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Psychological antecedents of telehealth acceptance: A technology readiness perspective

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ABSTRACT

The ongoing coronavirus pandemic has been threatening the healthcare system. In this context, telehealth is a potential solution to deliver effective and safe health care to the public. To facilitate the application and acceptance of telehealth, a good understanding of psychological determinants is of great importance. Therefore, this study aims to examine the public's positive and negative mindsets towards telehealth. A theoretical model was established by employing the technology readiness model and perceived value theory. To empirically test the relationships between constructs, a total of 500 responses from residents in Singapore were collected; thereafter, structural equation modeling was performed. The results indicate that discomfort negatively impacts perceived value whereas optimism and innovativeness positively impact users' perceived value. Further, perceived value positively impacts the acceptance of telehealth via attitude. Demographic factors (i.e. internet literacy, age, education) can also influence certain aspects of technology readiness (e.g. innovativeness, optimism). Moreover, social influence is an important moderator between perceived value and the acceptance of telehealth. The empirical findings enhance the understanding of users' psychology concerning telehealth and provide policy recommendations regarding the development of telehealth to improve public health.

1. Introduction

The COVID-19 has been posing great challenges to global healthcare systems. The unprecedented spread of the virus has created a booming demand for healthcare. The urgent demands can exceed the health system's maximum capability, depriving the public from accessing medical services and leading to healthcare system disruption.[1] Medical supply chains have also been disrupted, leading to a shortage of medical supplies and devices [1].

In this context, governments have been trying to improve the resilience of healthcare system using various measures, such as ensuring the availability of medical facilities and recruiting more health workers.[2] Meanwhile, to improve the delivery of effective and safe healthcare services to the public, the incorporation of telehealth into healthcare system has been receiving special focus [2]. Telehealth is defined as "*the use of electronic information and telecommunication technologies to* support *long-distance clinical health care, pa-*

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[1] https://www.who.int/news-room/feature-stories/detail/attacks-on-health-care-in-the-context-of-covid-19.
[2] https://www.hrsa.gov/rural-health/telehealth/what-is-telehealth.

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tient and professional health-related education, health administration, and public health.".[2] It is deemed as an effective solution to provide healthcare services while minimizing physical contacts between patients and physicians, and the risk of getting infected by the coronavirus. Therefore, it can protect the health of both patients and health workers [3,4]. Moreover, telehealth can optimize the use of facilities in medical centers by prioritizing medical facilities for patients in critical needs, relieving the pressure of insufficient medical resources and allowing users to receive timely medical consulting [3].

As a key potential technology combating the COVID-19 and providing effective medical service, the development of telehealth is critical for protecting public health and enhancing societal preparedness for future health crises. The public (e.g. patients, physicians) are the key users of telehealth. Hence, understanding the public's perspectives and feedback towards telehealth is of great importance for telehealth's wide application.

To understand the influential factors of the public's acceptance of telehealth, a theory-driven approach is used. The technology readiness model and perceived value theory are selected to be the theoretical basis of this research. Technology readiness refers to users' mental predisposition to use a technology [5]. The acceptance propensity is classified into four dimensions: optimism and innovativeness, which are positive and favorable, acting as drivers of technology acceptance; discomfort and insecurity, which are negative and unfavorable, playing inhibitory roles in technology acceptance [6,7]. The inter-relationship and balance of the four dimensions can determine users' inclination to accept innovations [8]. Depending on their balance, consumers with high positive beliefs tend to be more willing to accept new technologies whereas consumers with high negative beliefs tend to be reluctant to be acceptors. Previous research has supported that the technology readiness model is useful for understanding users' mental readiness to accept technologies [9,10]. Nevertheless, the model has been less utilized to investigate users' acceptance of telehealth. Therefore, this research extends the application of the technology readiness model to the investigation of users' acceptance of telehealth during the pandemic. Integrated with the perceived value theory, which states the importance of expected economic, social and functional utilities obtained from accepting telehealth, this research aims to examine the relationship between technology readiness, perceived value, and telehealth acceptance. Furthermore, to fully consider the influence of social factors, the moderation effect of social influence is examined as well.

Consistent with the research objectives, the research questions are: how do technology readiness factors affect users' acceptance of telehealth via perceived value and attitudes? Moreover, how does social influence moderate the association between perceived value and acceptance of telehealth? To address the research questions, the questionnaire survey was used to collect telehealth users' subjective experiences about telehealth. Structural equation modeling was performed to analyze the collected data. Structural equation modelling is a suitable methodology for this research because it is effective in examining the relationship between more than one dependent variable and independent variables; it can provide a reliable statistical result for the relationship between different constructs [11].

This research makes contributions to the existing literature by proposing a theoretical model combining technology readiness model and perceived value to explain telehealth acceptance's contributors and inhibitors. The empirical results shall provide policy implications to facilitate the acceptance of telehealth.

2. Theoretical model and hypotheses

2.1. Telehealth

Telehealth refers to a broad range of digital healthcare services provided by health professions, including remote health education, digital consulting or treatment, and remote monitoring [12]. Telehealth has been applied in numerous countries to combat the COVID-19. Its applications include live video conferencing that supports communications between physicians and patients[3]; mobile health or websites where patients can seek consultations and receive health notifications [13]. This study refers telehealth to the delivery of health services using technologies, specifically, the provision of consulting, diagnostics, prescription and treatment services via mobile-based apps or webs.

