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Accelerating the adoption of booster vaccine shots: From the psychological and behavioural perspectives

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Abstract

Taking booster vaccines plays a critical role to enhance the effectiveness of vaccine programs and their positive externalities to community health. This study treats the booster vaccine as a value and expands the theory of planned behaviour to examine determinants of behaviours to take that value among the public. Mixed research methods are used in this study. While qualitative data from the in-depth interviews support the identification of new themes serving the development of hypotheses and measurement scales, quantitative data from 771 respondents from all walks of life are employed to provide generalized findings. The estimation results indicate five factors that drive the intention to take the booster vaccine shots, including perceived behavioural control, subjective norms, switching costs, communication quality and health concern. More interestingly, results from another follow-up survey about their actual behaviour imply that given the existing intention, those who demonstrate good objective knowledge about booster vaccines are more likely to take the booster shot in practice. These findings draw important implications for policymakers to encourage the behaviour of taking booster vaccines.

Keywords: booster vaccine; theory of planned behaviour; switching costs, communication quality; health concern; objective knowledge.

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1. INTRODUCTION

Vaccination is a method aimed at enabling individuals to develop immune responses against infectious diseases through the use of vaccines. The protection effect of some vaccines only works well when the original or primary dose is given along with a booster shot. While the original dose activates the immune system to recognize and produce antibodies against the virus, the booster ones are needed to remind the body's immune system about the virus against which it was created to defend. There are several reasons for the necessity of the booster dose (WHO, n.d). First, some people are so immunocompromised that they do not respond adequately to the primary vaccine dose as other healthy ones. The booster shot is, therefore, crucial as the previous doses have not done what they are supposed to. Second, as time flies, the immunity attained from the primary vaccine dose starts to deteriorate. In this case, the booster shot would give the immune system "a boost". Third, the existence of virus variants over time may reduce the actual performance of the vaccines. The booster dose could be designed to help the immunity well defeat the virus variants.

Given the importance of the booster vaccine especially under the context of the recent Covid-19 pandemic, there is a growing body of research which examines the factors that affect either the likelihood of taking the booster vaccines or the booster vaccine hesitancy/refusal among the vaccinated adults. As the topic is new and context-based, most of the previous works start with the exploratory approach to the development of the conceptual model. Several studies further collect quantitative data to serve the validation and testing of hypothesised relationships. Perceived risk or uncertainty is emerged as the most prominent factor that causes booster vaccine hesitancy due to two reasons. First, they may place low trust in either government or the vaccine delivery system (Bennett et al., 2022; Huang et al., 2023). Second, while the safety of the booster vaccine (i.e.possible side effects to their short-term and long-term health) is questionable, they also doubt the efficacy of the booster vaccine (Cunha et al., 2022; Noh et al., 2022; Paul and Fancourt, 2022). Level of knowledge and media coverage are also found to enrich citizens' confidence about the booster vaccine dose and encourage the likelihood of taking booster shots (Cokro et al., 2022; Wang et al., 2022). On the other hand, some research examine the determinants of the behaviour to adopt the booster dose from the theoretical framework of planned behaviours. Correspondingly, other behavioural factors are also affirmed to influence the intention to take the booster shot, including attitudes, perceived behavioural control, and perceived support from significant

others such as family, friends, doctors, and the government (Cokro et al., 2022; Wang et al., 2022). Due to the urgency and widespread effects of the Covid-19 virus, the recent literature about the booster vaccine dose mostly focuses on the Covid-19 vaccine. Since during the 2021-2022 period, the vaccine and its booster dose were relatively new, it is not surprising that perceived risks, uncertainty, and doubts about its safety, efficacy, and delivery system emerged as the most important factors that discourage booster shot adoption. However, given the proven effectiveness of Covid-19 vaccines and many other popular vaccines (that may be adopted for even decades) until now, it is necessary to revisit this research stream with a variety of vaccines in a normal setting. In addition, despite that the theory of planned behaviour has been employed in examining determinants of the booster spot application, the use of this theory itself implies some research gaps. First, the theory of planned behaviour is criticized for merely considering cognitive factors related to subjective judgments and evaluations and their impacts on behaviour while neglecting other possible emotional determinants (Corner et al., 2013) and personality (Nguyen Thi Tuyet et al., 2017). In addition, the intention-behaviour gap does exist and calls for further research in various contexts, especially in case of health-related behaviours (Orbell and Sheeran,1998).

