The determinants of continuance intention to use pandemic contact tracing apps: the case of COVID-19

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Abstract: This study examines the determinants of pandemic contact tracing apps adoption and explores their impact on the intention to continue use. Data were collected from a sample of 243 users from those who have downloaded and used the 'Aman' app, the Jordanian version of the contact tracing app, to combat the COVID-19. Smart-PLS structural equation modelling software was used to analyse data. The results reveal a significant role of performance expectancy, risk perception and social influence in the intention to continue using contact tracing apps in responding to coronavirus COVID-19. Furthermore, the results did not reveal a significant role of privacy concerns and facilitating conditions in the intention to continue using contact tracing apps. This study adds valuable insights to continued investigation on contact tracing apps adoption and use. The research model offers a practical paradigm that can be employed to develop effective contact tracing apps to combat global epidemic outbreaks.

Keywords: pandemic contact tracing apps; performance expectancy; risk perception; privacy; social influence; facilitating conditions; intention to continue using.

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1   Introduction

While pandemics have been one of the most looming threats to humanity for decades, the COVID-19 outbreak has produced shocking an unprecedented global health crisis that generations have known. Governments have made extraordinary interventions, racing prevents the entry and reduces the transmission of coronavirus by restraining travel, quarantining people and stopping large gatherings. Contact tracing was a critical procedure to combat and limit the spread of COVID-19 infectious disease as both, a warning application for citizens and a targeted intervention approach for the government (Focacci et al., 2022). Traditional manual contact tracing methods were unable to handle the coronavirus outbreak or share information and contact tracing of people infected as the number of cases continued to rise swiftly.

IT, social media and smartphones applications have always been sources of novel solutions in contemporary crises. At the beginning of the COVID-19 crisis, the mobile contact tracing apps have represented promising solutions to face the challenges of pandemic spread. In responding to the pressures of finding a novel way to control the spread of the COVID-19, many countries around the world have launched national contact tracing apps to protect their societies and map the spread of the virus. Pandemics contact tracing app is a mobile application that uses digital contact tracing, employing phone location data to monitor, identify and alert people who may have been in contact with infected individuals (Duan and Deng, 2021). There are numerous frameworks for developing contact tracing apps have conducted. However, many models of this novel application have still under evaluation.

The continued dissemination of the virus implies that the current situation may stay for a while (Yap and Xie, 2020). The massive public adoption of contact tracing apps is critical to reaching the critical mass required for containing the pandemic outbreak. As it goes with launching any new technologies or applications, many issues are raised regarding the determinants of adoption and use, such as motivations, requirements and concerns that have a critical impact on the continuance use. While the focus of the present studies is on privacy stemming from using mobile contact tracing applications, the critical question that has not obtained adequate attention revolves around why or why not people continue using such applications? optimising the knowledge of stakeholders handling the pandemics is a primary part of developing an effective app and can be leveraged to increase the adoption of such applications. The existing models and frameworks for studying contact tracing apps lack central aspects, issues and heterogeneities of attitudes and attention to use present in real-world that are relevant for epidemic dynamics.

This study aims to examine the determinants of pandemics' contact tracing apps adoption, exploring their impact on the intention to continue using. It attempts to answer the urgent question: what are the determinants of continuance intention to use pandemic contact tracing apps? The present study has used an online survey to answer the research question. Data were collected from a sample of Jordanians who have downloaded and used the 'Aman' contact tracing app. The results of this study present valuable academic and practical contributions to the drivers of intention to continue to use these applications during epidemic crises.

The rest of our study is structured as follows. Section 2 presents the literature review for determinants of continuance intention to use pandemic contact tracing apps. The research model and related hypotheses are developed and justified in Section 3. Section 4

explains the method, measures and instrument. Section 5 displays the results of data analysis and testing the research model and hypotheses. Section 6 discusses findings. Finally, Section 7 presents conclusions and implications.

2   Literature review

Contact tracing is a series of processes to identify potentially infected persons by examining their Figure 2020). According to Zeinalipour-Yazti et al. (2020), contact tracing is a mobile application that employs the rich features of mobile sensors, such as location, proximity and social networks, facilitating the procedures of identifying who individuals contact with a disease infected patient. The mechanism of this app was stated to involve identifying people that have contact with infected patients to be isolated and tested, treated and thus curtail the disease transmission any further. However, contact tracing apps are not new. These technologies represented a core surveillance action in epidemics, such as HIV and Ebola (Brack et al., 2020). A large amount of attention and resources have been devoted to innovating novel means to leverage contact tracing technologies in responding to the recent contagious disease outbreak. These efforts take advantage of the widespread availability of smartphones connecting to the Internet, which integrates GPS capabilities of location tracking and Bluetooth that can sense the proximity between devices (Ross et al., 2020).

Recently, new waves of investigations in the field of e-health were devoted to developing and investigating novel systems and applications to monitor the health status of the users. More recently, as COVID-19 invades the world, tremendous efforts were presented on digital contact tracing. In the meanwhile, the mobile-based contact tracing apps have gained extensive attention in the literature as one of the mean technology-based responses proposed to restrict the spread of this virus.