During the pandemic, the usage of telehealth has surged. Based on the report of Mckinsey, the use of telehealth of April 2020 was 78 times higher than that of February 2020.[4] Moreover, it is estimated that users could spend 232 billion EUR on digital healthcare services in 2025 [14]. The benefits of telehealth have become more obvious due to the outbreak COVID-19. First, telehealth allows patients to access medical care at home and relieving the costs of long-distance movement [15]. Moreover, telehealth can control the transmission of the coronavirus by minimizing physical contact [3]. Therefore, it is found that users are becoming more acceptable to telehealth during the pandemic. Whilst a lot of research has reported a high acceptance rate of telehealth services, a few research has reported low acceptance rates in certain areas as well, possibly due to the challenges of using the telehealth [16]. Hence, it is worthwhile to investigate the technology readiness level, as well as incentives and inhibitors of telehealth acceptance to facilitate the development of public health delivery services. Therefore, this research synthesizes the technology readiness model and perceived value theory to empirically investigate influential factors and provide useful implications for users' perceptions and acceptance of telehealth services.

2.2. Theoretical model

In the context of telehealth acceptance, commonly used theoretical models include the technology acceptance model and the unified theory of acceptance and use of technologies [17,18]. For example [17], examined the impact of expected performance, ease of

[3] https://www.healthit.gov/topic/health-it-health-care-settings/telemedicine-and-telehealth.

[4] https://www.mckinsey.com/industries/healthcare/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality.

use, and social influence on users' acceptance of telehealth records. Whilst the performance of telehealth, the expected efforts of usage, and social influence have been proven as powerful explanatory factors of telehealth acceptance, the subjective positive or negative readiness about telehealth has been relatively less explored in previous studies. Therefore, the technology readiness model which measures users' mental incentives or inhibitors of using telehealth is another appropriate approach to investigate users' acceptance of the telehealth [19].

The technology readiness model explains users' positive or negative perceptions about technologies from four dimensions: innovativeness, optimism, insecurity, and discomfort. It has been well applied to examine users' innovation acceptance behavior [20]. To increase the explanatory power, the technology readiness model has often been integrated with the technology acceptance model (i.e., technology readiness and acceptance model) or perceived value theory [10,21]. In this study, the technology readiness model and perceived value theory are synthesized to investigate the factors that influence the acceptance of technology-based health delivery services. Perceived value theory is selected because how the incentives and inhibitors influence users' perceived utilities of telehealth is of interest. Based on the perceived value theory, users' perception of value is determined by their evaluation of the expected benefits obtained from the service compared with the expected cost. The expected benefits and costs can be influenced by users' technology readiness. For example, users with a high level of optimism and innovativeness may perceive that telehealth contains high values, even if it is unfamiliar to them. From this perspective, the synthesis of the two theories can help to identify users' technology readiness levels and perceived utilities, therefore, develop strategies to promote the development of telehealth.

Moreover, whilst previous research has supported that social influence is an important antecedent of the telehealth acceptance [17], this study further hypothesis that social influence can be a moderator between the relationship of perceived value and telehealth acceptance. This hypothesis further examines the impact of how high and low levels of social influence affect the influence of perceived value on the acceptance of telehealth. The hypothesized relationships between the constructs are presented in Fig. 1. The hypothesized positive effects of innovativeness and optimism, as well as the negative effects of insecurity and discomfort, are consistent with the existing research [20,22]. Utilizing the four dimensions of technology readiness model, combined with perceived value, attitudes, and social influence, this theoretical model provides a fitting and coherent explanation of the psychological causes of telehealth acceptance.

2.2.1. The determinants of users' perceived value towards telehealth

The first four arguments propose a direct relationship between four attributes of technology readiness model and perceived value (H_1–H_4). The proposed impact of four technology readiness on perceived value is consistent with the previous literature [21,23].

Optimism is defined as the positivity towards telehealth's effectiveness and efficiency; innovativeness refers to the willingness to be a pioneer of a technology [8,24]. Optimists have a strong tendency to believe that they have good control of a technology, and the technology can help them to complete tasks more effectively [21]. In the context of telehealth, optimistic users hold a positive view of the functions and values brought by telehealth and tend to believe that telehealth is a cost-effective and safe way to receive medical care during the pandemic. Moreover, innovative users are interested in exploring telehealth's attributes and correspondingly, embracing telehealth to enjoy its values. Therefore, it is reasonable to propose the following hypotheses.

H1. Optimism has a positive impact on perceived value.

H2. Innovativeness has a positive impact on perceived value.