In response to those gaps, this research attempts to examine the factors that either encourage or hinder the intention to take the booster vaccine of various types in a normal setting (no vaccine is neither too new nor risky). Based on the original theory of planned behaviour, we first employ the exploratory approach to expand this model using qualitative data from in-depth interviews. The thematic analysis reveals three additional factors that possibly influence the intention to take the booster shot including health concerns, perceived risks, communication quality, and switching costs (i.e. costs of quitting the booster shot for alternative defending methods against viruses). Quantitative data is collected later through two surveys which are launched three months apart. While the first survey helps measure the potential determinants, objective knowledge about the booster vaccine, and intention to take the booster vaccine, the follow-up survey tracks the respondents' actual behaviour. Based on quantitative data from the two surveys, we validate and test the moderating role of objective knowledge, which may influence individuals' confidence about the value of booster vaccines (Yupari-Azabache et al., 2022), in the intention-behaviour gap.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1. The adoption of the Theory of Planned Behaviour

Given the importance and risk of getting the vaccine to humans' lives, we treat the taking of booster shots as a planned behaviour which could be driven by clear motivation as reflected by beliefs, efforts, and intention to carry it out (Ajzen, 1991). The theory of planned behaviour has long been the most prominent model for predicting human behaviours. Specifically, this model highlights the central role of intention, as the temporary cognitive state, and its three determinants, including attitudes towards the behaviour, subjective norms, and perceived behaviour control in predicting a well-thought behaviour.

As the function of behavioural belief (Ajzen, 2002), an attitude towards conducting a behaviour indicates how strongly an individual believes that performing such behaviour will result in positive outcomes. In this regard, a more favourable attitude further boosts an intention and hence raises the likelihood that behaviour is actually executed (Ajzen, 1991). Empirically, positive attitudes towards getting the booster shot are affirmed to negate hesitancy to take the booster Covid-19 vaccine among either the elderly in North Jakarta (Cokro et al., 2022), the cancer patients in China (Wang et al., 2022), and citizens in Ghana (Storph et al., 2023). During our qualitative research, when facing the question "Why do you intend/don't you intend to take the booster shot?", the respondents share various concerns regarding the possible outcomes of the booster shot, including the efficacy of the booster vaccine to either enhance their defensive immunity against the virus or reduce the likelihoods of infection, infecting, and hospitalization.

H1: Attitude influences the behaviour of receiving booster vaccination.

Subjective norms refer to the perceived social pressure from important groups of people towards the decision to perform a behaviour or not. Due to the inherently social nature of humans, individuals tend to pay attention to signals of behaviour, attitudes, and values that are widely accepted by others (Nolan et al., 2008). In the context of consumer behaviour, Liu et al. (2019) consider these acquaintances (family members, friends, and colleagues) as the primary source of social norms and found their positive impact on willingness to purchase. In the context of vaccination, the influence of social relationships, such as family members, colleagues, and healthcare professionals, on vaccination decision-making, is found significantly positive (Hossain et al., 2022). If they know that the majority wants to receive the coronavirus vaccine, this can help them believe that this behaviour is appropriate, effective, and should be followed. From another perspective, Machida et al. (2021) affirm that

a higher level of collective responsibility promotes individuals' vaccination intentions. When individuals know that others can benefit from their vaccination, it can increase their willingness and intention to be vaccinated (Rieger, 2020). When it comes to booster vaccination, subjective norms, in the forms of support and encouragement from family members, friends, doctors, and the government are found to motivate the intention to take the booster shots (Cokro et al., 2022). The qualitative data collected from the in-depth interviews in this study also reveal that the respondents are confident and motivated to receive the booster shots thanks to the encouragement of the government, family members and the community at large. In addition, they are also confident about such a decision since they observe similar behaviour among their friends.

H2: Subjective norms influence the intention and behaviour of receiving booster vaccination.

Perceived behavioural control is linked to perceived self-efficacy or an individual's assessment of their capability to perform a specific behaviour (Ajzen, 2002). In this regard, a similar linkage may exist concerning the behaviour of receiving booster vaccination. It is noted that vaccination is not always free. Previous works by Richter et al. (2022) and Hossain et al. (2022) reveal that many individuals tend to refuse vaccination due to financial issues. In addition, insufficient time for vaccination, coupled with inconvenient travel and waiting procedures, are also two reasons why many individuals decline booster vaccination (Tokiya et al., 2022). In the same vein, qualitative findings from in-depth interviews also reveal barriers to the booster vaccine, including money, waiting time, and complicated procedures. There is another barrier that emerged from our qualitative phase is the lack of control regarding the safety of the booster vaccine. Specifically, the respondents perceive that they have no way to make sure about the safety of the vaccine. Such a sense of lack of control may be originated from low trust towards the vaccine delivery system. (Islam et al., 2022).

H3: Perceived behavioural control influences the intention and behaviour of receiving booster vaccination.

2.2. The expansion of the Theory of Planned Behaviour

Despite the popularity and validity of the theory of planned behaviour in numerous empirical studies in various contexts, including booster vaccination, this theory is still criticized due to 2 reasons. First, this theory has been criticized for focusing only on rational reasoning while neglecting the role of emotions or affective determinants and (Corner et al., 2013) and personality (Nguyen Thi Tuyet et al., 2017). In addition, empirical studies show the existence of a certain gap between intention and behaviour (Ajzen, 2011), indicating a weak

indicating function of intention when translating into actual actions. Orbell and Sheeran (1998) conducted a longitudinal test and also find it problematic when predicting health-related behaviour by surveying their intention at a point in time. One of the most prominent reasons for the intention-behaviour gap is the existence of moderating factors in the relationship between intention and behaviour. Specifically, intention which is formed with high confidence and commitment will more likely lead to actual behaviour (Ajzen et al., 1982). The reason is that there exists a time gap between the formation of intention and the execution of actual behaviour. During this time span, the behaviour may be hindered by the emergence of new information or competing intentions. Correspondingly, the more regret that the decision maker perceives when they do not perform a specific behaviour, the higher likelihood that the behaviour is actually conducted (Sheeran, 2002).

