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RESEARCH ARTICLE

A Conceptual Framework of COVID-19 Location-Based Mobile Applications.

Theodoros Oikonomidis*, Konstantinos Fouskas and Maro Vlachopoulou

ISeB Lab., Department of Applied Informatics, University of Macedonia, Egnatia 156, 546 36 Thessaloniki, Greece.

*t.oikonomidis@uom.edu.gr

ABSTRACT

A leading problem that threatens the global economy and security of countries is the lack of immediate action and readiness to face a common threat. In addition to the mass vaccination and quarantine measures implemented as an emergency response to the rise of COVID-19, information systems and telecommunications were also utilized in the form of location-based mobile applications to control the mobility of global population, for contact tracing, and for compliance with quarantine measures. Early implementations of code and software in the form of location-based mobile apps as an emergency response, failed to face the waves of coronavirus due to the low adoption rates of smartphone users that led to minimization of citizens' freedom. The scope of this paper is to examine the phenomenon of adoption of COVID-19 location-based mobile applications by the users of smartphones. This paper builds a novel conceptual framework for the factors that affect the adoption of COVID-19 location-based mobile applications.

Keywords: Location-based mobile applications, Contact-tracing apps, COVID-19, Coronavirus

Introduction

Location-based mobile applications as an emergency response is a field that has emerged in the last years with the launch of smartphones and is defined as the continuation of location-based services[1]. Location-based services predate smartphones and specialized devices are essential to bring such services to the market[2]. Therefore, the definition of location-based mobile applications as well as their functions do not present a continuum and differ depending on the bibliographic approach[3].

The utilization of location-based mobile applications when it comes to emergency response against a serious threat is crucial and need further consideration[4]. When Bill Gates warned in 2014 that a virus could threaten the global economy, it seems that the countries around the world did not take any precaution measures for that case[5]. As a result, in 2019 we faced the spread of COVID-19 and the consequences of these actions. Subsequently this paper examines the adoption factors of location-based mobile applications by smartphone users. By researching these factors and analysing the research theories that dominate the field, we identify the theories that cover adoption of mobile applications and serve the purpose of this paper. It will be used to interpret and analyse the factors that influence the acceptance and use of location-based mobile applications from a holistic perspective. The aim of this paper is to build a theory that explains the adoption phenomenon of COVID-19 location-based mobile applications. The correlations that can be demonstrated between the factors and influence the adoption of COVICD-19 location-based mobile applications may be the key to increase adoption rates of such applications by the population of each country-region where an emergency phenomenon occurs such as the coronavirus.

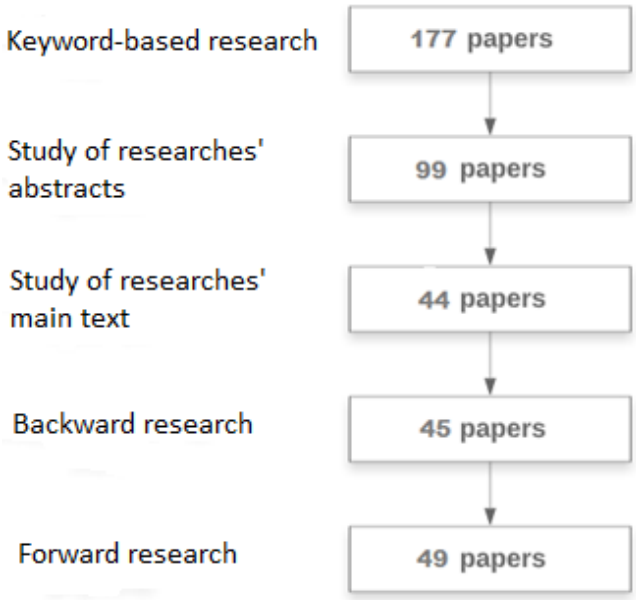
The remainder of this pape ris structured as follows: First, we describe research issues and methodology, and present findings of the previous empirical research. Following this, we discuss related work leading to the formulation of a novel conceptual framework including the factors that affect the adoption of COVID-19 location-based mobile applications. Finally, in conclusion section, we summarize our results and implications, drawing future research.