Recent research confirms that the value of contact tracking apps is critically related to their installation rate. While these apps are still in their infancy, the lack of consensus around the determinants of adoption, non-adoption, or discontinuation may impede the contribution of such technologies to the pandemic response and prevention (Fahey and Hino, 2020). However, the majority of previous studies have focused on privacy and developing new models and technical solutions to address the limitations of the current contact tracing apps. Taking into consideration the continuous incentives research efforts, Table 1 sets forth a categorisation of the majority of previous studies, which investigated the contact tracking apps in responding to COVID-19 pandemics.

The literature review reveals the lack of empirical research from the users' perspective on the determinants of contact tracking apps. Most of the previous studies were merely constructed on descriptive, theoretical methodology. Many scholars (e.g., Baumgärtner et al., 2020; Maccari and Cagno, 2020) leaned on content analytics of databases that describe contacts between persons in different contexts. At the same time, a large amount of prior research (e.g., Barrat et al., 2020; Sun et al., 2020) on contact tracking apps stood on macro-level mathematical models assuming homogeneous mixing of populations.

Although there is a growing interest (e.g., Duan and Deng, 2021; Ezzaouia and Bulchand-Gidumal, 2021; Fox et al., 2021) in examining the drivers of contact tracing apps adoption and use employing the theme of the UTAUT model, most of these studies have ignored the role of privacy and perceived risk of a pandemic. In addition, far less

empirical attention has been given to studying the determinants of continuous use from the perspective of those who already adopted the app.

Table 1   A categorization of previous studies the contact tracking apps in responding to COVID-19 pandemics

| *Focus*	*Authors*
Privacy issues.	Van Kolfschooten and de Ruijter (2020) and Zeinalipour-Yazti et al. (2020)
Developing and designing new models and solutions of contact tracing.	Brack et al. (2020), Polenta et al. (2020), Wang et al. (2020), Yasaka et al. (2020)
Ethics and legal issues.	Thayyil et al. (2020)
The role of contact tracing apps in reducing the spread of pandemic.	Hernández-Orallo et al. (2020) and Maccari and Cagno (2020)
Performance and effectiveness.	Barrat et al. (2020) and Von Wyl et al. (2020)
Benefits and barriers.	Altmann et al. (2020) and Redmiles (2020)
Challenges of deployment and adoption.	Dar et al. (2020) and Vitak and Zimmer (2020)
The impact of delays on contact tracing.	Kouliaridis et al. (2020) and Jenniskens et al. (2021)
Comparing features, functionalities and characteristics of apps.	Fahey and Hino (2020)
Trust and transparency.	Oldeweme et al. (2021)
Design dynamic algorithms and protocols.	Culler et al. (2020)
Security and risks.	Baumgärtner et al. (2020) and Sun et al. (2020)
The impact of effort expectancy, perceived value, social influence and facilitating conditions on the intention to adopt/use.	Duan and Deng (2021), Ezzaouia and Bulchand-Gidumal (2021) and Fox et al. (2021)

In summary, the literature denotes the substantial need to empirically examine the determinants of continuance intention to use pandemic contact tracing apps. Based on the literature review, this study seeks to present a coherent framework, including the role of performance expectancy, privacy, risk perception, social influence and facilitating conditions in the continued use of the COVID-19 contact tracing apps, employing the theory of unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003, 2008, 2012).

3   Research model

The UTAUT model represents a summary of eight technology acceptance models. This model aims to study the adoption factors and explain user intention to use information systems and acceptable behaviour. According to Venkatesh et al. (2012), the UTAUT is a well-researched and empirically validated model that has been successful in predicting intention to continuous usage of IT and technology use in a variety of domains technologies in both organisational and non-organisational settings. The extended

UTAUT was adapted for two reasons. First, the original UTAUT integrates the most prominent models to determine the user acceptance and intentions to use IT, with their extensions, into a unified theoretical model that captured the essential elements of previously established models (Venkatesh et al., 2003). Second, the extended version of UTAUT makes it applicable in the context of voluntary behaviour and non-organisational settings (Venkatesh et al., 2012). However, the present study displays its research model in Figure 1.