To expand the application theory of planned behaviour in this research context, a qualitative research approach is employed to explore more determinants of intention to take the booster vaccine. First, the qualitative data collected from the in-depth interviews with 20 citizens from all walks of life reveal three additional factors that emerged as the potential determinants driving the intention to receive the booster shots of various types of vaccines, including perceived risks, health concerns and switching costs.

Perceived risk refers to the feeling of uncertainty about the outcome of a specific decision or transaction. This uncertainty directly affects the formation of intentions (Wei et al., 2018). According to Bauer (1960) perceived risk is the risk that an individual perceives primarily due to their lack of either information or understanding. Since the vaccination itself, either primary or booster shots carry risks and potential side effects such as allergic reactions, blood clotting, or even rare Guillain-Barre syndrome, perceived risk may always exist regardless of how much they trust the vaccine delivery system. In the context of vaccination, health behaviour models assume that perceived risk is a predictor of behavioural intentions, and is related to vaccine hesitancy and vaccination uptake (Benin et al., 2006; Brewer et al., 2007). Findings from our qualitative research phase indicate various concerns among citizens when being asked about the intention to take the booster vaccines. Specifically, most of them are worried about the efficacy (i.e. if not effective, they may lose time and effort spent on the booster shot) and safety of the booster shot such as side effects, expiry date, and the accusation of the vaccine type. In addition, their perceived risk is also embedded in their low trust in the purpose of the vaccine. Specifically, some respondents are afraid that vaccines and their booster spots are products of economic warfare (the idea of viruses and vaccines developed in a laboratory for financial

gain) or biological warfare (population reduction policy, genetic modification, personal data collection, etc.). Thereby, they would be a victim if taking either the primary/booster shots. Those findings are quite consistent with recent studies about the COVID-19 vaccine and booster hesitancy and refusal. Specifically, uncertainty about the safety and efficacy of the booster doses (Cokro et al., 2022; Cunha et al., 2022; Huang et al., 2023; Noh et al., 2022) and fears about the short-term and long-term side effects of the booster vaccine are found as the inhibiting factors underlying the hesitancy or refusal to the booster shot.

H4: Perceived risk influences the intention to receive a booster vaccination.

Switching costs refer to the related costs that buyers face when switching from one product supplier to another. Those costs can be categorized into at least two types: performance loss costs and uncertainty costs. The former refers to the potential loss of performance benefits and privileges guaranteed through continued patronage of a specific brand or product (Burnham et al., 2003). Those benefits and privileges are primarily originated from the value of the core service and thus create positive motivations to maintain the current exchange (Jones et al., 2002). Meanwhile, the latter indicates the psychological uncertainty surrounding the new choice of an unknown or untested service provider (Jones et al., 2002). Those uncertainty costs are higher when the quality is difficult to evaluate or significantly varies among choices.

Findings from the in-depth interview indicate that some respondents intend to quit the booster shot because they think it is better and feasible to rely on either their immunity system (that has been somewhat enhanced from the primary shot) or alternative measures which could be cheaper, safer and recommended by their families or friends. Meanwhile, others are worried about the performance costs of not taking the booster vaccine such as loss or reduction of defensive effects against the virus or more severe illness once infected. In fact, the booster vaccine could be a product with a certain value. Previous works also reveal that the availability of possible alternative defensive measures against the virus does inhibit the acceptance of either primary or booster vaccines. In the context of recent Covid-19 vaccination, Reifferscheid (2022) suggests that individuals who have recovered from COVID-19 are more likely to refuse booster doses due to their belief in antibodies. Additionally, many people trust the use of medications rather than vaccination for COVID-19 treatment due to concerns about side effects and doubts about the effectiveness of vaccines (Sun et al., 2022). Moreover, Quin (2022) revealed that a significant portion opts for healthy eating and regular exercise as substitutes for vaccination. Based on this theme, we treat “not

receiving booster shots" as a switching behaviour - quitting the booster shot to switch to the reliance on the body's existing immunity and alternative preventive methods and propose that:

H5: Switching costs positively affect the intention to receive a booster vaccination.