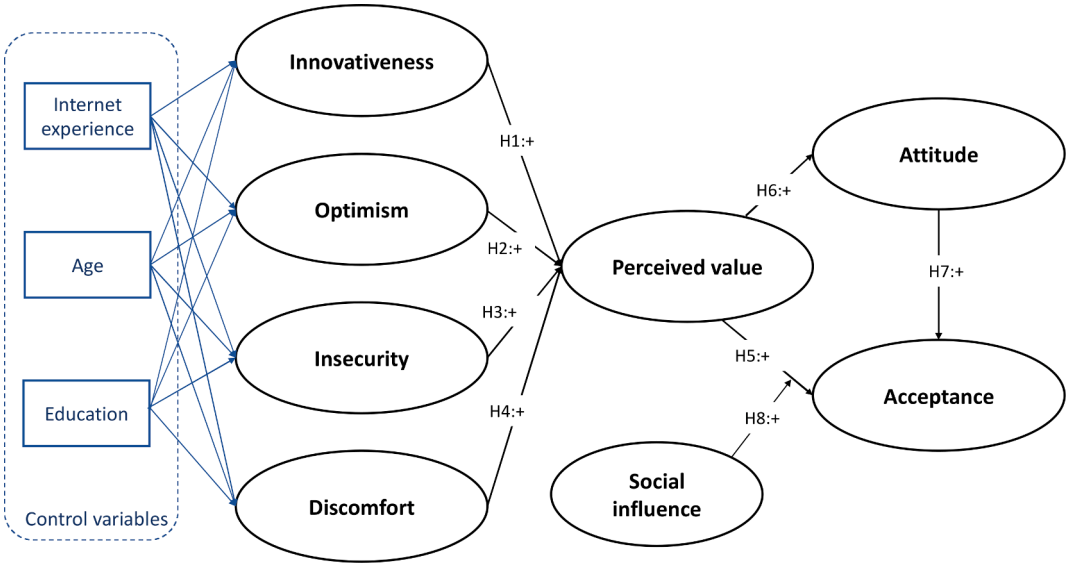

Fig. 1. The theoretical model.

Discomfort refers to the feeling of being controlled by technology and insecurity refers to distrust in telehealth on the abilities to function well and properly [24]. When users feel a lack of control over telehealth, they are likely to be anxious about using such technology. The feeling of being overwhelmed, and not being accustomed to using telehealth can trigger distrust and uncertainties on telehealth's utilities. Moreover, a strong sense of insecurity (e.g., worries about bad internet connection, system failure, misdiagnosis) can lead to skepticism and pessimism about telehealth's utilities, and subsequently, lower perceived telehealth's associated values. Hence, it is rational to propose the following hypotheses.

H3. Discomfort has a negative impact on perceived value.

H4. Insecurity has a negative impact on perceived value.

2.2.2. The direct effect of users' perceived value on acceptance of telehealth

The previous literature has demonstrated that perceived value can be an antecedent of consumers' behavior [25,26]. This can be rationalized by perceived value theory. Users' value perceptions come from the evaluations on the benefits or costs of using telehealth [27]. The value evaluation can stem from the economic, social and functional utility [28]. In the context of telehealth, if using telehealth can reduce total costs either by a reduction in treatment fees or travel fees, the economic value can be improved [29]. Further, when using telehealth effectively delivers satisfactory healthcare services while protecting the patients from being infected by the coronavirus through minimizing physical contact, users can form a high functional value of telehealth. Moreover, telehealth can contribute to the society by optimizing medical resources utilization. As a member of society, the social benefits may persuade users to accept telehealth. In sum, users with high perceived value (e.g. cost considerations and technology-based utilitarian consideration) would perceive telehealth as a rational choice and tend to be willing to accept telehealth. Therefore, the following hypothesis is proposed.

H5. Perceived value has a positive impact on users' acceptance of telehealth.

2.2.3. The indirect effect of users' perceived value on users' acceptance of telehealth

The current research also proposes that perceived value indirectly influences users' acceptance of telehealth via attitude (H_6 – H7). This follows the well-applied value-attitude-behavior model.

Attitude refers to users' positive or negative evaluation of telehealth's effects. It is a learned predisposition that can be affected by psychological and other antecedents. When users perceive a high functional and economic value of telehealth, they tend to establish a favorable attitude. On the other side, when users presume that telehealth brings low values to them, they are likely to form an unfavorable attitude. Furthermore, the impacts of perceived value on attitude has been supported by prior literature [30,31]. Therefore, the following hypothesis is proposed.

H6. Perceived value has a positive impact on attitude.

Previous research has empirically supported the association between attitude and consumer decisions [32–34]. Attitude has been empirically demonstrated to be a moderator between perceived value and acceptance as well [35]. In the current research, technology readiness is hypothesized to influence users' perceived value, which in turn, contributes to the shape of optimistic attitudes. Subsequently, when users believe that using telehealth is a rational and pleasure choice and form a favorable attitude, they are likely to accept telehealth. Therefore, the following hypothesis is proposed.

H7. Attitude has a positive impact on the acceptance of telehealth.

2.2.4. The moderation effect of social influence

The current paper refers to social influence as the influence of other people in society. Individuals are part of complex social networks; therefore, they tend to show conformity to surrounding environments or people to gain social acceptance. The opinions from families, friends, or other important people can exert such social influence on an individual [36]. Therefore, when users are surrounded by people who are using telehealth, possessing positive attitude toward telehealth or recommend using telehealth, their perceived value would be stronger, and they are more likely to be persuaded to accept telehealth. On the other hand, when surrounding people resist using telehealth, users are more likely to perceive lower value on telehealth and less willing to accept telehealth. From this perspective, it is reasonable to propose that social influence functions as a moderator that impacts the effect of perceived value on the acceptance of telehealth. The moderation effect of social influence has been supported by previous research [37,38]. Therefore, the following hypothesis is proposed.