Figure 1 Research model
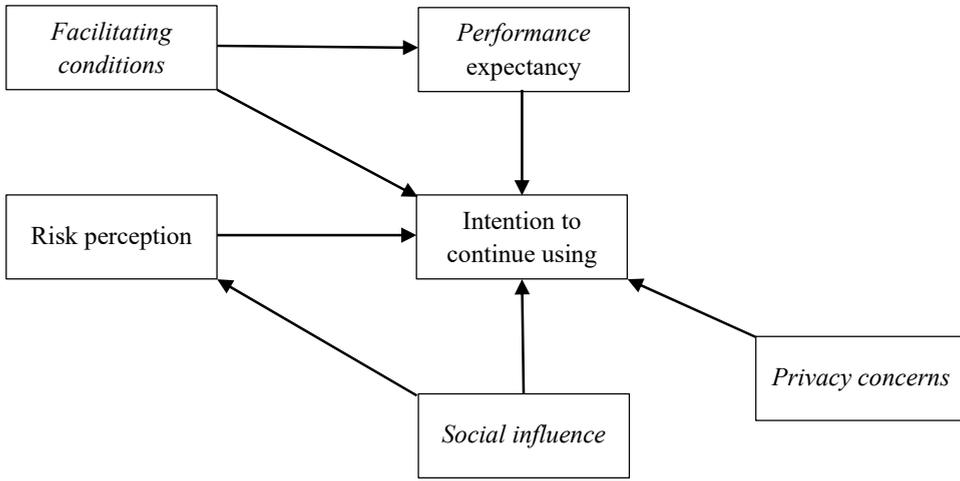
This study proposes that performance expectancy, risk perception, privacy, social influence and facilitating conditions have a significant impact on the intention to continue using contact tracing apps during the COVID-19 crisis. Furthermore, it proposes a significant impact of facilitating conditions on performance expectancy. At the same time, the present study proposes a significant impact of social influence on the risk perception, driving people to continue using contact tracing apps. The proposed impacts of the research model constructs are investigated below in more detail.

3.1 Performance expectancy

Performance expectancy is described as the extent to which individuals believe that using technologies will deliver benefits to users and enable them to perform particular activities (Venkatesh et al., 2012). Performance expectancy is parallel to extrinsic motivations and perceived usefulness in technology acceptance models as a pivotal determinant of adopting and using new IT (Venkatesh et al., 2003). Previous research confirmed that the viable adoption of ICTs solutions depends on the continued usage rather than first-time use (Venkatesh et al., 2012; Cao et al., 2013; Humbani and Wiese, 2019). This perspective assumes that users of such technology are goal-directed in their decisions to the continued use as a dynamic choice depending on gratifying their perceived needs or wants.

In the context of this perspective, a significant stream of research (e.g., Chung et al., 2016; Vaghefi and Tulu, 2019; Tam et al., 2020) have paid their attention to study why

people continue to use different mobile apps. Most of the previous studies confirmed that the conformation of expectations, satisfaction of needs and the perception of usefulness are critical determinants to continuous use, where users change their evaluation of such apps over time. The literature has widely investigated the benefits and performance of contact tracing apps in discovering and controlling the spread of infectious COVID-19 (Hernández-Orallo et al., 2020; Walrave et al., 2020).

Recent studies emphasised that the effectiveness of a contact tracing app deeply depends on its installation rate, which may be affected by users' perception of the utility of this app (Bianconi et al., 2020; Redmiles, 2020). Users who are more persuaded by the app's value and benefits would be more willing to continue using it. Recently, Ezzaouia and Bulchand-Gidumal (2021) concluded that performance expectancy is the main factor that affects the intentions to use contact tracing apps. Based on the prior discussion, this study hypothesizes that:

H1 Performance expectancy has a significant role in the intention to continue using contact tracing apps in responding to coronavirus COVID-19.

3.2   *Risk perception*

Risk perception can be described as the perceived likelihood of a risk and its consequences, where people become more likely to act, mitigating that risk by taking defensive and protective measures (Piltch-Loeb et al., 2019). The effect of risk perception on health behaviours has been investigated widely in pandemic crises (Piltch-Loeb et al., 2019; Huang et al., 2020). Previous studies investigated how risk perception affects decisions for taking protective actions. However, the literature (e.g., Rousseau et al., 2015; Bok et al., 2021) confirms that perceived risk often raises collective efforts and novel collaborative patterns of interactions and working together among crowds. The increasing gap between the individuals' perception of risk and the problem magnitude is associated with increased morbidity or mortality (Rousseau et al., 2013). At the same time, the frequent lack of alignment between the expert risks' assessment of the situation and those of key actors constitutes a major challenge in risk communication (Parady et al., 2020).

Understanding risk perception about the COVID-19 epidemic is quite ambiguous and not the same for every country (Huynh, 2020; Focacci et al., 2022). According to Boyd and Martin (2020), variation in the personal attributes of individuals is a critical determinant of interpreting the risk of a crisis and behavioural responses and how they should act. Prior research emphasised that the acceptance and responsiveness to public health and prevention measures depend on risk perception towards the pandemic (Piltch-Loeb et al., 2019; Huang et al., 2020). In a pandemic crisis, individuals are not able to completely perceive the risks and direct impact on themselves and the collectives near them that are not necessarily connected to them (Bok et al., 2021).

The subjective evaluation of threats affects an individual's attitudes and subsequent behavioural response to the risk (Lim and Nakazato, 2020). During a crisis or emergency, effective medical countermeasures communication is associated with escalating risk perception (Schoch-Spana et al., 2018). In the context of the COVID 19 outbreak, many recent studies emphasised that public support for contact tracing apps is governed by risk perception for the disease (Martinez-Martin et al., 2020; Loi, 2021). Parady et al. (2020)

also confirmed that the role of contact tracing applications relies on the perceived risk that society endures. Therefore, we propose that:

H2   Risk perception has a significant role in the intention to continue using contact tracing apps in responding to coronavirus COVID-19.