"Health concern" is the attitude that people perceive the healthiness of the products they put in their body and their lifestyle (Yang et al., 2014). Given a desired state of well-being, those who are health-conscious would be more likely to commit to healthy behaviours aiming at their goals for healthy living (Newsom et al., 2005). Thematic analysis of respondents' answers during the qualitative phase indicates that the receipt of vaccines is comparable to the consumption of healthy products. Taking the booster vaccine is depicted by some respondents as a "healthy lifestyle" or "healthy act". Empirical studies affirm the influence of health concerns on the intention to purchase organic food (Iqbal et al., 2021), green furniture (Xu et al., 2020), and personal care products (Kim and Chung, 2011) which are deemed to be good for health. Given a similar theme, we propose the following hypothesis

H6: Health concern positively affect the intention to receive a booster vaccination

Communication is a part of a marketing mix strategy and it is all about how well messages are communicated to customers. More specifically, this construct indicates the extent to which an individual is kept in touch and provided with timely and trustworthy information and helpful advice (Ball et al., 2004). Eventually, those communication activities could affect the audiences' perceptions, attitudes and behaviours. Previous studies affirm that higher exposure to vaccination information or media coverage, which helps mitigate citizens' doubts, is found to reduce the unwillingness to receive the booster Covid-19 vaccine (Cokro et al., 2022; Wang et al., 2022). In fact, findings from our qualitative research phase also indicate that the communication campaign about the importance of booster vaccines and the reminders from either the doctors, health care centres, or vaccination centres about the booster help customers actively remember the booster shot deadline and motivate their intention to receive the dose.

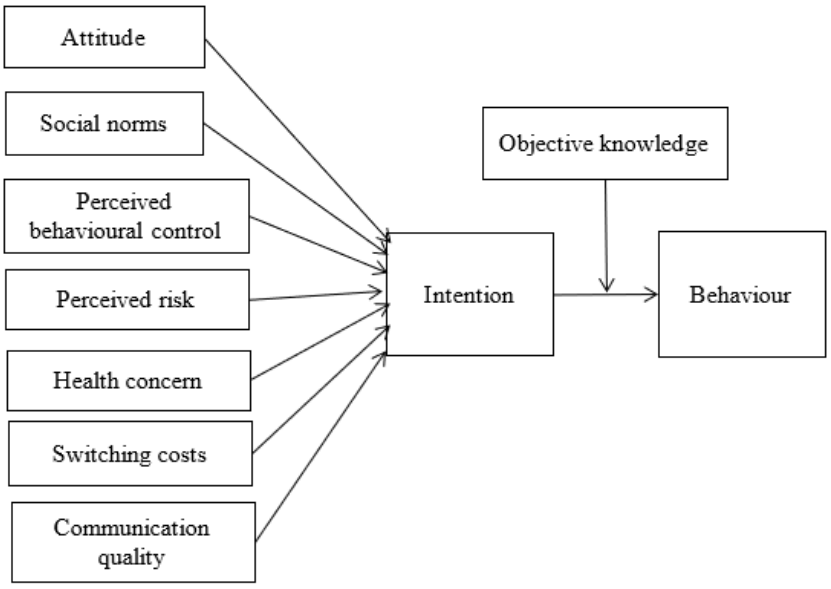
H7: Communication quality positively affects the intention to receive a booster vaccination.

Knowledge is an important construct in understanding human behaviours. The literature on knowledge distinguishes between objective and subjective knowledge. While the former refers to information stored in human's long-term memory that can be measured based on quiz scores, the latter refers to one's self-

evaluation of their levels of knowledge (Chang et al., 2016). Among the two forms of knowledge, objective knowledge is more relevant to the precision of value estimates and how communication messages are processed (Frankerberger and Liu, 1994). Therefore, this study gives a primary focus on objective knowledge about the booster vaccine. Regarding the intention-behaviour gap, Ajzen (1991) and Sheeran (2002) assert that confidence and commitment to the behaviour will help strengthen the stability of intention until an actual behaviour is translated. Knowledge is pointed out as one of the internal factors that could regulate the link between intention and behaviour through their influence on volitional control (Ajzen et al., 1982). We, therefore, argue that those who demonstrate better knowledge about the booster vaccine will be more confident and persistent about the decision to take the booster shoot. That confidence and commitment will strengthen the linkage between their intention and behaviour regardless of the incidents of new information during the waiting time.

H7: Objective knowledge about the booster vaccination positively moderates the relationship between intention and behaviour to take the booster shot.

Figure 1: Research model



3. RESEARCH METHODOLOGY

3.1. Data collection

Since there is a lack of literature about neither examining the determinants of taking booster vaccines nor validating the measurement scales of each construct in the theory of planned

behaviour in the context of vaccine consumption, this research combines both qualitative and quantitative approaches. Specifically, the qualitative study is conducted first to either explore the detailed dimensions of attitudes, subjective norms and perceived behavioural control associated with taking booster vaccines or expand the theory of planned behaviour to include more possible determinants.

