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Digital Technologies and COVID-19 Vaccine Acceptance:
Evidence From France and South Africa

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ABSTRACT

In light of the controversies surrounding COVID-19 vaccines, this study explored vaccine adoption through a theoretical model, focusing on France (n=2001) and South Africa (n=1107). Analysis using structural equation modelling and hierarchical cluster analysis revealed that social influences, personal opinions on vaccines, perceived severity of the pandemic, and perceived benefits of vaccination were primary drivers of adoption in both countries. Belief in conspiracy theories and perceptions of social distancing and stay-at-home measures had no influence on acceptance. Trust significantly influenced adoption intentions only in South Africa. Cluster analysis revealed four distinct opinion groups—"enthusiasts," "doubters," "followers," and "conspirationists"—each preferring different health information sources and technologies, with a common preference for traditional media over social media. These findings have implications for developing targeted health policies, communication, and trust-building strategies.

KEYWORDS

COVID-19, Diffusion of Innovations, Technological Innovation, Vaccine Acceptance

INTRODUCTION

The COVID-19 pandemic changed people's lives, organizations, and society (Dwivedi et al., 2020; Fosso Wamba & Queiroz, 2021; Pan & Zhang, 2020; Venkatesh, 2020). It also challenged scholars (Cui et al., 2022) and practitioners (McKinsey, 2020) to develop robust and quick solutions to respond to this crisis. The production of vaccines in 2020 was a herculean effort requiring countries, governments, and organizations to develop and validate potential vaccine candidates in record time (Druedahl et al., 2021).

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Vaccine hesitancy remains a barrier to the diffusion of COVID-19 vaccines and the allayment of the health crisis. In a recent 23-country survey, Lazarus et al. (2023) found that vaccine acceptance was still a serious public health issue, with hesitancy growing in eight countries. In a narrative review of 114 economies, Sallam et al. (2022) found that vaccine hesitancy was greatest in the Middle East and Northern Africa, Europe, and Central Asia, as well as in Western/Central Africa.

A number of papers have reported various barriers and enablers of the acceptance of the COVID-19 vaccine (Graffigna et al., 2020; Guidry et al., 2021; Harapan et al., 2020; Latkin et al., 2021; Qattan et al., 2021; Saied et al., 2021; Seale et al., 2021; Acar-Burkay & Cristian, 2022; Caserotti et al., 2021).

Despite the strong growth in the literature about COVID-19 vaccine acceptance, few empirical papers have addressed the enablers and the barriers of COVID-19 vaccine acceptance in an integrated model, and little is known about the influence of digital technologies on COVID-19 vaccine acceptance. To address these research gaps, our study seeks to answer the following research questions (RQ).

RQ1: What factors (social and contextual) and beliefs (health and vaccine) influence COVID-19 vaccine acceptance?
RQ2: How do digital technologies influence COVID-19 vaccine acceptance?

This paper makes several contributions. First, we develop a comprehensive model to investigate the behavioral intention of vaccine adoption by conceptualizing the COVID-19 vaccines as technological innovations. Second, we explore COVID-19 vaccine acceptance through a rich mix of social and contextual factors, and health and vaccine beliefs, in an integrated model. In so doing, we expand the body of COVID-19 vaccine acceptance literature, which has mainly focused on vaccine hesitancy (Lazarus et al., 2023; Sallam et al., 2022). Finally, understanding the set of influential factors aids in tailoring targeted, effective health communications and policies, improving vaccine uptake and, ultimately, public health outcomes. These insights could help policymakers and health educators in building trust, especially in regions where it is a significant determinant of vaccine acceptance, such as South Africa.

This paper is organized as follows. Section 2 reviews the literature on COVID-19 vaccines as a technological innovation, and then presents the hypotheses and the research model of this study. Section 3 provides details of the research method, followed by data analysis and a presentation of results in section 4. Subsequently, section 5 is devoted to discussion, implications, limitations, and future research directions. Finally, in section 6, we highlight the main conclusions.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

This section presents COVID-19 vaccines as technological innovations and their acceptance as part of the innovation diffusion process.

COVID-19 Vaccines as Technological Innovations

COVID-19 vaccines can be considered one of the most significant innovations of the 21st century with their unprecedently short development time and their diffusion on a global scale (Mo et al., 2021; Nachega et al., 2021). The development of the vaccines changed the dynamics of collaboration between countries and required the use of in-depth cutting-edge technologies at all stages of product development and diffusion (Bok et al., 2021; Druedahl et al., 2021).

An influential stream of research into technological innovation is diffusion of innovation theory. According to Rogers (2003) an innovation is "any idea, practice, or object that is perceived as new by an individual" and "diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system" (p. 5). Accordingly, COVID-19

vaccines can be seen as seen as technological innovations through an innovation diffusion theory lens, and their rate of diffusion depends on individual, technological, social, and contextual factors.

Vaccine Diffusion: A Multidimensional Perspective

Prior to adopting an innovation, individuals formulate conscious plans, or intentions based on their background knowledge and beliefs about it (Boden, 1973). An individual may choose not to adopt or use a technology as intended if perceptions or conditions of adoption and use change, such as "beliefs, attitudes, social norms, intentions, habits, abilities, and situational factors" (Warshaw & Davis, 1984, p. 111). Previous studies of vaccine hesitancy and acceptance have identified several influential factors. The following section integrates them into a model of innovation diffusion.

Social Factors

Innovation diffusion depends on the structure and functioning of an individual's social system. The degree of social influence between members of a community and their mutually reinforcing beliefs in conspiracy theories may influence vaccine diffusion.

In this paper, *social influence* refers to an individual's perceptions of the beliefs of other influential community members as to whether they should accept a COVID-19 vaccine. Recent studies have reported the importance of some types of social influence in the diffusion of COVID-19 vaccines (Latkin et al., 2021; Storopoli et al., 2020). For instance, social media campaigns are considered an effective strategy for vaccine acceptance (Latkin et al., 2021), and scholars have established that COVID-19 information consumption on social media is associated with preventive behaviors (Liu, 2021). This implies that the technological ecosystem (e.g., social networking sites from reputable influencers, government sites) can promote decisive support for the diffusion of vaccine acceptance. In this sense, we hypothesize that:

H1: Perceived social influence (SOCIAL) has a positive effect on the behavioral intention (INTENT) to accept a COVID-19 vaccine.

