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## Acceptability of the COVID-19 contact-tracing app – Does culture matter?

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## ABSTRACT

During the pandemic, several countries deployed contact-tracing apps in order to contain or reduce the community spread of COVID-19. However, the success rate in terms of acceptance and use of these apps was reportedly low. Using information gathered from citizens across four European countries and the United States of America, this study explores the role of national culture in relation to the acceptance of these apps.

Using partial least squares structural equation modelling (PLS-SEM), an analysis was undertaken of 3595 records from a cross-country survey dataset that is in the public domain and can be obtained from the Centre for Open Science (Study 1). This analysis was followed by another survey comprising 910 respondents (Study 2). The research model was then validated by using a qualitative approach and undertaking interviews with 51 participants from four countries (Study 3). The results confirmed the moderating role of national culture on the acceptability of the contact-tracing apps in relation to power-distance, masculinity, individualism, long-term orientation and indulgence in the pre-deployment phase (Study 1). There were, however, no significant differences in acceptability of the apps between countries in relation to uncertainty avoidance; and none of the hypotheses in Study 2 was supported.

The study concludes that national culture is significant in terms of the acceptance of COVID-19 apps only during the pre-deployment phase; therefore attention is required with pertinence to pre-deployment strategies. Recommendations regarding how governments and public health institutions can increase the acceptability of contact-tracing apps have been highlighted.

## 1. Introduction

The impact of COVID-19 on human life, society, the economy and politics has been enormous. Globally over 6 million people have lost their lives and almost half a billion cases have been recorded at the time of writing (Johns Hopkins University, 2022). The magnitude of the economic loss caused by COVID-19 is unprecedented; the pandemic has affected the gross domestic product (GDP) of many major economies including the United Kingdom (−9.8%) and France (−8%) in 2020 (IMF, 2022). Global recovery is set to decelerate amid continued COVID-19 outbreaks, with several new variants continuing to affect global economic activities.

A key response in tackling the pandemic has been to implement the use of technology. A study by Kretzschmar et al. (2020) suggests that app-based tracing alone remains more effective than conventional tracing, and it assists in reducing the reproduction rate (R) of the virus to below 1. These apps can be used for information provision, contact-

tracing and diagnostic purposes (Chidambaram, Erridge, Kinross, Purkayastha, & Collaborative, 2020). Quick and efficient contact-tracing via mobile apps is also considered a key strategy to de-escalate lockdown measures. Public health bodies and tech firms have developed COVID-19 contact-tracing apps, but little is known about how culture impacts the acceptability of technology-based solutions, such as the contact-tracing app, with reference to tackling the COVID-19 pandemic.

Unlike during previous pandemics, technological advances and increased penetration of ICT devices, such as smartphones, have led to the development and deployment of information systems (IS) solutions such as COVID-19 contact-tracing apps (Rowe, 2020). Together with other technologies, including location-tracking wristbands for quarantined and infected persons (Urbaczewski & Lee, 2020), big data analytics, machine learning and artificial intelligence, the role of IS cannot be over-emphasised (Agerfalk, Conboy, & Myers, 2020). The contact-tracing app is cost-effective, it has the potential to prevent up to 80% of all transmission (Kretzschmar et al., 2020) and it can aid the

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diagnostic process (Chidambaram et al., 2020). Despite some criticisms, particularly concerning privacy and security, the role of the contact-tracing app cannot be underestimated. Whilst its low acceptance has largely been attributed to these concerns mentioned, little is known as to whether national culture plays a role in its acceptance and, if so, how governments and health institutions can encourage its use.

There is emerging research pertinent to the use of COVID-19 contact-tracing apps developed by public health bodies around the world. A growing number of studies in this area focus on data protection, government surveillance (Guinchard, 2020), regulatory focus and the intention to use contact-tracing technology (Ross, 2021), impact on working professionals (Chakraborty & Kar, 2021), ethical guidelines and issues associated with contact-tracing apps (Morley, Cowls, Taddeo, & Floridi, 2020; Samuel & Lucivero, 2022) and the need for evaluation of these apps into an accepted and ethical tool that may be utilised during future outbreaks of other infectious diseases (Colizza et al., 2021). Despite the growing number of studies on contact-tracing apps, few of these studies focus upon the acceptability of contact-tracing apps from a cultural perspective. This research reports upon the role of culture with regard to the acceptability of COVID-19 contact-tracing apps in response to the call for studies on IS in the era of pandemics (Agerfalk et al., 2020). It does so by proposing the following research question:

**RQ:** *How does national culture affect the acceptability of COVID-19 contact-tracing apps?*

Evidence from the literature review suggests that Hofstede's six dimensions of culture (Hofstede, 2005; Hofstede, Hofstede, & Minkov, 2010) have not been tested in the context of the acceptability of mobile apps, and to the best of the authors' knowledge, no study has, as yet, explored the role of national culture in the context of acceptance of the COVID-19 contact-tracing app. Therefore, the integrated Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989; Venkatesh, Thong, & Xu, 2012) and Hofstede's six-dimensional model are used to study its acceptance in five countries: France, Germany, Italy, the UK and the USA. Publicly available cross-country survey data concerning contact-tracing apps are used. SEM-PLS modelling is applied that will test the moderating effect of national cultural orientation on the relationship between citizens' perceptions of how the government has handled the introduction of the app and its acceptability. The rest of the paper consists of the theoretical background and hypotheses, the methodology, results and discussion. The article ends with conclusions, limitations and future research directions.