Phase 1: Upon qualitative method, an in-depth interview was conducted in February 2023 on twenty participants who were selected to ensure diversity in terms of age, gender, education level, and levels of physical health (with and without background diseases). Interview moderators are trained and provided with a list of open-ended questions in advance to guide and encourage the interviewees to share their ideas. Some key questions include: "Which vaccine have you recently taken?", "Do you intend to take the booster vaccine? And why?"; "Have you ever missed, delayed or quit a booster vaccine? And why?". Upon prior consensus of the participants, each interview lasted about 30 minutes and the information collected was hand-written by two observers for cross-checking. The qualitative data was then under thematic analysis to formulate measurement scales and support hypothesis developments.

Phase 2: Quantitative data were collected for evaluating the measurement scales and testing hypotheses. We employed survey method and designed an online questionnaire as the primary data collection tool. The measurement scales used in the questionnaire were either adopted from previous studies or developed based on qualitative data collected from the first research phase (See Table 1). After being reviewed by four experts in marketing and vaccine fields for face validity, the questionnaire was pretested with ten participants from all walks of life in order to ensure its quality and mitigate any potential response bias (Hague et al., 2004).

Phase 3: The contact addresses of each respondent in Phase 2 were saved so that a follow-up survey was then conducted to track their actual behaviour of taking the booster vaccine. Based on the timing of the booster vaccine (as disclosed in the first survey), we contact the respondent and ask whether they have taken the booster vaccine as scheduled. The follow-up survey was not informed in advance to mitigate any potential response bias.

Table 2: Measurement items

Constructs	Items	Description	Sources for adaptation
Attitude towards taking the booster vaccine (ATT)	ATT1.	Taking the booster vaccine makes me more defensible against the virus	Ajzen (1991); Wang et al. (2022)
	ATT2.	Taking the booster vaccine reduces the likelihood of infection	

Constructs	Items	Description	Sources for adaptation
	ATT3.	Taking the booster vaccine reduces the likelihood of infecting others	
	ATT4.	Taking the booster vaccine reduces the likelihood of hospitalization	
Perceived behavioural control (PBC)	PBC1.	The booster shot is expensive	Ajzen (1991); Richter et al. (2022); Tokiya et al. (2022)
	PBC2.	The booster shot can take a long time	
	PBC3.	The procedure for injecting booster shots is inconvenient	
	PBC4.	There is no way to check the safety of the booster vaccine	
Subjective norms (SN)	SN1.	The State encourages people to get booster shots of the vaccine	Ajzen (1991)
	SN2.	The community in general encourages people to get booster shots	
	SN3.	My family members support me with booster shots	
	SN4.	My friends also get booster shots	
Health concern (HEA)	HEA1.	I often think about health-related issues	Iqbal et al. (2021)
	HEA2.	I think I'm a person who cares about health	
	HEA3.	I usually choose healthy products	
	HEA4.	I normally buy health products again if I have a good experience	
Switching costs (SWC)	SWC1.	Switching to other preventive measures is not as effective as taking the booster shot	Whiiten and Wakefield (2006)
	SWC2.	If I quit the booster shot, the disease prevention effectiveness of the original vaccine will be reduced.	
	SWC3.	If I quit the booster shot and switch to other preventive measures, the probability of my infection will be high	
	SWC4.	If I quit the booster shot, it becomes more difficult to treat the disease once being infected	
	SWC5.	I am worried that I will lose the special benefits of the vaccine in virus prevention by not getting the booster shot	

Constructs	Items	Description	Sources for adaptation
Perceived Risks (RISK)	RISK1.	I am afraid that taking the booster vaccine will have side effects	Hossain et al. (2022) ; Sun et al. (2022)
	RISK2.	I am afraid that taking the booster vaccine will not be effective because of the rapid mutation of pathogenic viruses/bacteria	
	RISK3.	I am uncertain about the booster vaccine's expiry date	
	RISK4.	I am afraid of getting the wrong types of the booster shot	
	RISK5.	I am afraid that vaccines and their booster spots are merely products of economic warfare	
Communication quality (COM)	COM1.	I am well-informed about the importance of booster shots	Ball et al. (2004)
	COM2.	I am reminded regularly to get a booster shot	
	COM3.	I am satisfied with the communication activities related to the booster vaccination	
	COM4.	I love the media about booster shots	
	COM5.	The communication content about booster vaccination is very up-to-date	
	COM6.	The media about booster shots are very helpful	
Knowledge towards booster vaccine (KNOW)	KNOW	Objective knowledge about booster vaccines is measured by five statements that are either true or false. We also include the ''I don't know" answer while still encouraging respondents to think to make sure they did not select the answer by chance. The total number of correct answers is used to score objective knowledge measure, thus ranging from 0 to 5.	Park et al. (1994)
Intention to take a booster vaccine (INT)	INT1.	I will consider taking the booster shot	Paul and Patel (2016)
	INT2.	I look forward to getting a booster shot of the vaccine in the near future	
	INT3.	I plan to prioritize booster shots for disease prevention over other preventive measures alone.	
	INT4.	I definitely want a booster shot in the near future	