A *conspiracy theory* can be defined as "a theory that provides an alternative explanation to the established understanding of a historical or current event. Often, it is claimed that this event is the result of conscious manipulations by individuals or secretive powers" (Bruder et al., 2013, p. 3). For example, theories circulated that COVID-19 vaccine affected fertility and modified DNA (Pertwee et al., 2022). During the COVID-19 outbreak, conspiracy theories were amplified on a global scale. For instance, social media (Röchert et al., 2022; Su et al., 2021) and television broadcasting (Romer & Jamieson, 2020) have negatively influenced management of the pandemic and vaccination campaigns. They can affect the preventive strategies designed to fight against the spread of the disease (Marinthe et al., 2020; Seddig et al., 2022). In a comprehensive review of 85 COVID-19 conspiracy belief studies, van Mulukom et al. (2022) concluded that "vaccine hesitancy has consistently been linked to COVID-19 conspiracy beliefs". Therefore, we hypothesize that:

H2: Conspiracy theories (CONSPIR) negatively affect behavioral intention (INTENT) to accept a COVID-19 vaccine.

Health Beliefs

Individual opinions and beliefs concerning science and vaccination in general, and trust in institutions to successfully cope with the COVID-19 pandemic, may both influence an individual's procedural-schema (Boden, 1973) and thus their behavioral intentions.

In this study, *opinions on vaccines* refer to individuals' deep held beliefs about vaccination, based on their cultural perspectives, values, and ethical concerns. Sentiment analysis and topic modeling

studies have shown that a populations' attitudes about vaccines change over time (Hu et al., 2021). Individual opinions of vaccines may influence the success of public health campaigns. On the one hand, positive opinions on vaccines can improve the acceptance rate of the population. On the other hand, opinions on vaccines can influence hesitancy, refusal, or delay in accepting a COVID-19 vaccination (Kerr et al., 2020). In a recent study of 2,055 American adults, Stoler et al. (2022) found that lower trust in scientists and lower confidence in science were both strongly associated with the refusal to be vaccinated. Hence, we hypothesize that:

H3: Opinions on vaccines (OPINION) positively affect behavioral intention (INTENT) to accept a COVID-19 vaccine.

In our study, *trust level* refers to the degree of confidence an individual has in institutions such as the government, hospitals, medical staff, and the media. Trust in institutions has been shown to be a key determinant of vaccine hesitancy (Yaqub et al., 2014; Adhikari et al., 2022). In a study of 7,554 individuals in Brazil, Storopoli et al. (2020) found that confidence in the ability of social institutions to cope with the pandemic positively influenced people's choice to adopt preventive measures for COVID-19. Similarly, Choi and Fox (2022) found that mistrust of public health institutions was a strong predictor of COVID-19 vaccine hesitancy among U.S. adults. In China, the lack of trust toward vaccine producers was also found to be associated with vaccine hesitancy (Wu et al., 2023). Consequently, we argue that the trustworthiness of key institutions and the media may influence COVID-19 vaccine adoption. Thus, we hypothesize that:

H4: Trust level (TRUST) positively affects behavioral intention (INTENT) to accept a COVID-19 vaccine.

Vaccine Beliefs

Individual beliefs about the innocuity and benefits of a COVID-19 vaccine may also influence their action plan and behavioural intentions.

In this study, *perceived barriers* refer to an individual's judgment about the challenges and obstacles concerning the safety, efficacy, adverse effects, worries, and limited information about a COVID-19 vaccine. Beliefs in the negative consequences of a COVID-19 vaccine are a major obstacle to acceptance (Li et al., 2022). Such barriers can exert a strong negative effect on vaccination campaigns. A recent study of medical students in Egypt found that the most prevalent barriers to COVID-19 vaccination were insufficient data about the vaccine's adverse effects and a lack of information about the vaccine (Saied et al., 2021). Following this work, we hypothesize that:

H5: Perceived barriers (VACBAR) negatively affect behavioral intention (INTENT) to accept a COVID-19 vaccine.

In our study, *perceived benefits* are defined as the degree to which an individual believes that vaccination will reduce the fear and likelihood of catching COVID-19 (Guidry et al., 2021). Perceived benefits concern the health benefits and reduced contraction risk that accrue from vaccination (Irfan et al., 2022). In general, the perceived benefits of COVID-19 vaccines are related to efficacy perceptions. A recent North American study found that people with higher perceived benefits about the COVID-19 vaccine had a higher likelihood of vaccine acceptance (Coe et al., 2022).

H6: Perceived benefits (BENEFIT) positively affect behavioral intention (INTENT) to accept a COVID-19 vaccine.

Contextual Factors

Several contextual factors may influence an individual's behavioral intention, such as new information or changing conditions. In the case of the COVID-19 pandemic, these may include the changing severity of the health crisis and government measures, such as lockdowns, social distancing requirements, and mask mandates.

In this paper, *perceived severity* refers to individual beliefs about the likelihood of catching COVID-19 and the harshness of its consequences (Clark et al., 2020). Contracting COVID-19 can notably disrupt one's life (e.g., negatively impact social life, physical health, work life). In a study of 5,044 German adults, Seddig et al. (2022) found that fear of COVID-19 positively influenced people's attitudes toward vaccination. Similarly, Diament et al. (2022) reported that the fear of the economic impacts of the pandemic strongly influenced willingness to get a COVID-19 vaccine in the United States. The perceived severity of COVID-19 has also been shown to be a predictor of other preventive measures such as the adoption of proximity tracing apps (Trkman et al., 2021). Perceived severity is related to the high levels of acceptance of COVID-19 vaccines (Qiao et al., 2022). Therefore, we advance the following hypothesis:

H7: Perceived severity (SEVERITY) positively affects behavioral intention (INTENT) to accept a COVID-19 vaccine.

In this paper, *preventive behavior* is defined as a set of healthy activities that an individual believes should prevent COVID-19 (Clark et al., 2020). For instance, during COVID-19, several preventive behaviors such as personal hygiene and social distancing were widely practiced (Raude et al., 2020). Mask use and avoiding public areas were also considered critical preventive behaviors to avoid COVID-19 contamination (MacIntyre et al., 2021). Thus, we argue that an individual's predisposition to preventive behaviors influences their intention to receive a vaccine. We hypothesize that:

H8: Preventive behaviors (PREVENT) positively affect behavioral intention (INTENT) to accept a COVID-19 vaccine.

In this paper, *lockdown barriers* refer to an individual's perception of the impediments and problems caused by isolation during the COVID-19 pandemic (Callow et al., 2020). The lockdowns imposed during the COVID-19 pandemic impacted all social activities globally. For example, the school year was impacted (Qazi et al., 2021), and eating and cooking behaviors changed (Philippe et al., 2022). Lockdowns also negatively impacted lifestyles, including physical activities (Robinson et al., 2021). In this sense, lockdown barriers result from individuals believing that a lockdown will cause severe problems in their lives (e.g., mental and physical health). We posit that vaccination adoption may be seen as a means to minimize the duration of the lockdown, and so we hypothesize that:

H9: Lockdown barriers (LOCKBAR) positively affect behavioral intention (INTENT) to accept a COVID-19 vaccine.