## 2. Literature review and conceptual framework

### 2.1. Technology adoption in times of crisis

COVID-19 is a major global crisis and information systems are crucial for successful crisis management (Antoniadis, Tsiakiris, & Tsopogloy, 2015; Housel, El Sawy, & Donovan, 1986). Although the technology acceptance model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) model (Davis et al., 1989; Venkatesh et al., 2012; Venkatesh, Morris, Davis, & Davis, 2003) have been used to investigate the critical factors and contingencies related to not only the attitude but also the prediction of behavioural intention and behavioural expectations to adopt or use a technology (Dwivedi, Rana, Jeyaraj, Clement, & Williams, 2019; Dzandu, Pathak, & Gulliver, 2020; Maruping, Bala, Venkatesh, & Brown, 2017), most or all of these studies were in non-crisis situations. Previous studies undertaken on government-driven technology adoption (Loo, Yeow, & Chong, 2009; Susanto & Goodwin, 2013) were in a non-crisis situation, leaving a gap in the literature on technology acceptance during pandemics, or times of crisis. Although the study by Kummitha (2020) on smart technology for fighting the COVID-19 pandemic made a significant contribution to the literature, this study was not based on empirical data. It is therefore imperative to

understand why, even with extensive resources employed by governments and institutions to introduce new technologies, solutions and services have inherently failed to translate into the individuals' use of the system, despite three decades of research using TAM/UTAUT (Davis et al., 1989; Venkatesh et al., 2012). Thus, acceptance by citizens of new technologies and services introduced by governments, even in non-crisis situations, is still a concern (Susanto & Goodwin, 2013; Zuiderwijk, Janssen, & Dwivedi, 2015). It seems logical to assume that technology acceptance in a major crisis, such as the COVID-19 pandemic, may be different (or not) compared to ordinary life. Hence, a variant of the technology acceptance theory is adopted to investigate the acceptability of the COVID-19 contact-tracing app and the moderating role of culture.

Usually, TAM is constructed on perceived ease of use and perceived usefulness (Davis, 1989; Venkatesh & Bala, 2008; Venkatesh & Davis, 2000). The Theory of Reasoned Action (Ajzen, 1985; Ajzen & Fishbein, 1980), from which TAM originated, includes prior factors such as normative, evaluative and behavioural beliefs, opinions or perceptions as antecedents of attitude and behaviour. The central theme of TAM is that perception (for example, perceived usefulness and perceived ease of use) is a critical factor that plays a part in peoples' intentions to use or accept new technology (Wu & Du, 2012). The "perception" constructs have since been extended and adapted to reflect new measures in a different context, such as perceived enjoyment, perceived image, perceived credibility and perceived playfulness (Ismail & Razak, 2011). In this study, the perception construct adapted is "Perception of government's handling of the COVID-19 App", whilst the dependent variable or construct adapted in this study is "Acceptability of the COVID-19 app". The relationship between perception and technology acceptance is well documented (Davis, 1989; Liu, Zhao, Chau, & Tang, 2015; Venkatesh & Davis, 2000) and evidence suggests that perception indirectly affects the acceptance of mobile app technologies (for example, Kim, Yoon, & Han, 2016; Zhang, Lu, & Kizildag, 2018). Therefore, there is expected to be a significant and positive relationship between the perception of how the government handled the COVID-19 app and the acceptability of the COVID-19 app. The focus of this study is, however, on the extent to which culture moderates the relationship between the perception of the government's handling of the app and the acceptability of the app by citizens.

This paper extends the existing studies regarding COVID-19 apps that compare countries (for example, Abeler, Altmann, Milsom, Toussaert, & Zillessen, 2020; Altmann et al., 2020; Blasimme, Ferretti, & Vayena, 2021; Milsom et al., 2020; Velicia-Martin, Cabrera-Sanchez, Gil-Cordero, & Palos-Sanchez, 2021; Zimmermann et al., 2021) and not national cultures. By looking at national culture, this paper explores a deeper understanding of the acceptability of COVID-19 apps by going beyond the country to consider the six dimensions of that country's culture (i.e. power distance, masculinity, individualism, long-term orientation, uncertainty avoidance and indulgence) and the levels of each of the dimensions (low, medium and high). The use of national culture as a factor in understanding a phenomenon such as the acceptability of COVID-19 apps is not out of place, since culture is a well-researched subject (for example, Goncalves, Oliveira, & Cruz-Jesus, 2018; Hoehle, Zhang, & Venkatesh, 2015; Minkov & Hofstede, 2012; Minkov & Hofstede, 2014; Srite & Karahanna, 2006; Sweetman, 2012). Therefore, using national culture tendencies to model the problem statement in this study is considered appropriate and relevant. COVID-19 apps were deployed at national levels; therefore, understanding how national culture moderates the acceptability of the app would provide governments with recommendations on how to deploy similar types of apps successfully in the future.

### 2.2. National culture and adoption of technology and mobile apps

Hofstede (2005, p. 5) describes culture as a "mental software" of people. According to him, culture connotes shared assumptions that result in a common frame of reference by members of society. The six

measures proposed by Hofstede have gained prominence in measuring national culture: power-distance, individualism-collectivism, masculinity-femininity, uncertainty avoidance, long-term versus short-term orientation, and indulgence versus restraint (Hofstede, 2005; Hofstede et al., 2010). Several studies using the model have confirmed the influence of national cultural settings on the behaviour and intention of individuals when considering the adoption of technology (Kovacic, 2005; Yoon, 2009). For example, cultural distance affects technology adoption (Ahluwalia & Merhi, 2020; Yoon, 2009). According to Kovacic (2005), collectivism and masculinity dimensions affect the adoption of technology, and strong individualistic cultures hold a positive attitude towards technology adoption. Table 1 below summarises the key recent literature showing the relationship between national culture and the use of technology.