Constructs	Items	Description	Sources for adaptation
Behaviour (BEHV)	BEHV	Dummy variable that takes value of 0 if the respondent did not take the booster vaccine as scheduled and 1 if he/she has already taken the projected booster vaccine	Ajzen (1991)

In this research, we conducted a longitudinal study (from February to the end of May of 2023) to both measure the intention at a point in time and track their actual behaviour. However, due to the time limit and the purposes of this study, we aim to access the target population including Vietnamese citizens, from both the North, the Middle, and the South of this country, aged 18 and above, who have neither persistent disease nor side effects from previous doses and need to complete at least one booster dose awaiting within the next 3 months. Unlike children, taking the vaccine is not popular among Vietnamese adults. Therefore, to reach such a special target population, we employed snowball sampling. Specifically, we first sent the online questionnaire to three small groups of people currently living in the three areas and of different age ranges and satisfying the above sampling criteria. Next, we ask those respondents to invite others with similar vaccination histories to join.

4. RESULTS

4.1. Sample structure

Among 800 responses received, 711 responses are usable while the remaining is either incomplete or has clear signs of response bias. As shown in Table 1, the research sample covers both males and females (although the share of female respondents is quite dominant - 67.4%). Our respondents are mostly aged between 18 and 44 (91.1%). This percentage is deemed to be reasonable since during this age range, the human bodies are in good condition to take vaccines the most. Our sample is relatively diverse regarding the respondents' occupations and income. This allows us to reach generalized findings across different knowledge levels and social classes in society. As Covid-19 is the latest pandemic in Vietnam and there are still many Covid-19 cases every day in this country, the majority of respondents have just taken Covid-19 vaccines as their latest vaccine dose 52.5%). However, our sample still demonstrates a certain level of diversity in terms of vaccine types with not only Covid-19 vaccine but also other most popular vaccines among Vietnamese adults, including Flu, HPV, Hepatitis B, and Tetanus vaccines.

Table 1: Sampling structure

Sampling characteristics		Frequency	Percentage
Gender	Male	251	32.6%
	Female	520	67.4%
Age	18-24	399	51.8%
	25-34	233	30.2%
	35-44	70	9.1%
	45-54	42	5.4%
	More than 54	27	3.5%
Occupation	Officers	290	37.6%
	Unemployment/Students	147	19.1%
	Farmers/Workers	328	42.5%
	Retired	6	0.8%
Income	Less than 2 million VND	138	17.9%
	2- Less 5 million VND	174	22.6%
	5-Less than 10 million VND	234	30.4%
	More than 10 million VND	225	29.2%
Type of latest vaccine	Covid 19	405	52.5%
	Flu	136	17.6%
	HPV	90	11.6%
	Hepatitis B	84	10.8%
	Tetanus	56	7.5%

4.1. Assessment of the measurements

We adopted the procedure for testing the measurement properties as proposed by Anderson and Gerbing (1988) to evaluate the reliability and validity of measurement scales for latent constructs used in the conceptual model. Specifically, the pool of measurement items for attitudes (ATT), perceived behavioural control (PBC), subjective norms (SN), health concern (HEA), switching costs (SWC), perceived risks (RISK), communication quality (COM) and intention to take a booster vaccine (INT) undergoes an exploratory factor analysis (EFA) with principal factor as extraction method followed by varimax rotation. EFA results show weight factors that emerged corresponded to how they were initially measured (See Table 2). However, the factor loading for SWC6 is smaller than the threshold value of 0.5 as suggested by Straub (1989). In consideration of low factor loading and the theoretical contribution of this measurement item to the concept of "switching cost", we decide to remove this item from the measurement scale of switching costs.

Table 2: Principal Component Analysis extracted from EFA results

Measurement items	Component							
	1	2	3	4	5	6	7	8
COM5	0.764							
COM6	0.705							
COM3	0.653							
COM1	0.61							
COM2	0.559							
COM4	0.521							
RISK3		0.763						
RISK4		0.694						
RISK1		0.683						
RISK5		0.569						
RISK2		0.525						
INT4			0.769					
INT2			0.737					
INT1			0.711					
INT3			0.675					
SWC3				0.752				
SWC1				0.661				
SWC4				0.632				
SWC5				0.562				
SWC2				0.503				
SWC6				**0.329**				
ATT3					0.829			
ATT2					0.818			
ATT4					0.784			
ATT1					0.765			
PBC3						0.788		
PBC4						0.719		
PBC1						0.684		
PBC2						0.6		
HEA3							0.753	
HEA2							0.738	
HEA4							0.669	
HEA1							0.603	

SN2								0.729
SN3								0.721
SN1								0.678
SN4								0.569

Next, all the remaining measurement items were then subjected to a confirmatory factor analysis (CFA). The CFA results as shown in Table 3 reveal that all factor loadings were statistically significant and their values are all higher than the threshold of 0.4 as suggested by Nunnally and Bernstein (1994). This affirms the convergent validity of the measurement properties (after SWC6 is removed). Moreover, the figures shown in Table 4 further indicate that all of AVE values are greater than the square of correlations between each of the two constructs. Therefore, the discriminant validity of the constructs was also deemed verified (Anderson and Gerbing, 1988). Additionally, a CFA on the eight-factor model reveals that the proposed model with all measurement items (except SWC6) demonstrated a good fit with the data (CMIN/df = 2.877; P<.001; RMR = 0.045; GFI = 0.89; TLI = 0.872; CFI = 0.885; AGFI = 0.871; RMSEA = 0.049; PCLOSE = 0.639).

