM; ADT: actual usage of MVM.

Source: Author’s data analysis.

have a favorable impact on their intention to make an online purchase. Understanding the importance of these factors can enhance their relationships with consumers and create more opportunities. Furthermore, according to the results of this study, performance expectancy is an important factor in determining whether a vending machine is actually used. In the context of this study, an increase in any other aspect of input would not be meaningful without achieving a certain level of performance expectancy.

The understanding and acceptance of new technologies vary across user and customer age groups. Thus, it is an interesting and worthwhile perspective to use age as a moderator to examine the impact of factors such as performance expectations and effort expectations on users’ intention to use them. Natarajan et al.<sup>31</sup> argued that age had a moderating effect on users’ intention to use technologies such as apps, and confirmed that younger individuals were significantly more interested and receptive to using new technologies than older individuals. Furthermore, Chawla and Joshi<sup>10</sup> found in a study on mobile wallet adoption that factors such as perceived trust and facilitation conditions or compatibility significantly influenced users’ attitudes and intentions moderated by age, and that age moderation showed higher trust and willingness in relation to younger users. The results of the moderation analysis showed that

age had a moderating effect on users’ willingness to use vending machines. Specifically, middle-aged and older users tended to value the ease of use and convenience of e-health services such as MVM more than younger users, who subconsciously rejected perceived complex new information technologies and did not pay too much attention to their performance expectations, effort expectations, and social impacts. However, middle-aged and older adults are more interested in the facilitating conditions and ease of use that products and services such as new technologies can provide in their daily lives. This suggests that age moderates the relationship between perceived ease of use and intention to use, but it does not moderate the relationships between performance expectancy and intention to use, effort expectancy and intention to use, and social influence and intention to use. Although vending machines have been prevalent in society and the marketplace for decades, unlike mobile applications such as digital wallets, the emergence, and diffusion of MVMs can bring convenience and ease of access to purchasing medications to a wider audience. Therefore, the results of this study show that age moderates the relationship between facilitating conditions and actual use, implying that younger users would value the convenience and accessibility of new technology products, such as MVMs, as much as middle-aged and older users.

Surprisingly, effort expectancy and social influence do not have a significant positive effect on intention to use vending machines. Effort expectancy has a positive effect on the intention to use vending machines but it is not statistically significant in any way. Social influence has a significant negative effect, suggesting that increased investment in social influence may lead to a decline in the intention to use vending machines. This does not meet our expectations and hypotheses, and is not in line with the results of previous studies.<sup>16</sup> By combining the results of the NCA, we reconfirm that effort expectancy and social influence are neither necessary nor deterministic factors in the intention to use vending machines. This is a very interesting finding, as social influences are usually impacted by factors such as friendships, social stratification, surroundings, and cultural factors<sup>16</sup>; however, the survey on the intention to use vending machines seems to be very unsuitable for this context. A very likely explanation for this is that the broad and deep influence of sociocultural factors in the traditional consumer environment is not easily changed, and the social influence that consumers bring to traditional pharmacies does not seem to be easily broken.

## Implications

### *Theoretical contribution*

This study examined the relationship between PC, perceived trust, performance expectancy, effort expectancy, and social influence on the intention to use MVMs based on the UTAUT model and found that PC, perceived trust, and performance expectancy are significantly related to intention to use MVM. These results narrow the existing literature gap and further extend the applicability of the model. This study further investigated the moderating effect of age on the relationship between performance expectancy, effort expectancy, social influence, and the use of MVMs. Additionally, this study investigated the moderating role of age between facilitating conditions and the actual adoption of MVMs. The findings pointed to a greater focus on the presence of facilitating conditions among relatively younger individuals, and as the most dominant group of current users of MVMs, the findings are quite significant as a guide.

The analytical technique of PLS-SEM combined with NCA as a complementary analysis of linear and causal relationships allows the study to discuss in greater depth the factors necessary to influence endogenous constructs and to better facilitate the theoretical development. The combination of the two analytical techniques allows researchers to provide theoretical support for their ideas more clearly, which also opens up new pathways for testing theoretical alternatives to current models. This study provides future researchers with more theoretical underpinnings and case references.

### *Practical implications*

Given the moderating role of age, the main objective of this study was to analyze the relationship between customers' performance expectancy, effort expectancy, social influence, perceived trust, PC, facilitating conditions, intention to use MVMs, and actual usage of MVMs. The uniqueness of this study lies in the use of a combination of PLS-SEM and NCA techniques for data analysis, and a discussion based on its result. This study examined the impact between performance expectation and intention to use MVMs and found that performance expectation was a necessary factor influencing the intention to use MVMs. In addition, perceived trust and convenience were relevant determinants of the intention to use MVMs. The study also found that intention to use MVMs is a necessary factor for actual usage; however, facilitating conditions are only a relevant determinant and not a necessary factor for actual usage of MVMs. When the intention to use MVM reaches a certain level, an appropriate increase in facilitating conditions can be effective in increasing actual consumer adoption. This shows the way for MVMs to improve their promotional efficiency. Further diffusion on MVM will help reduce the wastage caused by hoarding commonly available medicines in most households, contributing to a reduction in household expenditures and wastage of social resources.

## Conclusions

Future researchers can build on NCA results and further explore how the model works in other situations. In addition, small- and medium-sized pharmaceutical or medical companies can make appropriate strategic adjustments based on this research. Based on the evidence presented above, we recommend that future researchers use PLS-SEM and NCA in conjunction in future studies. This study has the potential to examine unproven assertions of necessity that have been made in a number of different scientific fields, and replication using a combined PLS-SEM and NCA technique provides a viable option for future research. This is particularly true for confirming and further developing existing knowledge of the established models. The use of NCA to evaluate mediator models and enhance group-specific PLS-SEM analyses is another intriguing part of this study (including models involving moderation). In summary, the proposals presented will be supported by applications from several disciplines that use PLS-SEM in conjunction with NCA. These applications will also contribute to the development and expansion of the standard.

### *Limitations and future recommendations*

This study only examined the intention and actual usage of MVMs, without considering subsequent long-term factors such as user satisfaction, loyalty, and willingness to

recommend. This means that the study overlooks the long-term impact and value of MVMs, making it difficult to comprehensively assess their advantages, disadvantages, and future prospects. Future research could build upon this model by incorporating additional factors such as user satisfaction and willingness to recommend to explore the long-term impact and value of MVMs on users. This could help researchers evaluate the advantages, disadvantages, and development prospects of MVMs more comprehensively, while also providing more feedback and recommendations for vending machines operators.

Furthermore, this study was conducted in a single city in Henan Province, China, which may introduce regional and cultural differences. These differences could affect the generalizability and applicability of the model, thus preventing the study from validating the robustness and reliability of the model in other contexts. Future research could test this model in different countries and regions to compare its applicability and variability across different cultures and backgrounds. This could help researchers consider factors such as economic levels, social influences, and cultural impacts on the intention and actual usage of MVMs in different countries and regions, while also validating the reliability of the model in other cultural contexts.

Finally, this study solely relied on questionnaire surveys to collect data, which may introduce biases such as self-reporting bias, measurement errors, and sampling errors, thereby impacting the quality and validity of the data. Future research could consider using the FsQCA research approach and incorporate methods such as interviews to incorporate more practically significant influencing factors.

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