3.3   Social influence

Social influence represents the extent to which individuals perceive the importance of others believes they should or should not adopt and use any new technology (Venkatesh et al., 2003). It includes social pressures significant others exercise on individuals to take specific actions or behaviours and the effects people have on the beliefs of others (Huynh, 2020; Ezzaouia and Bulchand-Gidumal, 2021). In the Theory of Reasoned Action (Fishbein and Ajzen, 1975), such influence has been described as a subjective norm that represents an individual's perception that most individuals who are important to him think he should or should not follow a specific behaviour.

The citizens' behavioural and attitudinal changes vary with the behaviour and attitudes of the reference group (Parady et al., 2020). Scholars imply that when governments disseminate risk information through formal channels, people tend to their community, taking the initiative to validate this information and explore additional explanations (Reynolds, 2011; Boyd and Martin, 2020). Risk communication describes an interactive process of exchanging and sharing information, knowledge and opinions in a community regarding potential or emergent risks to people or the environment (Lim and Nakazato, 2020). Van Bavel et al. (2020) have explained the role of social influence in forming the perception of COVID-19 risks. Recent research also emphasises that social networks are an active means to gather the information that forms the initial perception of risks posed by COVID-19 (Parady et al., 2020; Oldeweme et al., 2021). Therefore, this study hypothesizes:

H3   Social influence has a significant role in shaping risk perception.

The impact of social influence has been acknowledged by several IT adoption models. For example, in their proposed TAM model, Davis et al. (1989) highlighted the impact of social influence on user acceptance of IT. However, prior research (e.g., Zhou and Li, 2014) found that social influence significantly impacts attitude, intention and actual usage of mobile applications. The literature also confirmed that social influence plays a pivotal role in IT users' intention toward certain behaviors (Venkatesh et al., 2012; Ezzaouia and Bulchand-Gidumal, 2021). Furthermore, previous studies (e.g., Jurisch et al., 2015; Lotaibi et al., 2016) demonstrated a positive effect of social influence on behavioural intention to e-government interactions.

The literature has investigated widely the impact of social anxiety as a major aspect of social influence that affects their behavioural responses during pandemic crises (Lei Zheng et al., 2020; Fox et al., 2021). According to Quinn et al. (2013), public anxiety is a challenge to effective communications during pandemic crises. Recent studies confirm that social networks play a significant role in amplifying the spread of behaviors, which are beneficial or harmful during epidemics (Walrave et al., 2020; Van Bavel et al. 2020). On the other hand, the literature (e.g., Zhou and Li, 2014; Oghuma et al., 2016) investigated how social influence can impact the intention to continue using mobile applications. Recently, scholars (e.g., Fox et al., 2021; Oldeweme et al., 2021) confirmed

that social influence contributes to decreasing citizens' uncertainty about tracing apps. Therefore, this study hypothesizes:

H4 Social influence plays a significant role in the intention to continue using contact tracing apps in responding to coronavirus COVID-19.

3.4 Privacy concerns

The introduction of contact tracing apps has led to a storm of academic debates regarding users' privacy. The literature (e.g., van Kolfschooten and de Ruijter, 2020) confirmed that privacy concerns associated with contact tracing apps are a major factor that influences their adoption. The public debate also has concentrated on privacy issues as these apps represent the first-ever mass-scale contact tracing technology initiated by local governments. Users are constantly expressing their concerns about their collected personal data, raising serious questions about who owns their data and how the monitoring authority access and manipulates these data.

At the core of the contact tracing app is collecting personal information, such as health status, health history social interactions, name, gender and age. Furthermore, many privacy questions have appeared already on the current contact tracing apps used by agencies or countries in terms of collecting users' location data, tracking the mobile data, storing personal data of known patients in public databases and keeping track of patients' travel history. Prior research (e.g., van Kolfschooten and de Ruijter, 2020; Thayyil et al., 2020) explained how these apps enable possibly unethical use of personal data collected for contact tracing, violating user privacy. The collection of these details rises the potential for personal data to be used by the government or other groups for purposes other than management the prevention and control of COVID-19 spread (Thayyil et al., 2020).

Although Fox et al. (2021) have recently revealed that privacy concerns do not significantly affect the willingness to rely on the app, many previous studies (e.g., Vitak and Zimmer, 2020) indicated that privacy and security matters of contact tracing apps create panic and make users anxious, which increases unwillingness of adopting and using these applications. Therefore, this study hypothesizes:

H5 Privacy concerns play a significant role in the intention to continue using contact tracing apps in responding to coronavirus COVID-19.