Finally, results from the reliability test as shown in the final column of Table 4 indicate that the internal consistency of the measurement properties is relatively high as all Cronbach'Alpha coefficients are greater than the recommended level of 0.7.

We, therefore, conclude that the measurement scales after SWC6 is removed have acceptable validity and reliability and hence, should be used for further hypothesis testing.

Table 3: Confirmatory factor analysis results

Estimate	Mean	Standard deviation	Factor loading	t-value
ATT1	3.93	0.88	0.696	___
ATT2	4.07	0.85	0.781	17.595
ATT3	4.04	0.90	0.752	17.231
ATT4	4.01	0.95	0.673	15.851
PBC1	3.37	1.14	0.725	___
PBC2	3.35	0.96	0.702	17.049
PBC3	3.12	1.02	0.543	13.449
PBC4	3.11	1.05	0.756	18.055
SN1	4.19	0.73	0.707	___
SN2	3.89	0.77	0.659	14.098
SN3	3.87	0.84	0.51	11.591
SN4	3.64	1.00	0.576	12.816

HEA1	3.99	0.82	0.541	___
HEA2	3.76	0.82	0.598	11.08
HEA3	3.8	0.76	0.665	11.666
HEA4	4.11	0.76	0.679	11.762
INT1	3.72	0.89	0.821	___
INT2	3.26	0.94	0.58	15.695
INT3	3.53	0.84	0.775	21.49
INT4	3.19	1.16	0.708	19.591
SWC1	3.74	0.88	0.725	___
SWC2	3.52	0.90	0.586	14.183
SWC3	3.63	0.94	0.603	14.543
SWC4	3.51	0.91	0.646	15.454
SWC5	3.41	0.92	0.521	12.699
RISK1	3.89	0.94	0.548	___
RISK2	3.67	0.96	0.458	10.175
RISK3	3.31	1.09	0.75	14.003
RISK4	3.34	1.09	0.73	13.818
RISK5	2.96	1.22	0.723	13.75
COM1	3.92	0.86	0.648	___
COM2	3.59	0.89	0.556	13.025
COM3	3.58	0.88	0.729	16.143
COM4	3.44	0.91	0.653	14.862
COM5	3.48	0.82	0.63	14.444
COM6	3.65	0.86	0.511	12.12

Table 4: Average variance extracted, inter-construct correlation and reliability

Constructs	ATT	PBC	SN	HEA	INT	SWC	RISK	COM	Cronbach's Alpha
ATT	**0.639**								0.815
PBC	0.001	**0.494**							0.775
SN	0.01	0.12	**0.46**						0.707
HEA	<0.001	0.183	0.135	**0.386**					0.717
INT	<0.001	0.228	207	0.161	**0.527**				0.809
SWC	0.003	0.349	0.312	0.094	0.228	**0.393**			0.751
RISK	<0.001	0.466	0.122	0.199	0.203	0.36	**0.426**		0.779
COM	0.002	0.198	0.325	0.191	0.386	0.324	0.293	**0.412**	0.79

Note: Square roots of average variances extracted (AVEs) is bold.

4.2. Hypothesis testing

PLS-SEM is selected for testing the proposed hypothesis with the use of WarpPLS 8.0 based on large sample size. This analytical method is employed because the conceptual model involves complex hypothesized relationships. The structural model has a statistically acceptable model fit and quality indices (Average adjusted R-squared = 0.189, $p < 0.001$; AFVIF = 1.396; GoF = 0.363; SPR = 0.889; RSCR = 0.996).

Table 5 demonstrates the estimated standardized structural coefficients and their statistical significance for the construct paths being hypothesized in the conceptual model. According to PLS-SEM analysis results as shown in Table 5, five variables including perceived behavioural control, subjective norms, switching costs, communication quality and health concern have significant direct positive effects on intention to take the booster vaccine. In turn, such intention is a robust determinant of actual behaviour to do so. This relationship is significantly strengthened if the citizen has good knowledge about the booster vaccine.