H8. Social influence positively moderates the effect of perceived value on the acceptance of telehealth.

3. Methodology

3.1. Indicator development

To collect empirical data, a self-administered questionnaire is used. Measurement items are adapted from prior literature. The detailed measurement items are listed in Table 1.

Table 1
Measurement items.

Construct	Measurement items	Reference
Innovativeness	Other people would come to me for advice on new technology usage	[39]
	I am usually the first to use new technology in my circles	
Optimism	Digital health technology would give me confidence to engage with professionals	[39]
	Digital health technology would make healthcare services more efficient	
	Digital health technology would give me higher flexibility and control over my healthcare.	
Insecurity	A professional cannot always be accessed online when I need help	[39]
	Consultants via the telehealth system are less reliable than face-to-face health services.	[40]
Discomfort	I feel awkward when having trouble communicating with professionals online when others are watching	[39]
	Human touch is important for medical treatment and Internet connection may lower medical service quality.	[41]
	Digital health technologies might not be helpful because it's more difficult to explain things clearly online.	
Perceived value	I feel that using digital health technology is effective and efficient.	[42]
	I feel that using digital health technology has positive effects on the environment and society	[43].
	I feel that digital health service is reasonably priced	
Attitude	Using digital health technology is a wise idea during and after COVID-19	[44]
	Using digital health technologies would be a pleasant experience	
	I would have positive attitude towards using digital health technologies	
Social influence	People who influence my behavior think that I should use digital health technologies	[45]
	People who are important to me think that I should use digital health technologies	
	People whose opinions are valued by me would prefer that I use digital health technologies	
Acceptance	I would consider using digital health technologies when they are provided by hospitals	[44]
	I would recommend digital health technologies to my families and peers	
	I would encourage others to use digital health technologies	

3.2. Survey design and administration

The questionnaire survey is composed of three sections and takes around 10 min to complete. The first section provided the objective of this research, as well as an overview of the pandemic and telehealth applications (i.e., the provision of consulting, diagnostics, prescription and treatment services via mobile-based apps or webs, such as Doctor Anywhere). Confidential statements were also provided to encourage respondents to give honest answers. In section two, respondents were asked to rate the level of agreement on the twenty-two measurement items listed in Table 1. A 7-point Likert scale was used. Moreover, two logic test questions that ask the respondents to select a predetermined answer (e.g., please select "7" for this question) were mixed in section two randomly. Those who failed to answer the two logic test questions correctly would be deemed disqualified and deleted from the sample because of the failure to pay enough attention to the questionnaire. Finally, respondents' demographic information was enquired in the third section.

The survey was administered with the assistance of a professional survey company, Rakuten Insight. Volunteer sampling is used to collect data via online surveys. The target population is residents in Singapore, where a variety of telehealth services are being licensed and provided. The respondents were required to have experience using telehealth services during the pandemic. A soft launch was conducted from 12th April to 14th April 2021. A total of 50 valid responses were collected to ascertain the reliability of the questionnaire questions. Then a formal survey proceeded from 16th April to 22nd April 2021. A total of 389 respondents failed to pass the logic questions and a total of 500 valid responses were collected.

3.3. Non-response bias and common method bias

Non-response bias and common method bias are two concerns in self-administrated surveys. First, non-response bias happens if the answers from non-respondents differ from respondents. However, the collection of non-responses is not possible (Whitehead et al., 1993). To address this concern, a *t*-test comparison of early and late responses is a common approach (Whitehead et al., 1993). The underlying assumption is that late respondents can be a proxy for non-respondents. They can be considered non-respondents if the data collection period ended earlier (Lahaut et al., 2003). Based on this assumption, all responses were divided into two groups based on the time of completion. The results indicate that there is no significant difference between the respondents who finished early and those who finished late. Therefore, non-response bias is not a major concern in this study.

Common latent factor is used to examine the common method bias. A common latent factor was created and linked to all observed items of the measurement model. The model was run again, and the standardized loadings were obtained. Then the differences between the corresponding loadings with and without the common latent factor were calculated. Results show that the differences were lower than 0.2, indicating that common method bias is not a concern in this study [46].

3.4. Data analysis methods

A two-step approach is used to perform data analysis. The consistency and reliability of all constructs were tested, and a confirmatory factor analysis was conducted to confirm the reliability and validity of the measurement model. Then, a structural equation model was performed to empirically test the relationship between constructs. AMOS 21 was used to perform the analysis.

4. Empirical analysis and discussion

4.1. Demographics characteristics

The respondents' demographic characteristics are listed in Table 2 and described as follows. Males (50%) and females (50%) each take half of the total respondents, and the proportion is similar to the gender distribution of Singaporeans (48.9% males and 51.5% females).[5] The median age is 34, indicating that this sample more reflects the responses from younger generations. The median household income of respondents falls between $8000 to $11990, consistent with the median monthly household income of the total population which is $9189.[6] Furthermore, 67.8% of the respondents hold a higher than a university degree, indicating the respondents are relatively well-educated.