According to Tuunanen and Kuo (2015), culture plays a crucial part in the IS requirements collection phase, such as developing a mobile app and the importance of understanding the cultural context of the users is essential for success. Tuunanen and Kuo (2015) suggested incorporating a values-based requirement prioritisation approach, which implies that

**Table 1**  
Summary of recent studies on the link between culture and technology adoption.

Authors	Study	Methodology/ context	Findings
Ahluwalia and Merhi (2020)	Country level adoption of e-commerce	PLS analysis of 69 countries for e-commerce adoption	Risk mitigating mechanisms facilitate the adoption of e-commerce in countries with high uncertainty avoidance.
Sunny, Patrick, and Rob (2019)	The impacts of cultural values at the individual level on the extended TAM by considering technology readiness	Survey research with data from target respondents who were hotel employees within the context of the hotel industry in the US	Introducing a new hotel technology under a less masculine cultural environment can greatly help hotel employees minimize their discomfort
Peltonen et al. (2018)	The role of geographic and cultural factors affecting the use of mobile apps on Android platforms across 44 countries	Large-scale statistical analysis of geographic, cultural, and demographic factors in mobile app usage.	Countries with collectivist and feminine values prefer family-related apps, while countries with low power distance, have a higher preference for leisure-related apps.
Lee, Trimi, and Kim (2013)	The impact of cultural differences on technology adoption; the impact of South Korea and the US cultural differences on mobile phone adoption patterns	A non-linear least squares (NLS) research in which Hofstede's cultural dimensions are applied to examine differences between two countries, South Korea and the USA	In individualistic cultures, people tend to seek information on their own from direct and formal sources; in collectivistic cultures, people rely more on subjective evaluation of other people who have adopted the innovation.
Kummittha (2020)	Smart technologies for fighting pandemics: The techno- and human-driven approaches to controlling the virus transmission	An analysis of academic papers, World Health Organization reports and newspapers.	Chinese cities and governments adopted a techno-driven approach, whilst Western governments adopted a human-driven approach to control the transmission of Covid-19.

more focus should be placed on understanding the values of both the potential and the current users of systems. Hoehle et al. (2015) examine Hofstede's six cultural dimensions as contingency factors in the context of mobile social media applications; they found that espoused cultural values moderate the effects of usability constructs on the individuals' continued intention to use mobile social media applications. Therefore, in moments of crisis, such as the COVID-19 pandemic, it is expected that the behaviour of people might not be the same as in non-crisis situations (Arru & Negre, 2017; Housel et al., 1986; Mirbabaie, Bunker, Stieglitz, & Deubel, 2020), hence the need to understand the role of cultural relationships with the acceptability of contact-tracing apps in a crisis situation. The following sub-sections relate each of the six dimensions to the adoption of technology as a basis to hypothesise about the moderating effect of national culture on the relationship between citizens' perception of the app and acceptability of the contact-tracing mobile app.

### 2.2.1. Power-distance

The power-distance indicator suggests that an individual expects and accepts that people possess different degrees of power (Hofstede et al., 2010). Countries with high power-distance are characterised by the respect they have for a complex, nuanced system of titled classes and untitled "commoners" and they tend to grant much power to those at the top (Sweetman, 2012). Citizens tend to be respectful of authority and are highly likely to follow the guidelines and recommendations from the government to download and use the app. We, therefore, hypothesised that:

*H1 – National culture moderates the relationship between perception of government and acceptability of the app such that countries high in power-distance would be more likely to accept the contact-tracing app than those countries that are low.*

### 2.2.2. Masculinity

Hofstede's second dimension suggests that countries high on the masculinity indicator are achievement-driven, assertive and competitive and they expect material rewards for success. On the other hand, feminine countries tend to be consensus-oriented and cooperative, modest and caring for the weak and place emphasis upon quality of life (Hofstede, 2001). However, Srite and Karahanna (2006) found no significant moderating effect of masculinity/femininity in the relationship between perceived usefulness and intended behaviour. Therefore, we hypothesise the following:

*H2: National culture moderates the relationship between perception of government and acceptability of the app such that countries low on masculinity would be more likely to accept the contact-tracing app than those countries that are high.*

### 2.2.3. Individualism

In countries with a high individualism indicator, individuals are expected to take care only of themselves and their immediate families, as opposed to collectivist countries where individuals can expect their relatives, or members of a particular in-group, to look after them in exchange for unquestioning loyalty. Collectivist cultures are socially oriented and value the opinions of the group (Hofstede et al., 2010); thus, countries low on this scale would be more accepting of the app on the recommendation of family and group members. This leads to the hypothesis that:

*H3: National culture moderates the relationship between perception of government and acceptability of the app such that countries low on individualism would be more likely to accept the contact-tracing app than those countries that are high.*

#### 2.2.4. Long-term orientation

Countries with a long-term orientation consider the future and forthcoming events in decision-making (Hofstede, 2001). Thus, this cultural value is important in the context of mobile app use as citizens are likely to evaluate the app in relation to whether it can deliver value or save time over the long-term (Hoehle et al., 2015). Short-term orientation is associated with respect for the past, and for tradition, and fulfilling social obligations (Hofstede, 2001).

Since long-term orientation towards the new application is likely to offer value or rewards in the future, we hypothesise that:

**H4:** National culture moderates the relationship between perception of government and acceptability of the app such that countries high on long-term orientation would be more likely to accept the contact-tracing app than those countries that are low.

#### 2.2.5. Uncertainty avoidance

The uncertainty avoidance dimension focuses on how cultures adapt to change and handle uncertainty. Countries with high uncertainty avoidance maintain rigid codes of belief and behaviour and are intolerant of unorthodox behaviour and ideas. One of the characteristics of countries with high uncertainty avoidance is that the citizens look to their social environment for cues that will suggest whether accepting a technology is appropriate (Srite & Karahanna, 2006). However, countries low on uncertainty avoidance tend to have a relaxed attitude in which practice counts more than principles; they are open to change and innovation and like to try new things. Hence the hypothesis that:

**H5:** National culture moderates the relationship between perception of government and acceptability of the app such that countries low on the uncertainty avoidance scale would be more likely to accept the contact-tracing app than those countries that are high on the scale.