3.5 Facilitating conditions

Facilitating conditions describe the perception of the availability of resources required and factors that impede or make an activity easier to conduct or engage in the target behavior (Mahardika et al., 2019). This dimension has related the extent to which users believe that organisational, technical and environmental conditions exist to support the use of a particular technology (Venkatesh et al., 2003). These resources may include applications, networks and coverage, operating systems, platforms, devices and user experience (Mahardika et al., 2019). According to Lu et al. (2005), it may also include user rights protection, security procedures and service quality. Furthermore, facilitating conditions may contain supporting staff, management support, promotion and training to facilitate the use of a system.

Empirical support was found on the significant impact of facilitating conditions on perceived usefulness (Lu et al., 2005). What distinguishes these conditions is that the accessibility of most of their resources is generally not under users' control. Mahardika et al. (2019) claimed that the decision of technology adoption is influenced by the results of the interaction between facilitating conditions and the perceived value of using that technology. Prior research revealed that facilitating conditions increased knowledge-sharing behaviors in both offline and virtual communities (Jeon et al., 2011; Tamjidyamcholo et al. 2014). Furthermore, Peñarroja et al. (2019) found that facilitating conditions can increase the sense of community in virtual communities, enhancing the perceived value of membership, where members feel less isolated and more committed to helping others and giving mutual support to reach their objectives. This implies that if the user does not have adequate resources to support system use, the user's behavioural expectation about the benefits of that system will be lowered. This leads to hypothesize:

H6 Facilitating conditions have a significant impact on the performance expectancy of contact tracing apps.

Although the impact of facilitating conditions on new technology adoption has been well-recognised in the literature, Ezzaouia and Bulchand-Gidumal (2021) and Utz et al. (2021) have listed this construct as much less important to have a significant influence on the intention to use contact tracing apps. However, another stream of research (e.g., Duan and Deng, 2021; Fox et al., 2021) found facilitating conditions to significantly affect app use intention. Duan and Deng (2021) affirmed that facilitating conditions, including the availability of information and assistance, training and technical support and skills and knowledge of users can facilitate the adoption of contact tracing apps. However, Venkatesh et al. (2003) concluded that facilitating conditions have a direct effect on usage beyond that explained by behavioural intention alone. Therefore, this study hypothesizes:

H7 Facilitating conditions have a significant role in the intention to continue using contact tracing apps in responding to coronavirus COVID-19.

4 Research method

4.1 Instrument development

Drawing on the research model, the measures of research constructs, including performance expectancy, risk perception, social influence, privacy concerns, facilitating conditions and the intention to continue using, were derived from the existing literature as shown in Table 2.

The questionnaire was reviewed for its content validity by a specialist from the Jordanian Ministry of Health, an academic expert in contact tracing apps and a member of the COVID-19 JOTECH Community that has developed the Jordanian copy of the application – Aman. Furthermore, the instrument items were pilot tested on 30 randomly selected participants.

As shown in Table 3, the survey involved 24 questions. A five-point Likert scale was used to measure the items on an interval level that ranged from 'strongly agree' to 'strongly disagree'.

Table 2   Sources of measures

Constructs	Code	No. of items	References
Performance expectancy	PE	4	Redmiles (2020) and Duan and Deng (2021)
Risk perception	RP	4	Boyd and Martin (2020) and Walrave et a (2020)
Social influence	SI	4	Van Bavel et al. (2020) and Duan and Deng (2021)
Privacy concerns	PC	4	Thayyil et al. (2020)
Facilitating conditions	FC	4	Peñarroja et al. (2019) and Fox et al. (2021)
Intention to continue using	ICU	4	Venkatesh et al. (2012) and Fox et al., (2021)

Table 3   Measurement items

Constructs	Code	Measurement items
Performance expectancy	PE1	Contributed to better knowledge about the spread of the virus.
	PE2	Contribute to preventing the spread of the pandemic.
	PE3	provided me the opportunity to assess my risk of being infected, giving me peace of mind.
	PE4	Protected my family and society.
Risk perception	RP1	Infection by the COVID-19 has critical consequences on my health.
	RP2	People should consider all necessary preventive actions against COVID-19.
	RP3	It is a high potential that I could be infected by the COVID-19 virus.
	RP4	Infection with coronavirus is very dangerous and may lead to death.
Social influence	SI1	People who influence my decisions believe that I should use contact tracing
	SI2	Using the contact tracing app is recommended by trusted people.
	SI3	This app protects the people who are important to me.
	SI4	The government of my country has strongly supported the adoption of contact tracing apps.
Privacy concerns	PC1	Increase government surveillance and access to personal sensitive data beyond the pandemic.
	PC2	Reveal private aspects of users' lives.
	PC3	Enable the possibly unethical use of personal data collected for contact tracing.
	PC4	In general, reduce users' privacy.

Table 3   Measurement items (continued)

Constructs	Code	Measurement items
Facilitating conditions	FC1	I have the necessary smart mobile device to use contact tracing apps.
	FC2	The Internet and communications infrastructure are constantly available at a low cost.
	FC3	I have the knowledge to operate and use the app.
	FC4	I can get assistance from others with difficulties or unexpected problems when using the app.
Intention to continue using	ICU1	I intend to continue using the app.
	ICU2	I plan to keep using the app in the future.
	ICU3	I would like to continue interacting with the app.
	ICU4	I encourage others to continue using the app.