Behavioral Intention

Behavioral intention refers to "the degree to which a person has formulated conscious plans to perform or not perform some specified future behavior" (Warshaw & Davis, 1985, p. 214). In this study, we argue that a person's intention to get the COVID-19 vaccine is related to their actual acceptance of the vaccine. Accordingly, as positive attitudes regarding vaccines increases (Chu & Liu, 2021), actual acceptance of COVID-19 vaccines should also increase. Therefore, we hypothesize that:

H10: Behavioral intention (INTENT) positively affects the actual acceptance (ACCEPT) of a COVID-19 vaccine.

Consistent with previous studies of vaccine adoption, we added control variables to INTENT for gender, age, and education (Ferris et al., 2009; Jimenez-Garcia et al., 2010; Kini et al., 2021).

To summarize, the conceptual framework for our hypotheses is presented in Figure 1.

RESEARCH METHODS

Sample and Data Collection

A web-based survey was used for this study. Before final data collection, a pretesting of the survey was realized using five information systems academics and three health practitioners. Data collection was conducted by a market research firm called Bilendi[1] in May 2021, using the members of its French and South African panels. An invitation was sent out to all the members of each panel eligible to participate in the study. Out of the 3,538 members who agreed to participate in the survey, 3,108 questionnaires were correctly filled out and thus considered as valid were completed (response rate of 88%). Table 1 presents the principal characteristics of the sample.

Measures

All variables were measured using a seven-point Likert scale ranging from "strongly disagree" to "strongly agree" (Guidry et al., 2021; Trkman et al., 2021). Scales were drawn from prior literature and adapted to suit the context of the study. All measurement items are listed in the Appendix and discussed below.

Figure 1. Research model

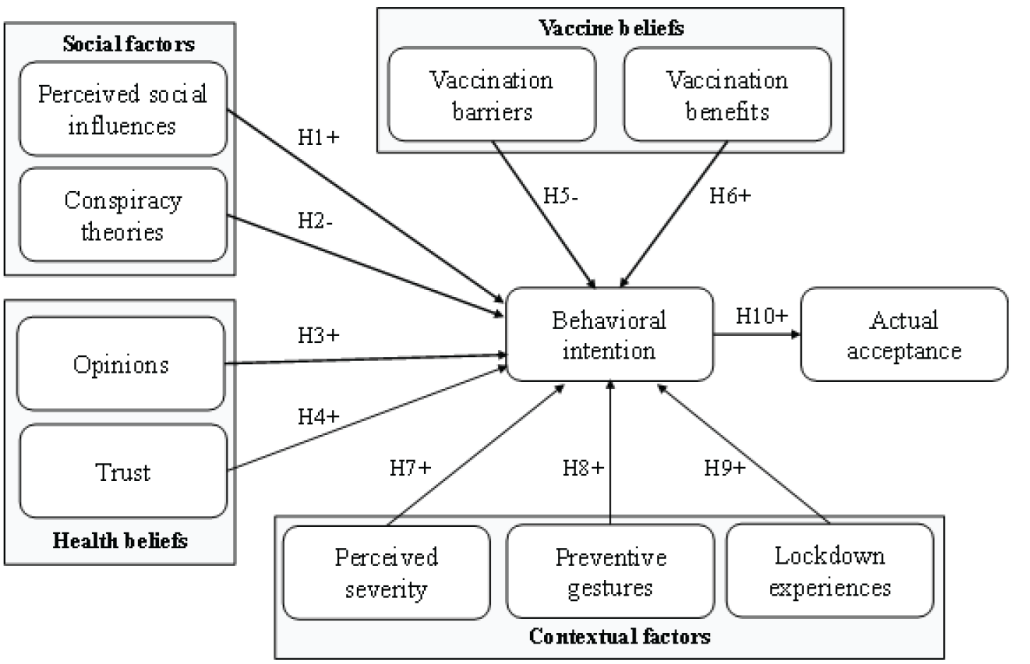

Table 1. Demographic profile of the sample

Characteristic	France		South Africa	
	n	%	n	%
Gender				
Male	941	47%	540	49%
Female	1059	53%	562	51%
Other	1	0%	5	0%
Age				
18-25	0	0%	0	0%
26-33	221	11%	197	18%
34-41	306	15%	344	31%
42-49	495	25%	324	29%
50-64	498	25%	175	16%
65 +	481	24%	67	6%
Highest educational level				
Secondary	934	47%	438	39%
Tertiary	810	40%	561	51%
Doctorate	70	4%	8	1%
Other	187	9%	100	9%
Socio-professional categories				
Upper	590	30%	457	41%
Lower	610	30%	336	30%
Inactive	801	40%	314	29%

Independent Variables

The four items used to measure perceived social influences for COVID-19 vaccines (SOCIAL) were adapted from Venkatesh et al. (2003). The five items for belief in conspiracy theories (CONSPIR) were adapted from Bruder et al. (2013). The two items used to measure opinions on vaccines (OPINIONS) were taken from Kerr et al. (2020). The three items used to measure the perceived severity of COVID-19 (SEVERITY) and the six items used to measure preventive behaviors (PREVENT) were taken from Clark et al. (2020). The seven items used to measure the perceived barriers to vaccination (VACBAR) were adapted from Saied et al. (2021). The perceived benefits of COVID-19 vaccination (BENEFIT) were measured using two items taken from Guidry et al. (2021), and the five items used to measure perceptions of lockdown barriers were adapted from Callow et al. (2020). The four items used to measure confidence in social institutions (TRUST) were taken from Storopoli et al. (2020). This last construct was conceptualized as formative.

Dependent Variables

The items used to measure the behavioral intention to accept a COVID-19 vaccine (INTENT) and the three items used to measure the actual acceptance of a COVID-19 vaccine (ACCEPT) were adapted from Venkatesh et al. (2003). Means, standard deviations, and ranges for all variables are reported in Table 2.