#### 2.2.6. Indulgence

This is a new dimension incorporated recently into Hofstede's model, and few studies have been published about its relationship with technology acceptance (for example, Huang, Teo, Sanchez-Prieto, Gracia-Penalvo, & Olmos-Miguelanez, 2019). The indulgence indicator suggests hedonic behaviour; for example, how freely people can satisfy their basic needs and desires. Citizens of countries with a high level of indulgence prioritise enjoyment and having fun. On the other hand, restraint characterises a society that suppresses the gratification of needs and regulates it by means of strict social norms (see Hofstede et al., 2010 and Hofstede-Insights (2020) for a complete discussion on Hofstede's dimensions). Based on this argument, we propose that:

**H6:** National culture moderates the relationship between perception of government and acceptability of the app such that countries low on

indulgence would be more likely to accept the contact-tracing app than those countries that are high.

### 2.3. Conceptual framework

This study is underpinned by a variant of the technology acceptance model (TAM) and focuses on perceived factors and acceptance of the COVID-19 contact-tracing app. However, in a departure from known technology factors such as antecedents to the intention to adopt and use technology, this study makes a unique contribution to the literature by extending TAM into the socio-political space by considering the citizens' perception of the government's handling of the introduction of the COVID-19 app and how this affects its acceptance. National culture orientation is incorporated into this variant of TAM in order to produce a research model for the acceptability of the COVID-19 mobile app (Fig. 1).

Among the selected countries, there are very limited studies that have investigated the acceptance of the COVID-19 app along the lines of national culture. The closest one is Zimmermann et al. (2021), who explored perceptions of the app in German-speaking countries and found similar results among the nations. Velicia-Martin et al. (2021) investigated the acceptance of the COVID-19 tracing app by incorporating theory from the technology acceptance model. Similarly, Blausimme et al. (2021) studied Digital Contact Tracing (DTC) against COVID-19 in selected European countries and compared the features of the apps with Asian countries, where the users cannot opt out of many of the app features. It is, however, noted that none of these studies, or other prior studies, considered culture as a moderating factor in the acceptability of the Covid-19 app. Therefore, this study is unique, and perhaps the only study so far that considers national culture dimensions in order to understand the acceptability of the app.

### 3. Data sources and method of analysis

The study adopts a quantitative approach to analyse data from a cross-country quantitative survey conducted in the US, France, Germany, Italy and the UK. The data are publicly available from the Center for Open Science (2020) (<https://osf.io/7vgq9/>) and were originally used in studies by Milsom et al. (2020), Altmann et al. (2020) and Abeler et al. (2020) on contact-tracing apps in the selected countries. The data for the study was sourced from this public dataset by considering those questions that reflect the selected constructs (Chin, 1998a). All the items for the key constructs were measured on a 5-point Likert scale, and these were extracted from the original instrument and dataset without altering their original semantics (see Appendix A for details of the questionnaire and the dataset). Six key hypotheses based on TAM and national culture were developed and tested through structural modelling (Saunders, Lewis, & Thornhill, 2012).

The key construct that affected the acceptability of the contact-

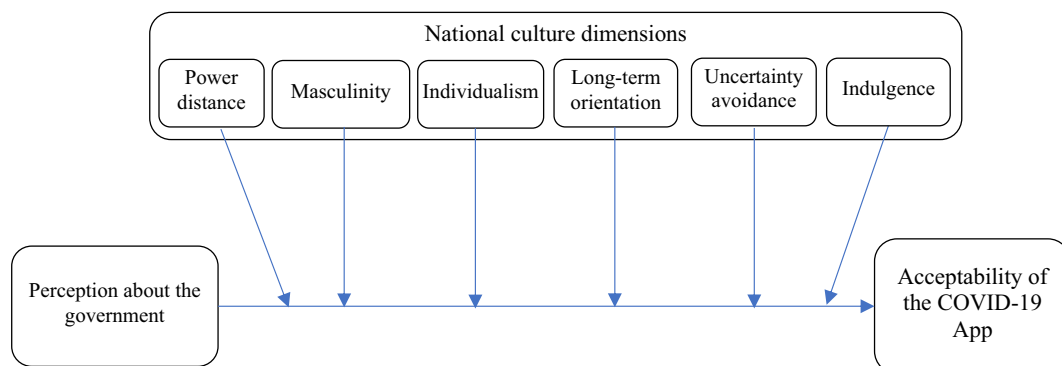


Fig. 1. Moderating role of national culture on the acceptability of the COVID-19 app.

tracing app was citizens' perception of how the government was handling the introduction of the COVID-19 app, measured with two items (PoG1 and PoG2, refer to questionnaire in Appendix A). Acceptability was measured with seven items (AC1 to AC7, refer to questionnaire in Appendix A). The initial scoring of all the items was reversed to reflect higher scores close to "5", representing more positive opinions, and lower scores close to "1", representing less positive opinions on the Likert scale. The scores for national culture orientation were sourced from Hofstede-Insights (2020) (<https://www.hofstede-insights.com>), Hofstede (2001) and Hofstede et al. (2010). The original percentage scores were grouped into three, based on Hofstede's (2001) scoring of high (70–100), medium (40–69), and low (0–39) for each of the six national culture dimensions (see Table B.1 in Appendix B). The low and high parts of the classification can also be inferred from Hofstede (2001), Hofstede et al. (2010) and the Corporate Finance Institute (2021). This formed the basis for comparing the moderating effect of the national culture dimensions on the relationship between the perception of the government's handling of the COVID-19 app and the acceptability of the app among the citizens from the five countries.