4.2   Sampling and data collection

Jordanian society, like other societies, was exposed to the challenges of the Covid 19 and sought to use similar prevention measures and technologies to limit the spread of the epidemic. In May 2021, the Jordan government has launched a national contact tracing app to protect society and map the spread of the virus. The 'Aman' application was developed as a community initiative for the Ministry of Health by COVID-19 JOTECH Community, a group of Jordanian resident and expatriate experts working in the IT sector who volunteered their expertise and skills to help Jordan with efforts to contain the coronavirus. The application aims to detect exposure to the virus using GPS technology, which makes isolating cases of emerging coronavirus infection faster and before it infects others, which leads to the containment of the virus and ensures the safety of its users, their families and their community.

The 'Aman' app stores data on the users' devices only without asking for any personal information or data that could lead to identification or violation of their privacy. User data is automatically erased every 14 days (the virus incubation period), which will not be possible to restore the stored data. the patient can, with his consent, export the data stored on his phone and share it anonymously with other users through Ministry of Health officials. When there is a notification of a meeting point at a person, this person does not know who the infected person is or who was close to him and he is asked to contact the hotline of the ministry of health and request a test for the virus.

An online questionnaire was developed to collect data. Since the current study examines determinants of continuance intention to use pandemic contact tracing apps, it was reasonable to select the population from those who have downloaded and used the 'Aman' app to be qualified to participate in the survey. The questionnaire distribution has taken more than one month, from 10 June 2021 to 17 July 2021. The authors have employed the COVID-19 Information Center on Facebook that has been launched by the Ministry of Health in Jordan to assist in promoting and answering the questionnaire. This study has also resorted to large Facebook pages and groups to attract more participants who were claimed to invite more respondents to fill out the questionnaire. After two months, 243 usable answers were obtained. The characteristics of participants are displayed in Table 4.

Table 4   Characteristics of participants

Characteristics	No.	%
Gender		
Male	139	57.3
Female	104	42.7
Total	243	100
Age		
< 18	7	3
18–24	44	18.3
25–34	9	3.7
35–44	85	35
45–54	55	22.5
> = 55	43	17.5
Total	243	100

5   Data analysis

This study has used Smart PLS software to analyse the collected data. This statistical tool enables the assessment of the measurement model, including research model reliability and validity and the structural model, through testing hypotheses.

Internal consistency, convergent validity and discriminant validity were used to validate the instrument. Factor loading assessment was employed to purify measures and improve the research instrument. Factor loading > 0.70, as a cut-off value, reveals a distinct factor structure. However, except for one item from risk perception (RP2) and privacy concerns (PC4) scales, factor loadings of items are more than 0.70.

The average variance extracted (AVE), composite reliability (CR) and Cronbach's α are used to measure convergent validity and test the consistency that multiple items present in measuring the same construct. As shown in Table 5, Cronbach's α composite aeliability (CR) and rho_A for all constructs were > 0.70, confirming acceptable reliability of scales. The results also confirm adequate convergence validity, where the average variance extracted (AVE) is more than 0.5 for all constructs.

Table 5   Validity and reliability

Constructs	Cronbach's α	rho_A	CR	AVE
Performance expectancy	0.840	0.846	0.893	0.676
Risk perception	0.745	0.760	0.853	0.659
Social influence	0.815	0.826	0.879	0.646
Privacy concerns	0.817	0.869	0.884	0.717
Facilitating conditions	0.911	0.915	0.938	0.790
Intention to continue using	0.918	0.927	0.942	0.802

Employing Fornell and Larcker's (1981) criteria, Table 6 confirms an acceptable discrimination validity.

Table 6   Discriminant validity

No.	Constructs	1	2	3	4	5	6
1	Performance expectancy	0.822					
2	Risk perception	0.167	0.812				
3	Social influence	0.327	0.334	0.804			
4	Privacy concerns	0.191	0.423	0.205	0.847		
5	Facilitating conditions	0.222	0.335	0.517	0.121	0.899	
6	Intention to continue using	0.418	0.493	0.581	0.201	0.452	0.896