Table 2. Descriptive statistics

Construct	France				South Africa			
	Min	Max	Mean	SD	Min	Max	Mean	SD
SOCIAL	1	7	4.71	1.67	1	7	5.11	1.67
CONSPIR	1	7	4.16	1.43	1	7	4.97	1.34
OPINION	1	7	5.32	1.59	1	7	5.34	1.70
SEVERE	1	7	4.97	1.28	1	7	5.28	1.42
VACBAR	1	7	4.19	1.47	1	7	4.20	1.63
BENEFIT	1	7	4.77	1.58	1	7	4.70	1.77
PREVENT	1	7	5.55	1.18	1	7	5.91	1.08
LOCKBAR	1	7	4.52	1.01	1	7	4.78	1.46
INTENT	1	7	4.97	2.08	1	7	5.04	2.07
TRUST	4	28	17.93	4.92	4	28	19.02	6.12

DATA ANALYSIS AND RESULTS

Measurement Model

SmartPLS 3.0 (Ringle et al., 2015) was used to estimate the measurement properties of our model. The study applied nonparametric bootstrapping (Chin, 2010; Efron & Tibshirani, 1994) with 5,000 replications to obtain the standard errors of the estimates (Hair et al., 2016) and a path weighting scheme to estimate the structural model relationships.

Construct and Indicator Reliability

Reliability and validity analyses were conducted to evaluate the quality of the measures used. The composite reliability statistic was computed to evaluate the internal reliability for each construct and is presented in Table 3. All values are above the recommended acceptable level of 0.7 (Nunnally & Bernstein, 1994), indicating adequate internal consistency.

Convergent Validity

The convergent validity of each reflective construct was evaluated by inspecting the outer loadings of each individual item and the average variance extracted (AVE). The results are presented in Table 3. The individual item loadings are all above 0.7 on their respective reflective constructs, and the average variance extracted of each construct is above the 0.5 threshold (Fornell & Larcker, 1981) indicating adequate convergent validity of the instrument items.

Discriminant Validity

The discriminant validity of each reflective construct was assessed by calculating Heterotrait-Monotrait Ratio (HTMT) statistics. The HTMT values were all below the 0.85 thresholds, supporting the discriminant validity of the constructs.

The formative TRUST construct was evaluated separately following the procedure outlined in Hair et al. (2016). The variance inflation factor (VIF) statistics of the four indicators indicated an absence of collinearity. All outer weights and outer loadings were significant, providing empirical support to retain the indicator.

A full collinearity test was conducted following the procedure outlined by Kock and Lynn (2012). All VIF statistics were below 3.3, confirming that the model was free of common method

Table 3. Measures of internal consistency reliability and convergent validity

Variable	Items	France			South Africa		
		Loadings	Cronbach's Alpha	AVE	Loadings	Cronbach's Alpha	AVE
Perceived social influences for COVID-19 vaccine	SOCIAL1 SOCIAL2 SOCIAL3 SOCIAL4	0.911 0.948 0.850 0.945	0.936	0.841	0.897 0.941 0.855 0.935	0.928	0.824
Conspiracy theories	CONSPIR1 CONSPIR2 CONSPIR3 CONSPIR4 CONSPIR5	0.797 0.790 0.725 0.841 0.861	0.872	0.661	0.765 0.827 0.557 0.781 0.848	0.818	0.582
Opinions on vaccines	OPINION1 OPINION2	0.964 0.964	0.928	0.933	0.961 0.962	0.919	0.925
Perceived severity of COVID-19	SEVERE1 SEVERE2 SEVERE3	0.824 0.832 0.836	0.775	0.686	0.798 0.825 0.862	0.773	0.687
Perceived barriers to vaccination	VACBAR1 VACBAR2 VACBAR3 VACBAR4 VACBAR5 VACBAR6 VACBAR7	0.885 0.867 0.810 0.829 0.790 0.738 0.757	0.922	0.681	0.900 0.875 0.775 0.815 0.850 0.669 0.680	0.906	0.639
Perceived benefits of vaccination	BENEFIT1 BENEFIT2	0.940 0.919	0.827	0.851	0.944 0.938	0.871	0.886
Preventive behaviors	PREVENT1 PREVENT2 PREVENT3 PREVENT4 PREVENT5 PREVENT6	0.755 0.779 0.729 0.848 0.770 0.787	0.868	0.681	0.762 0.808 0.724 0.838 0.780 0.736	0.869	0.602
Lockdown barriers	LOCKBAR1 LOCKBAR2 LOCKBAR3 LOCKBAR4 LOCKBAR5	0.808 0.821 0.854 0.814 0.858	0.914	0.743	0.761 0.699 0.785 0.822 0.841	0.849	0.613
Behavioral intention to accept COVID-19 vaccine	INTENT1 INTENT2 INTENT3	0.965 0.975 0.951	0.963	0.931	0.960 0.974 0.950	0.959	0.924

bias. Once we confirmed that construct measures were reliable and valid, and that the model was free of bias, we then assessed the relationships between constructs in our structural model and its predictive capabilities.

Structural Model

Prior to interpreting path coefficients, we checked for collinearity between predictor constructs. All VIF statistics are below 5, indicating acceptable levels of collinearity (Hair et al., 2011).

We next examined the magnitude and strength of the paths of the structural model and then its overall explanatory power. Standardized paths should be around 0.20 and ideally above 0.30 and be directionally consistent with expectations to be considered meaningful (Chin, 1998). The loadings on the structural paths between perceived social influences (SOCIAL), perceived barriers to vaccination

(BARRIER), perceived benefits of vaccination (BARRIER), and behavioral intention (INTENT) were above 0.20, as was the path between behavioral intention (INTENT) and actual acceptance (ACCEPT). The results of the structural model are presented in Table 4.

French Sample

The path between "perceived social influence" and "behavioral intention" was significant ($\beta = 0.351$, $p < 0.001$), supporting hypothesis H1. In H2, we expected a negative relationship between "conspiracy theories" and "behavioral intention." Surprisingly, we found a small significant positive relationship ($\beta = 0.040$, $p = 0.006$). Consequently, H2 was not supported. As hypothesized, "opinions on vaccines" positively influenced "behavioral intention" ($\beta = 0.187$, $p < 0.001$), thus supporting H3.