From the original dataset of 6142 records, 3959 were usable after data cleansing, giving a response rate of 64.5%. During data preprocessing, the casewise deletion method for handling missing data was applied (Barladi & Enders, 2010; Hair, Hult, Ringle, & Sarstedt, 2017). Consequently, all incomplete answers or non-responses to the relevant questions were deleted so that only rows of data with valid responses for every question were used. The resultant response rate of 64.5% in Study 1 is greater than the 42% total usable responses achieved in Barr et al. (2017). Although the conservative casewise deletion method used to treat the missing data perhaps reduced the precision of the final model (Ringle, Wende, & Becker, 2015), the results were unaffected as there was no projected possible selection bias in the final dataset used.

The final sample for Study 1 consisted of 625 participants from France, 690 from Germany, 679 from Italy, 730 from the UK and 1235 from the US. The personal characteristics (sex and age) of the respondents show almost equal numbers of males (1939) and females (2004). There were a few non-binary (11) genders among the respondents. The age distribution shows an even spread among the various groups (see Table B.2 in Appendix B). The data were analysed using partial least squares structural equation modelling (PLS-SEM) software and SmartPLS, for its popularity and robustness in developing structural models (Hair et al., 2017; Ringle et al., 2015).

4. Results and discussion

4.1. Results from the quantitative approach – Study 1 (pre-deployment)

The model was first assessed for the quality of the measurement constructs (Hair, Hult, Ringle, & Sarstedt, 2013). The results of the reliability and validity assessment of the constructs (Table B3 in Appendix B) show composite reliability values of at least 0.893, Cronbach's alpha of at least 0.764, both against the set criterion of 0.7, and average

variance extracted (AVE) scores of at least 0.5 for each construct. In addition, discriminant validity (Table B.4 in Appendix B) is confirmed, since the square root of each construct's AVE was greater than the correlation with the other constructs. Furthermore, the Heterotrait-Monotrait Ratio (HTMT) values obtained were less than 1.0. Therefore, the constructs' reliability and discriminant validity were confirmed for the model.

The cross-loadings of each item on their respective constructs were high and met the set criterion of 0.50. One item for the acceptability construct was dropped since it was highly correlated with other items and had a variance inflation factor (VIF) of more than 5. The final model, therefore, had no issues with multicollinearity since the outer VIF values of the remaining items were below 5 (Hair et al., 2013). However, given that VIFs that are greater than 3.3 supposedly indicate the presence of uncontrolled collinearity, and hence the presence of common method bias (Kock, 2015), we carried out a full factor-level VIF analysis to identify any common method bias. The inner factor-level VIF was less than 3.3 (Kock, 2015); therefore, the model is deemed free of potential common method bias.

The test of predictive relevance of the model using the blindfolding method yielded Q<sup>2</sup> values greater than zero (Hair et al., 2013); therefore, the model has predictive relevance. The R<sup>2</sup> value of 0.433 was recorded for acceptability, indicating that the acceptability of the app could be explained by 43.3% of the variations in the citizens' perception of the way the government was handling the introduction of the app. The observed R<sup>2</sup> was greater than the recommended 0.30 threshold for meaningful consideration (Chin, 1998b).

The moderating effect of national culture orientation was assessed using standardised path coefficients that were obtained through bootstrapping. The moderating variable was grouped into Low (L = 0), M-Medium (M = 1) and High (H = 2) national culture. Multi-group analysis (MGA) of two groups at a time using bootstrapping techniques was used to assess the significance of the path coefficients (for example, Table B.5a and Table B.5b – in Appendix B for the Measurement Invariance test using MICOM results for Study 1 and Study 2 respectively).

The path co-efficient for the moderator, independent and dependent variables were used to assess the moderating effects for hypotheses H1, H2, H4 and H6 that were supported (Table 2). The results show that countries high on the power-distance scale (for example, France and Italy) were more accepting of the contact-tracing app when the citizens' perception of the way the government was handling its introduction was high. This is consistent with studies such as Blasimme et al. (2021) and Sweetman (2012) on the influence of power-distance in some societies. In the study of Digital Contact Tracing (DCT) undertaken by Blasimme et al. (2021) against COVID-19 in selected European countries, they compared the features of the apps with the Asian countries, where the users cannot opt out of many of the App features. Their findings support the results of our study, those results being that countries high on the power-distance scale are more likely to accept the contact tracing apps. For example, their data show that on average, and in terms of pure volume of downloads, India's Aarogya Setu app is a frontrunner (with

Table 2 Comparison of path co-efficient between cultural orientations – MGA (Study 1).

Hypothesis	Relationships	Moderator	Low	Medium	High	Outcome
			Std. Beta	Std. Beta	Std. Beta	
H1 -	PoG → ACC	PDI	0.626*	0.706*	0.730*	Supported
H2	PoG → ACC	MAS	-	0.522*	0.392*	Supported
H3	PoG → ACC	INDV	-	-	-	N/A
H4	PoG → ACC	LTO	0.673*	0.650*	0.734*	Supported
H5	PoG → ACC	UAV	0.653	-	0.622	Not supported
H6	PoG → ACC	IND	0.321*	0.460*	0.646*	Supported

NB: ACC – Acceptability of Covid-19 app; PoG – Perception of government handling of the app; PDI –Power distance, MAS – Masculinity, INDV – Individualism, LTO – Long-term orientation, UAV – Uncertainty avoidance, IND – Indulgence.

India high on the power distance scale) having more COVID-19 app downloads than the average of the European countries (Blasimme et al., 2021).