4.2. Reliability test

A reliability test was conducted to examine the constructs' reliability. As shown in Table 3, the Cronbach's alpha values of each construct is above 0.70, indicating good consistency and reliability. Further, the corrected item-total correlation (CITC) coefficients of all measurement items are larger than the critical value (0.5), indicating that the measurement items of each dimension are well under the latent construct [47]..

4.3. Confirmatory factor analysis

A confirmatory factor analysis was performed to examine the measurement model's goodness-of-fit, reliability and validity. The mean, standard variance, standardized factor loadings, average variance extracted (AVE) and composite reliability (CR) are presented in Table 4. The comparative fit index (CFI) is 0.981 and the Tucker-Lewis index (TLI) is 0.976, both well above the threshold value of 0.95 [48]. Moreover, the root mean square error of approximation (RMSEA) is 0.047 which is below the benchmark value of 0.06. The standardized root mean square residual (SRMR) is 0.033, well below the recommended cut-off value of 0.08 [48]. In sum, the results suggest a satisfactory measurement model fit.

Then, the reliability and validity were analyzed. The composite reliability (CR) of all constructs is above 0.70, implying that all measurement items are reliable [49]. Moreover, all latent constructs had AVE values greater than 0.50, indicating a good convergent validity [49]. Furthermore, as shown in Table 5, each construct's AVE value is greater than its corresponding square of correlations, supporting the discriminant validity [50].

4.4. Structural equation modeling and research hypotheses testing

The squared multiple correlation (R^2) of perceived value, attitude and the acceptance of telehealth is 0.855, 0.793 and 0.770, respectively. The values are all greater than 0.75 which are considered substantial [51]. This highlights good explanatory power of the proposed model. The structural equation modelling results are depicted in Fig. 2.

The effect of the three control variables, internet literacy, age, and education on the four dimensions of technology readiness are examined. Empirical results indicate that internet use literacy has a significant impact on discomfort, optimism and innovativeness. This indicates that users with good abilities to take advantage of internet tend to feel less uncomfortable about using telehealth. The finding resonates with previous studies that the level of literacy has associations with acceptance of the telehealth; the knowledge about the internet, as well as the ability to understand the knowledge and usage of telehealth, are incentives of being more confident with using telehealth [52,53]. However, internet literacy is not found to have a significant impact on insecurity, suggesting that rich experiences on the internet do not indicate a significantly lower perception of telehealth's potential risks. Moreover, age is found to have a significant negative impact on innovativeness. However, there is no significant difference between older and younger generations' optimism about telehealth. The result is indicated by the existing research as well [54]. found that the older generations are open to accepting technology-based services in the future. Therefore, although older generation may be less excited about being the pioneers of using telehealth than the younger generation, they can still be positive about the future of telehealth services. Furthermore, education is found to exert a significant impact on innovativeness and optimism, suggesting that users with higher education levels have more confidence in telehealth's effectiveness. Nevertheless, a higher education level does not indicate a significantly lower perception of telehealth's insecurities and discomfort.

After controlling for the impacts of control variables, all hypotheses were examined. Innovativeness is found to exert a positive impact on perceived value, confirming H_1. The result reflects that a high willingness to explore telehealth and be early telehealth users can increase the anticipated value of using telehealth. Optimism has a significant positive on perceived value, therefore, H_2 is supported. Positive expectations of the flexibility, effectiveness and efficiency of telehealth (e.g., provide high-quality health services, high flexibility due to online arrangements) can lead users to be confident in telehealth's values. Discomfort exerts a significant negative influence on positive motion. This highlights that users who are uncomfortable with telehealth tend to have a lower anticipated value due to the feeling of being overwhelmed. Insecurity does not exert a significant impact on emotions. Surprisingly, the effect is not significant. This contradicts previous research that the risks of telehealth are threats to telehealth usage [17,55]. A possible explanation is that the risks listed in the questionnaire survey are not persuasive enough to significantly reduce the expected value obtained from telehealth. Respondents do not significantly lower their perceived value due to insecurity from system stability and in-time service provided by telehealth. This has some association with Singapore's demographic characteristics where technology is well

[5] https://www.msf.gov.sg/Pages/default.aspx.

[6] https://www.singstat.gov.sg/-/media/files/news/press080022021a.pdf.

Table 2
Demographic information.

Characteristics	Items	Frequency (n = 500)	Percentage (%)
Gender	Male	250	50%
	Female	250	50%
Age	Smaller than 35	275	55%
	35–50	175	35%
	Larger than 50	50	10%
Household income	3999 and below	93	18.6%
	4000–7999	156	31.2%
	8000–11,999	139	27.8%
	12,000–19,999	74	14.8%
	20,000 and above	38	7.6%
Education	Post-secondary and below	65	13%
	Diploma	96	19.2%
	Undergraduate	290	58%
	Postgraduate	49	9.8%
Internet literacy	Beginner	8	1.6%
	Intermediate	174	34.8%
	Advance	318	63.6%

Table 3
Reliability test.

Construct	Alpha's Cronbach	CITC coefficient
Innovativeness	0.875	0.784
Optimism	0.935	0.815–0.837
Insecurity	0.803	0.539–0.630
Discomfort	0.855	0.747
Perceived value	0.856	0.617–0.704
Attitude	0.932	0.798–0.864
Social influence	0.962	0.877–0.915
Acceptance	0.920	0.725–0.916

Table 4
Confirmatory factor analysis.