Our H4 investigated the relationship between "trust level" and "behavioral intention." Unexpectedly, we found a small but nonsignificant effect and, consequently, this association was not supported for the French sample. The path between "perceived severity" and "behavioral intention"

Table 4. Results of the structural model: Direct effects

Paths	Sample	Path Coefficients	Standard Deviation	t Statistic	p-Value
Perceived social influences → Behavioral intention	France	0.351	0.021	16.410	<0.001
	South Africa	0.371	0.032	11.699	<0.001
Conspiracy theories → Behavioral intention	France	0.040	0.015	2.749	0.006
	South Africa	-0.005	0.019	0.260	0.795
Opinions on vaccines → Behavioral intention	France	0.187	0.021	9.034	<0.001
	South Africa	0.142	0.027	5.327	<0.001
Trust level → Behavioral intention	France	0.012	0.016	0.728	0.467
	South Africa	0.062	0.024	2.540	0.011
Perceived severity → Behavioral intention	France	0.060	0.016	3.846	<0.001
	South Africa	0.077	0.022	3.413	0.001
Perceived barriers → Behavioral intention	France	-0.201	0.019	10.782	<0.001
	South Africa	-0.227	0.023	9.795	<0.001
Perceived benefits → Behavioral intention	France	0.233	0.021	11.040	0.000
	South Africa	0.201	0.026	7.598	0.000
Preventive behaviors → Behavioral intention	France	0.011	0.015	0.755	0.450
	South Africa	-0.019	0.019	0.981	0.327
Lockdown barriers → Behavioral intention	France	0.023	0.013	1.793	0.073
	South Africa	0.026	0.019	1.352	0.176
Behavioral intention → Actual acceptance	France	0.280	0.007	38.472	<0.001
	South Africa	0.323	0.009	35.279	<0.001
Age → Behavioral intention	France	0.069	0.012	5.653	<0.001
	South Africa	-0.035	0.018	1.897	0.058
Education level → Behavioral intention	France	-0.018	0.011	1.549	0.121
	South Africa	0.009	0.018	0.487	0.626
Gender → Behavioral intention	France	0.015	0.012	1.291	0.197
	South Africa	0.034	0.018	1.890	0.059

was significant ($\beta = 0.060$, $p < 0.001$), supporting hypothesis H5. As hypothesized, "perceived barriers" negatively influenced "behavioral intention" ($\beta = -0.201$, $p < 0.001$), thus supporting H6.

The path between "perceived benefits" and "behavioral intention" was significant ($\beta = 0.233$, $p < 0.001$), supporting hypothesis H7. "Preventive behaviors" ($\beta = 0.011$, $p = 0.450$) and "lockdown barriers" ($\beta = 0.023$, $p = 0.073$) did not significantly influence "behavioral intention" at the 5% level (H8 and H9).

The path between "behavioral intention" and "actual acceptance" of the COVID-19 vaccine was significant ($\beta = 0.280$, $p < 0.001$), upholding hypothesis H10.

South African Sample

The path between "perceived social influence" and "behavioral intention" was also significant ($\beta = 0.371$, $p < 0.001$) in the South African sample, supporting hypothesis H1. The path between "conspiracy theories" and "behavioral intention" was also not significant at the 5% level (H2). As hypothesized, "opinions on vaccines" also positively influenced "behavioral intention" ($\beta = 0.142$, $p < 0.001$), thus supporting H3.

Unlike for the French sample, the path between "trust level" and "behavioral intention" was weak but significant ($\beta = 0.062$, $p = 0.011$), supporting hypothesis H4. The paths from "perceived severity" ($\beta = 0.077$, $p = 0.001$), "perceived barriers" ($\beta = -0.277$, $p < 0.001$), and "perceived benefits" ($\beta = 0.201$, $p < 0.001$) to "behavioral intention" were also significant, thus supporting H4, H5, and H6 respectively. These paths were also of similar magnitude for both samples.

Similarly to the French sample, the paths between "preventive behaviors" ($\beta = -0.019$, $p = 0.327$) and "lockdown barriers" ($\beta = 0.026$, $p = 0.176$) did not significantly influence "behavioral intention" at the 5% level (H8 and H9). The path between "behavioral intention" and "actual acceptance" of the COVID-19 vaccine was also significant ($\beta = 0.323$, $p < 0.001$), supporting hypothesis H10 (table 5).

Table 5. Results of hypothesis tests

Hypothesis	Results	
	France	**South Africa**
H1. Perceived social influence (SOCIAL) has a positive effect on the behavioral intention (INTENT) to accept a COVID-19 vaccine.	Supported	Supported
H2. Conspiracy theories (CONSPIR) negatively affect behavioral intention (INTENT) to accept a COVID-19 vaccine.	Not supported	Not supported
H3. Opinions on vaccines (OPINION) positively affect behavioral intention (INTENT) to accept a COVID-19 vaccine.	Supported	Supported
H4. Trust level (TRUST) positively affects behavioral intention (INTENT) to accept a COVID-19 vaccine.	Not supported	Supported
H5. Perceived severity (SEVERITY) positively affects behavioral intention (INTENT) to accept a COVID-19 vaccine.	Supported	Supported
H6. Perceived barriers (VACBAR) negatively affect behavioral intention (INTENT) to accept a COVID-19 vaccine.	Supported	Supported
H7. Perceived benefits (BENEFIT) positively affect behavioral intention (INTENT) to accept the COVID-19 vaccine.	Supported	Supported
H8. Preventive behaviors (PREVENT) positively affect behavioral intention (INTENT) to accept a COVID-19 vaccine.	Not supported	Not supported
H9. Lockdown barriers (LOCKBAR) positively affect behavioral intention (INTENT) to accept a COVID-19 vaccine.	Not supported	Not supported
H10. Behavioral intention (INTENT) positively affects the actual acceptance (ACCEPT) of a COVID-19 vaccine.	Supported	Supported

The coefficient of determination (R^2) was computed to assess the model's overall explanatory power. The analysis revealed that the structural model explained 74% and 34% of the variation in behavioral intention and actual acceptance, respectively, for the French sample and 69% and 42% for the South African sample, suggesting that the structural model provided adequate explanatory power (Hair et al., 2016). In addition to evaluating the model's predictive accuracy with the R^2 statistic, we also calculated Stone-Geisser's Q^2 value to assess the model's predictive relevance. Predictive relevance measures how well the path model can predict the originally observed values. The Q^2 values for INTENT (0.68 and 0.63) largely exceeded the recommended threshold of 0.35, indicating strong predictive relevance, and the values for the ACCEPT construct (0.33 and 0.42) demonstrate medium to strong predictive relevance across the two samples (Hair et al., 2016).

Analysis of Information Sources

In order to study our second research question and describe how IS/IT and other emerging technologies may contribute to COVID-19 vaccine acceptance, we segmented our dataset to explore the information sources used by different groups of individuals. We used hierarchical clustering[2] to segment the data into four groups according to opinions on vaccines (OPINION). The objective was to identify and describe the differences in information sources used.

Groups were descibed using demographic variables (Table 6) and variables from the research model (Table 7). The main information channels that individuals rely on for health information were also compared between groups (Table 8). The pecentage values represent the share of the information source in the mix of each respondant. The group profiles are presented below. All variables differ significantly between groups (ANOVA, $p < 0.05$) unless indicated as not significant (ns).