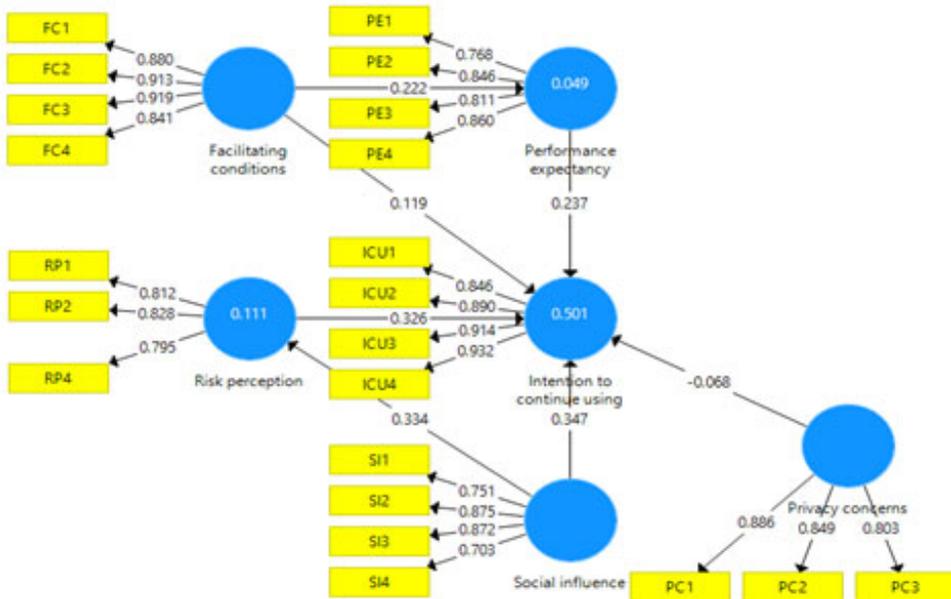**Figure 2**   The results of path analysis (see online version for colours)

Figure 2 represents the outcome of the PLS path analysis. It reveals that the research model accounts for 50.1 % of variances of the intention to continue using contact tracing apps in responding to coronavirus COVID-19.

Table 7   Testing hypotheses

H	Path	β	T value	P value	Results
1	PE → ICU	0.237	4.289	0.000	Supported
2	RP → ICU	0.326	5.446	0.000	Supported
3	SI → RP	0.334	6.395	0.000	Supported
4	SI → ICU	0.347	5.172	0.000	Supported
5	PC → ICU	-0.068	1.296	0.195	Rejected
6	FC → PE	0.222	3.790	0.000	Supported
7	FC → ICU	0.119	1.694	0.091	Rejected

As shown in Table 7, performance expectancy (H1) and risk perception (H2) play a significant role in the intention to continue using contact tracing apps in responding to coronavirus COVID-19. The results also indicate a significant role of social influence in shaping the risk perception (H3) and the intention to continue using contact tracing apps.

Unexpectedly, this study did not find a significant role of privacy concerns (H5) in the intention to continue using contact tracing apps. Furthermore, while the results confirm a significant role of facilitating conditions on performance expectancy (H6), they did not support its role in the intention to continue using contact tracing apps (H7) in responding to coronavirus COVID-19.

6   Discussion

The results of this study reveal that performance expectancy has a significant role in the intention to continue using contact tracing apps in responding to the COVID-19. These findings are in line with prior studies (e.g., Humbani and Wiese, 2019; Vaghefi and Tulu, 2019; Tam et al., 2020) confirming the impact of user expectations confirmation, the satisfaction of needs and the perception of usefulness on the continuous use of mobile apps. They also agree with recent research (e.g., Bianconi et al., 2020; Redmiles, 2020) that the effectiveness of a contact tracing app significantly depends on users' perceived benefits.

The findings support the significant role of risk perception in the intention to continue using contact tracing apps. The influence of risk perception on health attitudes and behaviours, including applications adoption, during pandemic crises have been reported in various recent studies (e.g., Rousseau et al., 2015; Piltch-Loeb et al., 2019; Huang et al., 2020). The results also accord with studies (e.g., Loi, 2021), which emphasised that public acceptance of contact tracing apps is governed by risk perception for the disease.

The findings indicate a significant role of social influence in shaping risk perception. These results are compatible with prior studies (e.g., Zhou and Li, 2014; Chung et al., 2016), which found a significant impact of social influence on intention and actual use of mobile applications. Recent studies (e.g., Parady et al., 2020; Van Bavel et al., 2020; Oldeweme et al., 2021) emphasise the impact of social influence in forming the perceived risks of the COVID-19. The findings also show a significant role of social influence in the intention to continue using contact tracing apps in responding to the COVID-19 crisis. These findings are compatible with earlier literature (e.g., Zhou and Li, 2014; Oghuma et al., 2016) that confirmed the impact of social influence on the intention to use mobile applications. They also agree with recent studies (e.g., Duan and Deng, 2021; Oldeweme et al., 2021) that social influence reduces citizens' uncertainty in tracing apps.

This study did not find a significant role of privacy concerns in the intention to continue using contact tracing apps. Although these results are not consistent with many previous studies, Fox et al. (2021) found that privacy concerns did not significantly affect the willingness to rely on the app. Zabihzadeh et al. (2019) confirm that the conceptual structure of the privacy concept differs among various cultures. Prior research confirms that members of collectivist culture, to which the population of this study belongs, tend to be slightly cautious regarding their online privacy (Marshall et al., 2008; Wang and Liu, 2019).