The study confirmed the moderating effect of masculinity on the relationship between perception and acceptance of the COVID-19 app (H2). This contradicts Srite and Karahanna (2006), who reported no significant moderating effect of masculinity/femininity on perceived usefulness and intended behaviour. The results (Table 2) show that countries that are low on the masculinity scale (for example, France) were more accepting of the app when the citizens' perception of how the government was handling its introduction was high. This is consistent with Hofstede's (2001) argument that feminine countries are usually consensus-oriented and cooperative, modest, and that they cared for the quality of life and were therefore found to be supportive of the COVID-19 app.

The data (Table 2) further revealed that countries low on the indulgence scale (for example, France, Italy and Germany) were more accepting of the app than countries such as the UK and the US that were high on the scale (H6). In low-indulgence countries, people are more willing to suppress self-gratification of their needs and adhere strictly to social norms (Hofstede et al., 2010), such as the government's call to adopt the COVID-19 contact-tracing app for the collective good in dealing with the pandemic.

The results from Study 1 confirmed the moderating role of some aspects of national culture, specifically power-distance, masculinity, long-term orientation and indulgence, on the acceptability of the COVID-19 contact-tracing app. In addition, the citizens' opinion of how the government handled the app's introduction had a significant impact on its acceptability. Therefore, governments and health institutions that were involved in deploying a contact-tracing app needed to engage with citizens to improve citizen participation and help increase the acceptance rate of the app.

#### 4.2. Results from the quantitative approach – Study 2 (post-deployment)

In Study 2, a questionnaire survey was used to collect data from 910 citizens from the five countries (see Table B.2b in Appendix B). Three items adapted from Gao, Krogstie, and Siau (2011) were used to measure the acceptability of the Covid-19 app (ACC). Trust in government (TiG) was measured with three items adapted from Parent, Vandebek, and Gemino (2005) and Upadhyay, Kumar, Dwivedi, and Adlakha (2022). Perception of government handling of the Covid-19 app (PoG) was also measured with three items adapted from Lazarus et al. (2020) and the data collection was carried out online. The results of the measurement assessments for reliability and validity are presented in Appendix B (Table B3b and Table B4b in Appendix B). In addition, the Heterotrait-Monotrait Ratio (HTMT) values obtained were less than 1.0, the cross-loadings were greater than 0.50 and all the variance inflation factor (VIF) values were below 3.3 (Kock, 2015); therefore the model is deemed to be free of potential multicollinearity and common method bias.

It is observed that the results (Table 2a) from Study 2 (post-deployment phase) did not confirm the results from Study 1 (pre-deployment phase). However, the fact that none of the sub-hypotheses (H1-H6) in

Study 2 were supported indicates that national culture did not matter in relation to accepting the Covid-19 app when the app was eventually deployed. It appears citizens from all the five countries that were included in the study were collective in their endeavours to support the efforts of their governments in dealing with the pandemic. The use of Hofstede's national cultural orientation was perhaps too generic and failed to account for individual cultural orientations when the app was fully deployed. Therefore, future studies could explore the effect of individual cultural orientation on the acceptance and non-acceptance of technologies to be developed and deployed in response to future pandemics.

#### 4.3. Study 3 - qualitative approach - validation of the structural model through interviews

A post-acceptance evaluation of the COVID-19 contact-tracing app was carried out by interviewing users of the app in four out of the five countries from which the surveys were conducted. The results from the qualitative interviews have enabled the researchers to validate the outcome of the structural model based on the actual experiences of citizens who have used the COVID-19 app. The empirical data serves as a benchmark to ascertain whether citizens' perceptions/expectations and intended acceptability of the COVID-19 app before its deployment differs significantly from their actual experiences with the app. The researchers recruited the participants with the help of their peer academics/researchers that were working in their respective countries. However, in a few instances where the participants were unavailable, they requested that the interview protocol be emailed to them. They were then given time to send their responses as either recorded audio voices or typed using the Microsoft Word application. The average time for the interviews was 29 min, with some sessions lasting anywhere between 21 min and 42 min. The interviews were conducted post-vaccine availability, between August and November 2021.

The majority of the interviews were recorded and transcribed (Corbin & Strauss, 2008). However, whilst the interviews with the UK and US participants were conducted in English, those with participants in France and Germany required the translation of the questions into French/German and the responses back into English. The translations were done with the support of fellow academic/researchers who were either native German or French and held at least postgraduate degrees.

The interviewees were asked questions under two main sub-sections – perception of the way that the government handled the COVID-19 app and the acceptability of the Covid-19 app (see Appendix C for the semi-structured interview protocol with sample questions). In addition, the interviewees were asked to provide a brief background about themselves and their general opinions and comments/suggestions for governments regarding the COVID-19 app. The interviews were transcribed, coded and analysed using the thematic analysis technique (Braun & Clarke, 2006) with the help of NVivo software.

The profile of the total of 51 interviewees who consented to the study shows an almost equal proportion of males (25) and females (22), similar to the gender representation in the survey. There was one non-binary gender representation and three interviewees who preferred not to disclose their gender (Table C.1 in Appendix C). The majority - 45

**Table 2a**

Comparison of path co-efficient between cultural orientations – MGA (Study 2).