Group 1: The Enthusiasts

The *enthusiasts* make up of 25% of the sample. They are the youngest group (m = 39.5), predominantly male (52%) and with a higher level of education than other groups. Upper socio-professional categories and inactives are over overrepresented in this group. Close to three quarters of enthusiasts (73%) had been vaccinated at the time of the study.

Table 6. Demographic profile of each group

Variable	Categories	Total Sample	Group 1	Group 2	Group 3	Group 4
Individuals	-	3108	794 (25%)	1016 (33%)	1052 (34%)	246 (8%)
Age	-	44.8	39.5	42.0	52.5	41.9
Gender	Male	47%	52%	46%	46%	45%
	Female	52%	48%	54%	54%	54%
	Other	1%	-	-	-	1%
Education	Secondary	44%	40%	46%	44%	51%
	Tertiary	44%	45%	42%	47%	37%
	Doctorate	3%	6%	1%	2%	2%
	Other	9%	9%	11%	7%	10%
Socio-professional categories	Upper	34%	36%	32%	34%	30%
	Lower	30%	20%	37%	30%	39%
	Inactive	36%	44%	31%	36%	31%
Country	France	64%	63%	69%	62%	59%
	South Africa	36%	37%	31%	38%	41%

This group believes least in conspiracy theories and reports higher levels of trust in the government, hospitals, medical staff, and the media to deal with the COVID-19 pandemic.

Enthusiast*s* perceive the COVID-19 virus as more severe than other groups and they perceive fewer obstacles to vaccination. Enthusiasts hold above average positive opinions about vaccines, perceive greater benefits from vaccination, and evolve in a social and family environment that is more supportive of vaccination than all other groups.

The main information channels that enthusiasts rely on for health information are traditional media (38%), such as television and radio, family or friends (34%), and specialized health sources (29%).

Group 2: The Doubters

The *doubters* make up 33% of the sample. They are of average age (42 years) and gender composition, and the French are overrepresented in the group. The doubters are mainly from lower socio-professional categories. Only 21% of doubters had received a COVID-19 vaccine at the time of the study.

The doubters have below average opinions about COVID-19 vaccines and perceive below average benefits from vaccination. Their social and family circles provide below average encouragement for them to receive a COVID-19 vaccine.

While doubters are not influenced by conspiracy theories, they do see several obstacles to vaccination. The doubters are concerned about the efficacity and the innocuity of vaccines, and they are also concerned about the severity of the COVID-19 pandemic.

The main information channels that doubters rely on for health information are traditional media (33%), such as television and radio, family, or friends (31%), specialised health sources (24%), and web-based sources (21%). The reliance on family or friends may reinforce the vaccine hesitancy of this group, and doubters reported below average scores on the SOCIAL variable.

Group 3: The Followers

The *followers* account for one third of the sample (34%). They are the oldest group, with an average age of 52 years. The followers mainly have a tertiary education. A little over one half of this group (54%) had been vaccinated with an available COVID-19 vaccine at the time of the study.

The followers reported above average opinions on vaccines. All other behaviors and perceptions were close to the sample average.

The main information channels that followers rely on for health information are traditional media (36%), such as television and radio, family and friends (33%) and specialized health sources (27%). The reliance on family and friends may be used to increase vaccination rates for this group, as followers reported high scores on the SOCIAL variable.

Group 4: The Conspirationists

The *conspirationists* are the smallest group in the sample (8%). Only 21% of this group have been vaccinated with a COVID-19 vaccine. Members of this group are slightly younger than average (41.9 years), mainly have a secondary education (51%) and belong to lower socio-professional categories (39%). South African nationals are overrepresented in this group (41%).

Conspirationists are less concerned about catching COVID-19 than other groups and engage in fewer preventive measures. They have lower opinions about COVID-19 vaccines, perceive fewer benefits from vaccination in general and report higher obstacles to vaccination than all other groups. Conspirationists report low trust in government, hospitals, medical staff, and the media to correctly manage the pandemic, and they move in social and family circles that do not recommend vaccination against COVID-19.

Conspirationists report lower overall use of all channels for health information compared to other groups: traditional media (25%), family or friends (25%), specialised health sources (16%), and web-based sources (17%). The reliance on family and friends may reinforce the vaccine hesitancy of this group, and doubters reported below average scores on the SOCIAL variable.

Table 7. Key variables for each group

Variable (Scale 1 to 7)	Total Sample	Group 1	Group 2	Group 3	Group 4
Opinions on vaccines	5.3	7.0	4.3	6.0	1.4
Conspiracy theories	4.5	3.9	4.7	4.4	5.2
Preventive behaviors	5.7	6.1	5.4	5.8	4.9
Perceived barriers to vaccination	4.3	3.0	5.0	4.0	5.5
Perceived benefits of vaccination	4.7	5.9	4.0	5.1	2.7
Perceived social influences	4.9	6.0	4.0	5.2	3.0
Trust level	4.6	5.4	4.0	4.8	3.1
Perceived severity of COVID-19	5.1	5.6	4.8	5.3	4.0
Lockdown barriers	4.6	4.5	4.7	4.6	4.9
Behavioral intention	5.0	6.5	3.8	5.7	2.2
Actual acceptance of COVID-19 vaccine	45%	73%	21%	54%	12%

Table 8. Information sources for health information by group

Variable	Total Sample	Group 1	Group 2	Group 3	Group 4
Traditional media	**35%**	**38%**	**33%**	**36%**	**25%**
- Television	68%	75%	65%	71%	50%
- Radio	41%	47%	36%	42%	31%
- Billboards^{ns}	13%	15%	13%	14%	9%
Specialised health sources	**25%**	**29%**	**24%**	**27%**	**16%**
- Health brochures	25%	30%	23%	26%	19%
- Family doctor	48%	60%	40%	51%	29%
- Hospital	33%	37%	30%	35%	27%
Family or friends	**32%**	**34%**	**31%**	**33%**	**25%**
- Family or friends (in person)	32%	34%	31%	33%	25%
Social media	**15%**	**14%**	**17%**	**16%**	**16%**
- Facebook^{ns}	26%	23%	27%	25%	28%
- Instagram^{ns}	11%	11%	12%	11%	13%
- Twitter^{ns}	13%	14%	11%	13%	14%
- WhatsApp^{ns}	17%	20%	16%	17%	15%
- Text message^{ns}	13%	15%	12%	14%	10%
Web based sources	**21%**	**21%**	**21%**	**21%**	**17%**
- Specialised web sites	23%	27%	22%	24%	18%
- Internet	55%	58%	53%	57%	46%

The answer to our second research question, as to how the use of digital technologies could influence COVID-19 vaccine acceptance, varies between groups. The *enthousiasts*, the *doubters,* and the *followers* all exhibited a strong reliance on traditional media (average of 35%), specialized

health sources (25%), web-based sources (21%), and family and friends (32%) for health information. The *conspirationists* relied significantly less on traditional media (25%), specialized health sources (16%), family and friends (25%), and web-based sources (17%). Interestingly, there was no significant difference in the use of social media between groups (15%).