Constructs	Indicator	Mean	SD	λ	AVE	CR
Innovativeness (INO)	INO1	4.84	1.476	0.890	0.784	0.879
	INO2	4.52	1.659	0.881		
Optimism (OPT)	OPT1	5.11	1.424	0.864	0.801	0.924
	OPT2	5.16	1.340	0.922		
	OPT3	5.24	1.318	0.899		
Insecurity (ISE)	ISE1	4.55	1.455	0.716	0.580	0.805
	ISE2	4.60	1.612	0.785		
	ISE3	4.61	1.501	0.782		
Discomfort (DIS)	ANX1	4.03	1.757	0.779	0.763	0.865
	ANX2	4.18	1.694	0.959		
Perceived value (PEV)	PEV1	5.18	1.253	0.882	0.751	0.900
	PEV2	5.32	1.330	0.863		
	PEV3	4.97	1.402	0.855		
Attitude (ATD)	ATD1	5.48	1.177	0.865	0.823	0.933
	ATD2	5.25	1.305	0.922		
	ATD3	5.29	1.273	0.933		
Social influence (SIF)	SIF1	4.54	1.555	0.924	0.893	0.962
	SIF2	4.54	1.600	0.963		
	SIF3	4.59	1.594	0.949		
Acceptance (ACE)	INT1	5.50	1.200	0.773	0.808	0.926
	INT2	5.12	1.427	0.947		
	INT3	5.11	1.396	0.964		

Notes: Model fit indices: $\chi^2 = 377.873$; $\chi^2/df = 1.87$; CFI = 0.981; TLI = 0.976; RMSEA = 0.047; SRMR = 0.033; SD represents standardized deviation; AVE represents average variance extracted; CR represents composite reliability.

Table 5
Discriminant analysis.

	INO	OPT	ISE	DIS	PEV	ATD	SIF	ACE
INO	**0.784**	0.292	0.001	0.090	0.397	0.265	0.315	0.309
OPT	0.541	**0.801**	0.012	0.175	0.723	0.764	0.471	0.691
ISE	−0.021	−0.109	**0.580**	0.201	0.005	0.005	0.007	0.002
DIS	−0.300	−0.418	0.448	**0.763**	0.189	0.154	0.074	0.158
PEV	0.630	0.853	−0.068	−0.435	**0.751**	0.737	0.553	0.657
ATD	0.515	0.879	−0.069	−0.393	0.850	**0.823**	0.424	0.739
SIF	0.562	0.686	−0.082	−0.272	0.744	0.651	**0.893**	0.402
ACE	0.556	0.831	−0.049	−0.397	0.811	0.860	0.634	**0.808**

Note: AVE values on the diagonal; correlation below the diagonal; square of correlation above the diagonal.

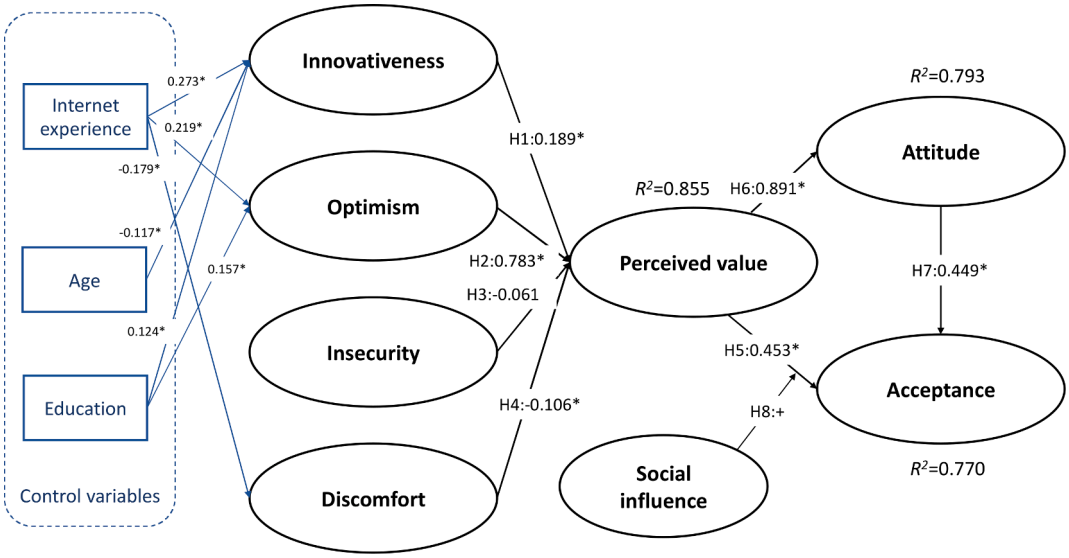

Fig. 2. Structural equation modelling results.

developed and the government is also providing telehealth regulatory guidelines to regulate the market.[7] Future research can use other measurement items (e.g. possible privacy information leakage) to further examine the extent that insecurity impacts users' perceived value. Further, perceived value exerts a significant positive effect on attitudes, supporting H_5. This is consistent with previous literature that posits perceived value can be a predictor of attitude [25,26]. This research empirically supports that the positive relationship exists in the context of telehealth as well. If users perceive high functional, social utilities, and economic utilities of telehealth, they tend to form positive attitudes. Therefore, enhancing service value is critical for promoting the acceptance of telehealth. Next, attitude exerts a significant positive impact on the acceptance of telehealth, supporting H_6. This result also corroborates prior studies, indicating that positive attitudes can be an important psychological factor in consumer behavioral [56,57]. The shaping of a favorable attitude contributes to the decision to accept telehealth. Further, perceived value is found to exert a direct significant impact on the acceptance of telehealth. Hence, H_7 is supported. This suggests that attitude partially mediates the effect of perceived value on users' acceptance.