Hypothesis	Relationships	Moderator	Low	Medium	High	Outcome
			Std. Beta	Std. Beta	Std. Beta	
H1 -	PoG → ACC	PDI	0.308	0.319	0.262	Not supported
H2	PoG → ACC	MAS	0.262		0.315	Not supported
H3	PoG → ACC	INDV	-		-	N/A
H4	PoG → ACC	LTO	0.372	0.190	0.319	Not supported
H5	PoG → ACC	UAV	0.303		0.319	Not supported
H6	PoG → ACC	IND	0.348	0.262	0.303	Not supported

of the interviewees - were between the ages of 18–50 years, whilst a few – that is 3 of the interviewees were close to retirement age (for example, age 51–60 years) and a further 3 of the interviewees were within retirement age (for example, older than 60 years). Overall, 12 interviewees were from France, 11 were from Germany, 18 were from the UK, and 10 were from the US. Unfortunately, after several attempts, the researchers could not secure interviews with potential participants from Italy, unlike for the survey. This, however, does not in any way affect the validity of the qualitative results. Moreover, the national culture orientation of Italy is similar to most other European countries, such as France (Table C.2 in Appendix C).

When the interviewees were asked their opinions on how they perceived the way that the government handled the introduction of the COVID-19 app, the majority answered negatively across all cultures. Thus, over three-quarters of the 51 interviewees had negative perceptions about how the government approached the implementation of the COVID-19 app. Some of the responses given include “the introduction used a big bang approach without appropriate user testing” (Interviewee #6, Female, UK, Low-Power Distance); “They were very insistent. I cannot say that it was reassuring as I did not see how this would help.” (Interviewee #44, Male, France, High - Individualism); “It seemed shrouded in secrecy. Not very transparent.” (Interviewee #37, Male, UK, Low - Uncertainty Avoidance) and “There was limited awareness creation on the app and it's important. Unlike other interventions the government implemented, the education and awareness creation were low.” (Interviewee #6, Male, US, Low - Long-term Orientation).

Conversely, a few interviewees had a positive perception of how the government introduced the COVID-19 app. Some of their remarks include, “Well, it was pretty good” (Interviewee #24, Germany, High - Long-term Orientation); “It is a good app to keep track of cases and be aware of the situation” (Interviewee #26, UK, Female, Low - Uncertainty Avoidance). Generally, most of the interviewees had a somewhat negative perception of the way the government handled the implementation of the COVID-19 app across various cultures/countries. This contradicts the data from the pre-implementation survey, where the respondents had a fair perception of their countries' governmental approach to the implementation of the COVID-19 app. This means that the governments would have to improve their engagement with the citizens and repackage their information campaigns, interventions and dissemination in a transparent and trustworthy manner in order to enhance the citizens' perceptions and, ultimately, the acceptability of the app.

The responses from the interviews indicated that apart from a few (5) interviewees who stated that they were compelled to install the app, the majority (46) said that they voluntarily installed the COVID-19 app without it being forced upon them. Those who indicated that the COVID-19 app was automatically installed on their mobile phones by their mobile phone service provider acting on the instructions of the government, remarked (for example): “It felt invasive. The idea of someone remotely installing an App on my phone without my consent raises questions about privacy.” (Interviewee #37, UK, Male, Low - Power Distance).

It was noted that few were receptive to the idea of forced acceptance. This was reflected in their comments, such as “Anything to help fight the virus” (Interviewee #9, UK, Male, Low - Uncertainty Avoidance) and “I'm Ok with it” (Interviewee #9, Germany, High - Long-Term Orientation). Generally, the responses indicate - from the countries studied - if the government had imposed the app upon the citizens by instructing mobile phone service providers to install the app on every subscriber's phone automatically, people would have rebelled, and the acceptance rates of the app would have been much lower than current levels.

The results showed that, in the order of importance, the top five considerations by the citizens in the implementation of the COVID-19 app were their lack of involvement in the design of the app (3.78), followed by lack of control over the app by “me” (3.57), lack of control of “my data” (3.08), lack of data privacy (2.72) and security, especially the

fear of surveillance (2.65). The implication of this is that both the government and technology developers involved in the design and deployment of the COVID-19 app must find a way to engage the citizens through user-centred-design approaches such as citizen development (Florin & Wandersman, 1990; Irwin, 2002) or co-creation (Pathak, Ashok, & Tan, 2021).

The interviewees also responded to a question as to whether they liked the COVID-19 app and whether they were ready to accept and recommend it to others. The general responses point to hesitation on the part of the interviewees to recommend the COVID-19 app to others because of the security, privacy and uncertainty regarding the lack of clarity on personal data. However, among the few participants who expressed their liking for the COVID-19 app and were willing to accept the app, the results showed that countries high in power-distance were more inclined to accept the app than those from countries low in power-distance. Similarly, more participants from countries low on masculinity and indulgence were more inclined to accept the COVID-19 app than those from countries low on masculinity and indulgence. These results are consistent with the outcome of the structural model for Study 1, where hypotheses H1, H2, H4 and H6 were supported. Thus, national culture indeed has some significant effect on the acceptability of the COVID-19 contact-tracing app before its deployment. However, Study 2 showed no significant moderating effect of national culture on the acceptability of the COVID-19 contact-tracing app when the app was fully deployed.

The implications of these results for the various governments across the world, technologists and national health institutions is to consider a segmentation approach to the design and deployment of the COVID-19 app that is not based upon the national culture orientations of each country, as classified by Hofstede (2001, 2021), but on individual cultural orientation. In the midst of the fourth wave of the COVID-19 pandemic and the super spreading Omicron variant, the real impact of the COVID-19 app should not be underestimated, as there are potentials for governments to gain real value from the Covid-19 app investments; there is the need to focus strategies on understanding individual culture of citizens and user behaviour to increase its acceptability.