In order to influence the two groups with the lowest opinions on vaccines, the *conspirationists* and the *doubters*, communication campaigns need to use television and in-person social circles. Social media, and in particular Facebook, can also be used as an effective channel for all groups.

DISCUSSION

The objective of this study was to extend our understanding of COVID-19 vaccine acceptance. The results reveal interesting behavior on the dynamics toward vaccine acceptance in France and South Africa. We found that perceived social influences, opinions on vaccines, perceived severity, and perceived benefits positively impact the behavioral intention to accept a COVID-19 vaccine. Also, we found evidence that behavioral intention strongly affects actual acceptance. In addition, we confirmed that perceived barriers to vaccination negatively affect behavioral intention.

Surprisingly, preventive behaviors and lockdown barriers did not significantly influence behavioral intention to accept a COVID-19 vaccine. Trust level did not influence behavioral intention for the South African sample although it did in the French sample. Also, contrary to expectations we found no significant negative relationship between belief in conspiracy theories and behavioral intention in both samples. This result is in contrast with recent research that has highlighted the influence of conspiracy theories on vaccination intentions (Fridman et al., 2020; Jolley & Douglas, 2014; Seddig et al., 2022).

The insignificant influence of conspiracy theories on behavioral intention may be explained by between-group differences: Belief in conspiracy theories was only associated with low opinions on vaccines for the smallest group in our sample. However, while a second larger group also had low opinions, their belief in conspiracy theories was average (4.7/7). Our clustering analysis underscores the multi-factor nature of vaccine acceptance. This analysis also confirmed the fundamental role of social media in supporting health information gathering (Pinto et al., 2023).

Our segmentation extends the extant literature on vaccine hesitancy. A number of previous studies have presented vaccination attitudes and decisions on a continuum (WHO, 2014; Benin et al., 2006; Leask et al., 2012), with those that oppose vaccination at one end and those who are willing to be vaccinated at the other. In between lies "the 'moveable middle' heterogeneous group with varying uncertainty levels about acceptance or hesitancy" (MacDonald et al., 2021). By grouping individuals according to their vaccine opinions, we focused on one of the key drivers of vaccine intentions. Analysis of between-group differences reveal that demographic profiles, information usage attitudes, and behaviors also differ across this "continuum." Our group descriptions contribute to the vaccine hesitancy literature.

Interestingly, the role of social media as an information source for health information did not differ between groups in our study. All groups reported a similar reliance on social media, albeit at a lower level than all other information sources. This result contrasts with recent studies that have promoted the use of social media for public health campaigns (e.g., Puri et al., 2020). Social media may play other roles in vaccine hesitancy and acceptance by facilitating the organization of offline activities (e.g., Karafillakis et al., 2021) and the sharing of content produced by more traditional media.

Finally, our segmentation revealed slight national differences across the vaccine opinion continuum. French nationals were overrepresented in group 2 (*doubters*), while South African citizens were overrepresented in group 4 (*conspirationists*). While previous studies have identified differences in vaccine attitudes and acceptance between nations (Sallam, 2021; Dubé et al., 2014; Aw et al., 2021), more explanatory research is required.

The following sections consider the implications for theory and practice of our results.

Implications for Research

First, the majority of the constructs in our model are sensitive to information systems influences. For example, perceived social influences, conspiracy theories, opinions on vaccines, and trust level may all be influenced by information management practices or the use of information technologies. Further research in the information systems and related fields is required to better understand the role of IS in leveraging COVID-19 vaccine information to lower barriers to adoption.

Second, our results confirm that perceived social influences, opinions on vaccines, perceived severity, and perceived benefits significantly influence the behavioral intention to accept a vaccine. The influence of SOCIAL is in line with the traditional literature on IS/IT (Venkatesh et al., 2003) and highlights the important role that social media platforms played in the COVID-19 vaccination campaign (Liu & Liu, 2021; Luo et al., 2021). Other IS/IT have previously been employed to understand the dynamics of the COVID-19 pandemic and behaviors toward vaccine acceptance. For instance, sentiment analysis of opinions pertaining to COVID-19 vaccines on Twitter (Yousefinaghani et al., 2021) and Reddit (Melton et al., 2021) could be used not only as indicators of opinions on vaccines but also of their perceived benefits, severity, and other perceptions in our model. Artificial intelligence technologies could be used beyond improvements to the vaccines development process (Vaishya et al., 2020), to monitor opinions, perceived benefits, and barriers to vaccine acceptance.

Third, while perceived social influences, opinions on vaccines, perceived severity, and perceived benefits positively influence the behavioral intention toward vaccine acceptance, a number of perceived barriers discourage vaccine acceptance. These barriers include doubts about vaccine safety, effectiveness, side effects, and the availability of information. Cutting-edge information systems and technologies could be used to mine data, and adjust and diffuse correct information about vaccines to address these barriers. Our findings shed more light on the emerging literature about the interplay between COVID-19 and the role of information systems (Doyle & Conboy, 2020; He et al., 2021; Trkman et al., 2021).

Fourth, our study surprisingly showed that belief in conspiracy theories has no significant effect on vaccine acceptance. While the literature on conspiracy theories during the COVID-19 pandemic have reported a negative relationship between conspiracy beliefs and COVID-19 vaccination intentions (Marinthe et al., 2020; Eberhardt & Ling, 2021), our study did not find empirical evidence to support this relationship. Furthermore, while Storopoli et al. (2020) found that confidence in social institutions was positively associated with the adoption of protective measures, we found no significant effect of trust on vaccine adoption intentions. We also found a nonsignificant effect of preventive behaviors on COVID-19 vaccine acceptance. This may be because such preventive behaviors during COVID-19 were mandatory in order to minimize the spread of the disease (Clark et al., 2020).

Finally, while we hypothesized that negative perceptions of lockdown constraints would positively affect vaccine acceptance, we did not find a significant association between these two constructs.