Finally, the moderation effect of social influence was examined and the results are presented in Table 6. The methodology employed by Ref. [58] was used in this study. The sample was split into two sub-groups based on the mean value of the social influence construct. The high subgroup consists of responses that are above the average ratings (n = 264) while the low sub-group consists of responses that are lower than the average ratings (n = 236). Then the model was run again. Results show that when social influence is low, the standardized path coefficient of user's perceived value on the acceptance of telehealth was 0.286; when social influence is high, the standardized path coefficient is 0.607. Next, the chi-square difference between the constrained model and the unconstrained model was compared. The test result shows that the influence from perceived value to the acceptance of telehealth was significantly different ($p < 0.05$). Therefore, H_8 is supported. The result corroborates the existing literature that social influence has a significant influence on people's acceptance of the telehealth [52]. [59] also found that the older generations are affected by the telehealth readiness of people around them. The result indicates that a supportive environment can encourage users to perceive the high value of telehealth and be more willing to accept telehealth.

[7] https://www.hsa.gov.sg/.

Table 6
Moderation effect test result.

Construct	Low	High	χ^2/df (path-constrained model)	χ^2/df (path-unconstrained model)	$\Delta\chi^2/\Delta df$	Test result
SIF	0.286	0.607	776.3/377	772.4/376	3.9*	H_8 supported

Note: *P < 0.05.

4.5. Bootstrapping analysis

A bootstrapping analysis was performed. By means of sampling with replacement, samples with 500 responses was created. Next, the direct, indirect and total effects were examined using the created sample. The sample was replaced one thousand times. Then, 95% bias-corrected percentile confidence interval was constructed and the two-tailed significance value was evaluated. The direct, indirect and total effects are presented in Table 7, further confirming the robustness of this theoretical model.

Among the factors that influence perceived value, optimism has the greatest total effect on psychological capital (c_{21} = 0.783). This is followed by balanced inventiveness (c_{11} = 0.189) and discomfort (c_{41} = −0.106). Perceived value, optimism, inventiveness, and discomfort are the factors that had the highest overall effects on attitude (c_{52} = 0.891, c_{22} = 0.697, c_{12} = 0.168, and c_{42} = −0.095, respectively). Perceived value has the biggest overall effect on the acceptance of telehealth (c_{53} = 0.853). The second place goes to optimism (c_{23} = 0.668). Attitude (c_{63} = 0.449), inventiveness (c_{13} = 0.161), and discomfort (c_{43} = −0.091) come after.

5. Conclusion

5.1. Discussion

COVID-19 has been posing challenges to healthcare system and public health. Telehealth is exhibiting its great potentials in providing efficient and safe healthcare services during health crises or disasters. To facilitate the application of telehealth and make preparedness for future health risks, it is critical to understand the psychological states of telehealth's users. In this light, this research aims to investigate how technology readiness factors affect users' perceived value and acceptance of telehealth during COVID-19. The structural modeling equation results indicate that younger generations are more willing to be pioneers of telehealth services. As there is no significant evidence that older generations are optimistic or passive about telehealth, the chances to deliver telehealth services to older generations should be further investigated. Moreover, it is found that innovativeness, optimism significantly enhances perceived value towards telehealth while discomfort significantly lowers users' perceived value. Nevertheless, insecurity does not have a significant negative impact on perceived value. Whilst ample research has identified that risks of telehealth can prohibit users from accepting the telehealth [55], the result of this research indicates that during the health crisis, the benefits of telehealth are becoming more evident; in this case, risks that cause fewer concerns may not significantly lower users' perceived value of telehealth. Further, attitude partially mediates the effect of perceived value on the acceptance of telehealth. Perceived value can lead to the formation of an optimistic attitude which consequently motivates users to accept telehealth. The result highlights the significance of enhancing users' perceived utilities of telehealth by developing incentives and controlling inhibitors. Lastly, social influence is found to significantly

Table 7
Direct, indirect and total effects.