## 5. Implications of the findings

### 5.1. Theoretical implications

Theoretically, this study contributes to the growing literature relating to the understanding of the techno- and human-driven approaches (Kummittha, 2020) towards adopting and using new technologies. This study extends the technology acceptance model into the socio-political space by looking at constructs such as the citizens' perception of the government handling of the COVID-19 pandemic and how this affects the acceptability of the app. To the best of our knowledge, no study has yet investigated how these two constructs affect the adoption intentions and acceptance of a government-led technology initiative such as COVID-19 contact-tracing apps. Another contribution to scholarship is our unique finding concerning the impact of the masculinity dimension on adopting responsive technology in the pre-deployment phase (Study 1). Contrary to the generally held assertion that technology is “masculine” (Lie, 1995), our findings indicated otherwise. This research is more encompassing because it is the first to test all six of Hofstede's cultural dimensions in order to understand the acceptance of mobile apps in a crisis situation. Although previous studies have operationalised the first five of Hofstede's cultural dimensions (for example, Hoehle et al., 2015), the indulgence dimension was excluded. Huang et al. (2019) did include indulgence in technology acceptance, but they examined only four of the six cultural dimensions. By investigating all six cultural dimensions, we are less likely to miss the relationship between them, which is essential for understanding the acceptance of the COVID-19 app and government-led technologies deployment in general.

## 5.2. Policy implications

Given that in Study 1, countries high on the power-distance scale are likely to accept the COVID-19 app, government agencies in countries low on power-distance should involve citizens in the development and testing of the app at the pre-deployment stage so as to ensure high uptake. Developers should follow the co-creation and co-design approach with citizens to ensure that the users perceive the value of these public-service offerings. The literature on value co-creation and co-design provides more specific information on integrating co-creation in the public service and the broader ecosystem to enhance user involvement (for example, Jaakkola & Alexander, 2014; McColl-Kennedy, Vargo, Dagger, Sweeney, & van Kasteren, 2012; Pathak, Ashok, & Tan, 2020). Although the COVID-19 crisis requires that solutions such as the contact-tracing app be delivered in a timely manner given the emergency, the app could have been co-designed using an agile development methodology. The results of our Study 1 suggest that countries low on the masculine index are more likely to accept the COVID-19 app, implying the need for intervention to counter resistance to acceptance. For example, since citizens of the UK, US, Germany and Italy are driven by material reward and achievement (Hofstede, 2001), government and public health institutions should integrate incentives or rewards (for example, a digital health certificate) to promote the use of the COVID-19 app. Countries high on the indulgence scale, such as the US and the UK, should link the use of the app through access to fun and leisure facilities in an effort to improve its acceptance. In future pandemics, government, policymakers and developers should co-operate in the pre-deployment phase whilst developing the app and endeavour to incorporate robust informational features that highlight the consequences of not using the app, for example, the potential closure of sports venues or health clubs, as this will appeal to citizens in high indulgence countries. Government and public health agencies should complement the deployment of the app with strong information campaigns and strategies that target individuals by communicating the seriousness of the pandemic and the need to use the app to help avoid further unintended disruptions in their daily activities.

## 5.3. Practical implications

The results of this study have direct managerial implications for IS practitioners, especially solutions developers. The need for the design and development of apps and IS solutions that incorporate cultural value at the macro (national), meso (society/group), and micro (individual) levels is imperative (O'Connor et al., 2018), especially at the pre-deployment phase. There is limited use of this approach, known as the Transition Management Framework (Geels, 2002), in developing innovation and IS studies (O'Connor et al., 2018). Cultural factors should be seriously considered from the conception, through requirements elicitation to the development and testing and optimisation of IS solutions such as contact-tracing apps. Thus, mobile apps should be designed to meet the context-specific needs of users to enhance their acceptability and use (Tuunanen & Kuo, 2015). Aside from the privacy and security issues of personal data, the adoption of the contact-tracing app is complex, and the assumption that citizens will generally accept it in any country to help combat the pandemic is false. The uptake of the COVID-19 contact-tracing app worldwide is generally low, below the estimated 20% of the population needed to use it to help reduce the R rate to below 1 (Kretzschmar et al., 2020). For example, it has only reached as far as 19.3% in the case of Singapore (Wiertz, Banerjee, Acar, & Ghosh, 2020). For a more targeted and personalised approach to engage individual citizens to adopt and use the contact-tracing app, future studies should further drill down from national culture to individual cultural differences. In addition, other studies could look at how personal characteristics, such as age, gender, and comorbidities, affect the acceptance of the app. Thus, future studies could investigate personality and individual differences and how these could be explored in customising the contact-tracing app to encourage its adoption and use.

## 6. Conclusions and limitations

The study addressed the question of whether national culture is significant in the adoption of the COVID-19 contact-tracing app, given its reported low level of success achieved in various countries. The study used a publicly available dataset for five countries, similar to other studies (for example, Urbaczewski & Lee, 2020). Four of the six hypotheses tested were supported in Study 1, concluding that national culture is essential in accepting the COVID-19 app. This study has limitations related to the data collection. The increasing number of research studies highlights key differences in cultural values within large countries such as the USA (for example, Duffy, Hewlett, McCrae, & Hall, 2019; Silver, 2021); these regional contexts and differences were not included because of the considerable resources involved in doing so. Another limitation of the study was the lack of data from emerging and developing countries to compare with the data from selected developed countries. This lack of diversity notwithstanding, the study clearly highlights the role that national culture plays in the acceptability of the contact-tracing app. Therefore, future studies should consider data from low- and medium-income countries to test this model in individualistic cultures.

Another limitation of this study is the consideration of only one antecedent construct (opinion of the government handling of the COVID-19 contact-tracing app). Therefore, future studies could benefit from purposely-designed constructs adopted either from TAM/UTAUT or newly developed socio-political constructs to help better understand how other factors (such as national income, GDP, level of democracy, type of governance system, political culture and other socio-economic and political factors) can influence government interventions such as the COVID-19 contact-tracing app. The adoption of the app alone does not necessarily guarantee success and the intended behavioural response from users.

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## Declaration of Competing Interest

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

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.giq.2022.101750>.

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