Table 5: Results of hypothesis testing

Construct path	**Model 1 (original)**
ATT → INT	-0.033
PBC → INT	0.143**
SN → INT	0.11*
SWC → INT	0.091*
RISK → INT	0.039
COM → INT	0.321**
HEA → INT	0.102*
INT → BEHV	0.128**
KNOW*INT → BEHV	0.059*
Model fit and quality indices	
Average adjusted R-squared	0.189**
Average full collinearity VIF (AFVIF)	1.396
GoF	0.363
Sympson's paradox ratio (SPR)	0.889
R-squared contribution ratio (RSCR)	0.996
Statistical suppression ratio (SSR)	1
Nonlinear bivariate causality direction ratio (NLBCDR)	1

Note: *p < 0.05; **p < 0.001

5. CONCLUSION AND RECOMMENDATIONS

This study comprehends the theory of planned behaviours to include new possible factors that may affect the intention to take the booster vaccines while gives more insights into the intention-behaviour gap. The findings indicate that communication quality and perceived behavioural control represent two factors that have the strongest impact on the intention to take the booster vaccine, followed by subjective norms, health concerns, and switching costs. These outcomes partially confirm the validity of the theory of planned behaviour (perceived behavioural control and subjective norms) in explaining the intention and behaviours towards the booster vaccination. Our results are also consistent with previous works which affirm the roles of support from reference groups (Cokro et al., 2022), exposure to vaccination information or media coverage (Cokro et al., 2022; Wang et al., 2022) in encouraging the receipt of the booster shots. This research also expands the existing knowledge about the contribution of health concerns to healthy behaviour. Specifically, health concern not only influences the purchase of healthy products (Iqbal et al., 2021; Yeon Kim and Chung, 2011; Xu et al., 2020) but also motivate the adoption of booster vaccines. On the other hand, we expand the findings of Reifferscheid et al. (2022) and Tokiya et al. (2022), the costs associated with the vaccine and the availability of alternative defensive measures are barriers to the access to not only the primary dose but also the booster shots.

Interestingly, our findings reveal that attitudes and perceived risks demonstrate insignificant impacts on the taking of booster vaccines. These results are inconsistent with most similar previous works in the context of the Covid-19 vaccines during their early launch (Cokro et al., 2022; Cunha et al., 2022; Huang et al., 2023; Noh et al., 2022). This may be because the set of vaccines under this research's survey has attained a certain trust among citizens. However, the significant positive moderation role of objective knowledge in the intention-behaviour gap affirms that the right perception about the booster vaccine helps strengthen the confidence and commitment among citizens towards the necessity of the booster shot. At the end of the day, it is more likely that they will actually take the booster dose.

The significant and strongest impact of communication quality as compared to the insignificant effect of attitude in their influences on intention to take the booster vaccine also provides interesting implications about the citizens' perception and learning process. Specifically, although they have formed favourable attitudes towards the booster vaccine through either their satisfaction with the primary

dose or knowledge gained from external sources, they still need to be reminded and driven towards the taking of the booster shot through communication. In this regard, the communication activities act as stimuli which “boost” the need for the booster shot and hence, trigger the appropriate intention and behaviours.

On the front policy, our findings suggest several ways to encourage the penetration of booster vaccines even when the vaccine has gained more trust among the public. In normal settings when taking the vaccine is not an urgent choice, reminding citizens regularly through in-person dialogues or timely, helpful, and interesting social campaigns while reducing the barriers in terms of time, financial costs and the complexity of vaccination procedure become paramount. In addition, when no pandemic immediately danger their health and survival, they may think more about alternative defensive measures other than the vaccine and its booster shots to protect against viruses. Therefore, the government should launch social campaigns to educate citizens about the costs of quitting the booster vaccines to increase their willingness to take the booster shot. In those social communication campaigns, the government should use appropriate executions to feature how the booster shot is expected by their important people, the government, and the community at large and many people like them are taking the booster shot. This would form favourable social norms towards the adoption of booster vaccines. Such social campaigns need to be tailored to two types of audiences - those who are relatively more health conscious and those who are not since the former group is more ready for the booster shot as compared to the counterpart. Finally, equipping citizens with proper knowledge about the booster vaccine through either direct communication efforts (via the advice of doctors) or effective and touching social communication campaigns will help narrow the gap between intention and actual behaviour to take booster shots.

This research has some limitations that leave room for future research directions. First, during the survey due to the time limit, we only focus on the vaccine that respondents need to receive the second booster shot in the next three months. As a result, due to the recent impact of the Covid-19 pandemic, most of our sampling units are involved with the Covid-19 booster vaccine. Second, our convenience sampling method may entail some inevitable sampling bias. Specifically, those who can remember the deadline for their next booster vaccine may be more ready and willing to take the booster dose. Third, our research only focuses on healthy people who have neither persistent disease. Meanwhile, the booster vaccine may be important (and even more important) to those who are more vulnerable compared to other social groups.

Future research should take the sampling frames from those who have received the primary vaccines of different types from the health centres or vaccination centres for the application of probability sampling methods or at least judgement sampling. The support from those centres may also facilitate the longitudinal research to track the actual behaviour of taking the booster shot over a longer time span. In addition, the inclusion of those who have persistent diseases in future studies could enable the comparisons of motivations to take booster shots among the two segments (with and without the persistent disease). This, in turn, provides more insightful implications and suggestions for policymakers to tailor their healthcare policies towards each group.

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