	Perceived value(j = 1)	Attitude (j = 2)	Acceptance (j = 3)
Direct effect (aij) of			
innovativeness (*i* = 1)	0.189 [0.093,0.277]	–	–
Optimism (*i* = 2)	0.783 [0.703,0.856]	–	–
Insecurity (*i* = 3)		–	–
Discomfort (*i* = 4)	−0.106[-0.180,-0.041]	–	–
Perceived value (*i* = 5)	–	0.891 [0.856,0.922]	0.453 [0.273,0.641]
Attitude (*i* = 6)	–	–	0.449 [0.252,0.637]
Indirect effect (bij) of			
innovativeness (*i* = 1)	–	0.168 [0.084,0.243]	0.161 [0.081,0.238]
Optimism (*i* = 2)	–	0.7697 [0.607,0.777]	0.668 [0.592,0.743]
Insecurity (*i* = 3)	–	–	–
Discomfort (*i* = 4)	–	−0.095 [-0.160,-0.036]	−0.091 [-0.156,-0.035]
Perceived value (*i* = 5)	–	–	0.400 [0.223,0.570]
Attitude (*i* = 6)	–	–	–
Total effect (cij) of			
innovativeness (*i* = 1)	0.189 [0.093,0.277]	0.168 [0.084,0.243]	0.161 [0.081,-.238]
Optimism (*i* = 2)	0.783 [0.703,0.856]	0.697 [0.607,0.777]	0.668 [0.592,0.743]
Insecurity (*i* = 3)	–	–	–
Discomfort (*i* = 4)	−0.106 [-0.180,-0.041]	−0.095 [-0.160,-0.036]	−0.091 [-0.156,-0.035]
Perceived value (*i* = 5)	–	0.891 [0.856,0.922]	0.853 [0.819,0.887]
Attitude (*i* = 6)	–	–	0.449 [0.252,0.637]

Note: Only hypothesis-supported results are presented; absolute value is used when comparing direct effects, indirect effects and total effects.

enhance the relationship of perceived value on the acceptance of telehealth. This finding supports the significance of creating a supportive social environment [52].

5.2. Theoretical and practical implications

This research contributes to the literature by providing a satisfactory framework to predict telehealth acceptance. Whilst previous research has investigated perceived usefulness, perceived ease of use, and various social factors, this study offers a perspective from how psychological incentives and inhibitors explain users' acceptance of telehealth. The proposed nomological network is based on the composition of technology readiness, perceived value theory and attitude. This model provides explanations on how positive and negative feelings about telehealth influence perceptions of telehealth's utilities, which subsequently leads to acceptance. The nomological structure exhibits good explanatory power, explaining a significant variance of users' acceptance of telehealth ($R^2 = 0.767$). Moreover, this study provides information on demographic differences in users' technology readiness. Overall, this study provides theoretical contributions to improving the public's technology readiness level, highlighting the necessity to enhance users' perceived value and convince the public of telehealth's effective functions.

The results provide managerial implications for the development of telehealth. Regarding the implications drawn from demographic characteristics, as internet literacy is found to exert a significant impact on users' technological mindfulness (i.e. optimism, innovativeness, discomfort), improving the public's internet literacy is of critical importance. The result supports that in the era of digitalization, improving the public's skills in utilizing the internet's benefits is beneficial for making people more positive and comfortable about using telehealth. To enhance internet literacy, educational activities can be organized within communities. Moreover, educational videos can be made and spread by social media to educate the public about useful and practical internet use tips. Furthermore, considering that the older generations have lower innovativeness than the younger generations, and the older generations are a special population requiring relatively more medical care, more social support can be provided to the older generation to encourage them to use telehealth services.

Regarding the implications drawn from technology readiness factors, policies can be formulated to improve the level of technology readiness, specifically, to enhance the level innovativeness and optimism and reduce discomfort. To build the public's confidence in using telehealth, the efficiency and benefits of using telehealth can be promoted via trustworthy media channels. Moreover, a reliable telehealth platform needs to be constructed and maintained. Telehealth developers should keep updating telehealth based on users' feedback to ensure the provision of high-quality, in-time service. Further, to reduce discomfort, telehealth apps or websites can be made user-friendly and user-interested by simplifying procedures and ensuring active interaction between physicians and patients. Active designs can trigger positive emotional feedback, reduce discomfort and encourage more engagement. Policymakers are also suggested to understand users' opinions about telehealth risks more deeply and allocate resources to deal with critical concerns.

Considering that perceived value has a positive influence on telehealth acceptance via attitudes, telehealth service providers and platforms can seek to improve their service from functional, economic, and social utilities. Suggested measures include deploying strategic and reasonable prices; providing convenient and reliable medical consulting, diagnosis and treatment; marketing the effectiveness of telehealth. Through proper marketing and continuous technological improvements, the public can have a better acknowledgement of telehealth's values and be more willing to accept telehealth.

Lastly, as social influence positively moderates the relationship between perceived value and the acceptance of telehealth, it is important to create a supportive social atmosphere by providing social support to users and publicizing the benefits telehealth.

5.3. Research limitations

This study has several limitations. First, the survey was conducted in Singapore which has its demographic characteristics. Future research can cross-validate the results by examining users' technological mindfulness in different regions and cultural backgrounds. Second, this study uses four dimensions of technology readiness, perceived value, and attitude to construct a theoretical model. Future research can extend the explanatory model by adding other theories or constructs. For example, the integration of the technology acceptance model and technology readiness model, or the application of other technology acceptance theories can be investigated. Third, 389 questionnaire surveys were deleted from the sample to ensure the validity of responses. However, there is a possibility that the respondents failed the attention checker due to lower education level, lower household income, or older age. Therefore, future studies can pay more attention to the responses of those who failed to pass logic questions. They can also increase the sample size or perform more nuanced studies on users' acceptance behavior among respondents with different demographics.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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