Implications for Practice and Policy

Our results also have managerial and policy implications. First, the positive effects of perceived social influences, opinions on vaccines, perceived severity, and perceived benefits, suggest that managers, practitioners, and government bodies should use emerging technologies (e.g., AI, big data analytics, IoT) as well as social media to analyze social discourse to gain insights about the enablers and barriers to vaccine acceptance (Doyle & Conboy, 2020; Dwivedi et al., 2020; He et al., 2021). For example, social media analysis could be used to identify both local influencers of vaccination opinions and intentions, and dominant local perceptions of virus severity and vaccination benefits (Karafillakis et al., 2021).

Second, our cluster analysis revealed that traditional media channels, such as television and radio, were more important for most groups than social media for health information. Doctors, hospitals, family, and friends are also favoured information sources. While a number of studies have focused

on the importance of using social media in public health campaigns, public bodies should continue to prioritise more traditional networks.

Third, by focusing on the key determinants of vaccine intentions, policymakers, policymakers can formulate targeted health policies and communications to increase vaccine uptake and improve public health. This knowledge can also help build trust in institutions and the media in areas where it significantly impacts vaccine acceptance, such as South Africa.

Limitations and Future Research Directions

The present study is limited in several ways. First, the study follows a cross-sectional approach, which only allows the collection of data about the phenomena under study at one moment in time. Future research could use a longitudinal approach to understand changes in the nomological network over time or a mixed-methods approach that uses both qualitative and quantitative research methods. Second, unobserved heterogeneity was not assessed in this study (Becker et al., 2013). Future research should consider this issue during the data collection and analysis process.

CONCLUSION

This study proposes and validates an integrated model of COVID-19 vaccine acceptance based on innovation diffusion theory across two continents. The results revealed interesting acceptance and diffusion behaviors and make several contributions to research and practice in global information management and related fields. By studying COVID-19 vaccine acceptance through the lens of technological innovation, we demonstrated the importance of social channels and information channels on rates of diffusion. We found that the set of variables that positively influence the behavioral intention to accept a vaccine (social and contextual factors, health, and vaccine beliefs) can be positively or negatively influenced by social media and other digital communications. Contrary to some existing literature, belief in conspiracy theories and the negative perceptions of social distancing behaviors and stay-at-home measures had no influence on vaccine acceptance. Interestingly, trust only significantly influenced adoption intentions in South Africa.

The study contributes to the ongoing debate around vaccine acceptance, particularly in the context of the COVID-19 pandemic. We suggest that public health campaigns should focus on highlighting the perceived benefits of vaccination, and target social influences and personal opinions on vaccines. The differences observed between France and South Africa also highlight the importance of considering local contexts when designing and implementing vaccine promotion strategies.

Our results open a promising avenue for scholars to identify the technologies and management practices that influence these perceptions and opinions.

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ENDNOTES

1 https://www.bilendi.fr/

2 Individuals were grouped together using Ward's method, based on Euclidean distances on the OPINION variable. Analysis was undertaken using base R. Inspection of the dendrogram revealed four clusters.

APPENDIX

Table 9. Description of the final survey items

Construct	Items	Source
Perceived social influences	SOCIAL1 People who influence my behavior think I should get the COVID-19 vaccine. SOCIAL2 People who are important to me think I should get the COVID-19 vaccine. SOCIAL3 My family doctor thinks I should get the COVID-19 vaccine. SOCIAL4 My immediate family members think I should get the COVID-19 vaccine.	Venkatesh et al. (2003)
Conspiracy theories	CONSPIR1 I think that many very important things happen in the world which the public is never informed about. CONSPIR2 I think that politicians usually do not tell us the true motives for their decisions. CONSPIR3 I think that government agencies closely monitor all citizens. CONSPIR4 I think that which superficially seem to lack a connection are often the result of secret activities. CONSPIR5 I think that there are secret organizations that greatly influence political decisions.	Bruder et al. (2013)
Opinions towards vaccination	OPINION1 I believe that vaccines are a safe and reliable way to help avert the spread of preventable diseases OPINION2 Vaccinations are one of the most significant contributions to public health	Kerr et al. (2020)
Trust level	TRUST1 I have full confidence in the government's ability to deal with the COVID-19 pandemic. TRUST2 I have full confidence in the ability of our hospitals to cope with the COVID-19 pandemic. TRUST3 I have full confidence in the ability of medical staff to cope with the COVID-19 pandemic. TRUST4 I have complete confidence in the media's ability to convey useful information about the COVID-19 pandemic.	Storopoli et al. (2020)
Perceived severity	SEVERE1 Contamination with COVID-19 would represent a serious danger to my health. SEVERE2 Having COVID 19 would be disruptive to my everyday life. SEVERE3 Having COVID 19 would be disruptive to my life overall. SEVERE4 Having COVID-19 would be disruptive to my physical health. SEVERE5 Having COVID-19 would be disruptive to my social life	Clark et al. (2020)
Perceived barriers	VACBAR1 I have serious doubts about the safety of vaccines. VACBAR2 I have serious doubts about the effectiveness of vaccines. VACBAR3 I'm afraid of the unknown side effects of vaccines. VACBAR4 I am afraid of the long-term genetic effects of certain types of vaccines. VACBAR5 I have limited confidence in the source of vaccination (producer). VACBAR6 I do not have enough information about vaccines. VACBAR7 I do not have enough information about possible side effects.	Saied et al. (2021)
Perceived benefits	BENEFIT1 Vaccination is a good idea because I feel less worried about catching COVID-19. BENEFIT2 Vaccination decreases both the possibility of contracting COVID-19 and its complications.	Guidry et al. (2021)
Preventive behaviors	PREVENT1 I wash my hands regularly with soap and water. PREVENT2 I avoid touching my mouth and nose with my hands. PREVENT3 I cough into my elbow. PREVENT4 I keep at least one meter of distance between myself and other people. PREVENT5 I avoid visiting friends and family who do not live with me. PREVENT6 I wear a protective mask when I go out.	Clark et al. (2020) and Romer and Jamieson (2020)
Lockdown barriers	LOCKBAR1 Isolation creates other problems that are more important. LOCKBAR2 Isolation is too painful. LOCKBAR3 Isolation is too difficult. LOCKBAR4 Isolation is not good for my physical health. LOCKBAR5 Isolation is not good for my mental health. LOCKBAR6 Isolation worries me because it will harm the economy.	Callow et al. (2020)
Behavioral intention	INTENT1 If the vaccine is recommended for me, I would get the vaccine. INTENT2 I plan to get the vaccine as soon as the vaccine becomes available for my age group. INTENT3 I predict that I will be vaccinated in the next few days according to the schedule established by the authorities.	Venkatesh et al. (2003)
Actual acceptance	ACCEPT Are you vaccinated? Yes/No	