The results of this study reveal that facilitating conditions significantly impact the performance expectancy of contact tracing apps. These findings are supported by earlier

studies (e.g., Lu et al., 2005; Mahardika et al., 2019; Peñarroja et al., 2019), which have emphasised the significant impact of facilitating conditions on the perceived usefulness and value of virtual communities. At the same time, the results did not show a significant role of facilitating conditions in the intention to continue using contact tracing apps in responding to the COVID-19. These findings suggest that when the necessary infrastructure, devices and support are available, facilitating conditions construct loses its effect on the intention to continue using the app.

7 Conclusions and implications

Contact tracing apps have been seen as the most important initial step to contain an outbreak. Traditional manual contact tracing methods were unable to handle the coronavirus outbreak or share information and contact tracing of people infected as the number of cases continued to rise swiftly. Smartphones applications became a primary source of novel solutions in contemporary crises. Mobile contact tracing apps have appeared as a valuable solution in the efforts of combating the COVID-19. While the focus of the prior studies has been on privacy concerns stemming from the use of mobile contact tracing applications, an important question that has not received sufficient attention revolves around why or why not people continue using such applications? Therefore, this study aimed to examine the determinants of pandemics contact tracing apps adoption, exploring their impact on the intention to continue using.

Performance expectancy has shown a significant impact on promoting the intention to continue using contact tracing apps in responding to the COVID-19. When users realise the role of this application in preventing the spread of the pandemic and protecting their families and society as a whole, they will continue to use it. The contribution of this application in providing better knowledge about the spread of the virus and assessing the risk of being infected also added a critical value to continue using it.

The public response to the pandemic crisis requires, in the first place, people's awareness of its risks and threats on the different aspects of their life. The results confirm the role of social influence in shaping risk perception. These results imply that people take into consideration the knowledge, judgments and opinions of influential individuals and groups who imitate them about risk assessment and how to deal with it. In unprecedented and highly uncertain crises, such as Covid-19, citizens not only rely on official information. They tend to their trusted communities and social networks to validate risk and threats information received from formal channels and explore additional explanations.

Furthermore, the significant role of social influence in the intention to continue using contact tracing apps emphasises the need for public awareness that goes beyond the conviction of individuals to continue using this application to motivate and persuade others to use it to protect themselves, their families and their communities. Trusted and important people, the most influential people in society and governmental support to continue using this application are very important. Such players with social influence will also make it easier to accept and use any new version developed of these applications.

The results confirm that facilitating conditions have a positive relationship with the performance expectancy of contact tracing apps. The availability of the required devices, internet and communications infrastructure at low cost and getting assistance from others to solve difficulties or unexpected problems when using the app gives users an adequate

opportunity to use this application and realise its benefits and value in combating the epidemic spread. Facilitating conditions promote knowledge-sharing behaviours among users to protect themselves and their families from this epidemic.

This study adds valuable insight to continued investigation on contact tracing apps adoption and use. The results of this study present valuable academic and practical contributions to the drivers of users' intention to continue to use these applications during unprecedented epidemic crises. Prior research has given little attention to the determinants of continuous use of contact tracing apps from the perspective of those who already adopted it. This study provides new horizons for exploring novel themes in the continued adoption of contact tracing apps, particularly the role of performance expectancy, risk perception, privacy, social influence and facilitating conditions to combat effectively and efficiently pandemics outbreaks. No empirical studies had earlier examined the impacts of these determinants of the intention to continue using contact tracing apps in responding to coronavirus COVID-19 in a unified model.

This study has many practical implications, particularly the design and development of more effective contact tracing apps. The research model offers a practical paradigm that can be employed as a basis for how to develop effective contact tracing apps to combat global epidemic outbreaks. The primary responsibility for developing contact tracing apps lies with governments and their partners, including providing applications, Internet and communication infrastructure, operating systems, platforms, devices and technical support. Developing an application that balances protecting users' privacy and fulfilling the expected functions of this app is important to encourage them to continue using it. Opinions of users' social networks, communities and people who influence their decisions play an important role in persuading them to continue using contact tracing apps. Governments need to employ social influence to support and encourage citizens to continue using the application. This requires the government to seek the assistance of the most influential people in society and intensify regular awareness campaigns that encourage the continued use of the application for the public interest and collective action that contributes to combating the epidemic. Such awareness campaigns must include raising citizens' risk perception about the epidemic spread in parallel with promoting expected benefits from using this application, whose chances of success increase with the increase in its use rates.

This study has some limitations, which need to be considered in future research. The cultural context of the sample limits the findings of this study from confidently being generalised to other cultures. If this study is executed in another region or culture, it may show diverse findings. There are cross-cultural variances regarding the determinants, such as privacy and social influence, warrant further attention. Therefore, future researchers can use samples from diverse nations or cultures to confirm these results. This study did not demonstrate the moderating role of participants' demographic characteristics, such as age, gender, education and social status, in the impacts of determinants on the intention to continue using contact tracing apps. Furthermore, many factors that have been incorporated in the literature of IT continued adoption in crises and emergencies, such as trust, application quality, environment effect, perceived ease of use and sense of community can be studied in future research.

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