Methods

For the purpose of this paper, a systematic literature review was implemented concerning COVID-19 location-based mobile applications. Thus we managed to focus on empirical research using SLR methodology described by Webster & Watson in 2002[6].

"Location-Based Services" and "Location-Based Mobile Applications" were the keywords used used with the addition of "and" "COVID-19" to ensure as much relevant research as possible. From the research in scientific electronic databases (Scopus, Web of Science, Google Scholar, Semantic Scholar, ScienceDirect, Springer, Elsevier, IEEE) 177 research were initially obtained. The diagram below shows the research for the relevant process.

Stages of Research Process



After careful study of the papers' abstract, papers were reduced to 99. Then, by carefully reading the entire content of papers, we arrived at 44 papers. With backward search we identified 1 additional paper and with forward research we found another 4 papers.

The survey exclusion criteria include papers that do not deal with location-based mobile applications but generally refer to mobile services without making any reference to the main location survey. Further exclusion criteria include papers that do not address location-based mobile applications, but generally refer to mobile services without making any reference to primary location research.

According to Creswell, the research problem that a research is called to solve also determines the type of research that will be conducted[7]. As the present research is called upon to investigate the acceptance and use of location-based mobile applications in the case of COVID-19, a research framework is developed that integrates research efforts to date to indicate appropriate influencing factors.

Findings

On the following paragraphs we present relevant information that were gathered from the study of the literature review and had an influence on the conceptual framework build.

In terms of findings, the papers highlight the relationships that showed a high degree of correlation with the acceptance and use of location-based mobile applications. An important factor that has been shown to confirm the association with behavioral intention is performance expectancy. Effort expectancy is shown to correlate with intention to use. The role of social influence is confirmed in papers. Ease of use is shown to influence user acceptance. Facilitation conditions play an important role in the intention to accept and use a location-based mobile application according to the paper.

By examining the influence of threats on privacy issues, only perceived vulnerability was found to be significant [8] . Cultures with high collectivism were also found to have a

reduced impact on privacy concerns on attitudes toward COVID-19 apps. Based on paper that demonstrates how self-efficacy changes the relationship between trust and intention to use the detection app and how self-efficacy positively affects both trust and intention to use the location app[9] . The positive relationship between perceived trust and intention to use the location-based mobile app was slightly stronger when self-efficacy was high. Negative self-efficacy exacerbates the negative effect of trust in using a COVID-19 tracing app. When self-efficacy increases, the effect of trust on intention to use decreases. Some significant predictors of relevant research was perceived benefits of implementation, followed by self-efficacy and perceived barriers. Perceived severity and perceived sensitivity were not related by intention to use the app[10]. Additionally, cues to action (ie, individuals' exposure to digital media content) were positively associated with intention to use apps. As respondents' age increased, their perceived benefits and self-efficacy for using apps decreased. The most important predictor was performance expectancy, followed by facilitating conditions and social influence[11]. Expected effort was unrelated to intention to use the app. In addition, individuals' innovativeness was positively related to app usage intention, while app-related privacy negatively affected intention.

Discussion

Some of the papers examine location-based mobile app acceptance and usage factors by creating a variable that leverages the user's location[12]. The methodology of these papers includes an application concept and implementation of questionnaire of users' prospective to confirm or not their null hypotheses.

A noteworthy observation is that some surveys refer to the public as "customers"[13]and as "consumer"[8] while in the rest of the papers refer to them as "users", even though both sides consider the acceptance and use of location-based mobile applications from the perspective of the end-user. Consequently, papers that focus on the m-commerce part and the specific literature refers to the user as a consumer-customer.

A group of papers regarding location-based mobile applications use the term "individuals" in their reference to the final recipients of the applications[14]. This term is more general than the aforementioned. Relevant research examines the acceptance of location-based mobile applications, or similar but in the tourism sector[15]. Papers focusing on COVID-19 location-based mobile applications show variation in the variables they use, focusing on the COVID part and examining their research from the perspective of end-users[16].

Factors that influence users' intention to adopt location-based emergency applications is determined from a holistic review on relevant research[17]. UTAUT is a theory that highlight concepts such as trust, privacy concern and fear of crime. Data was collected through questionnaires distributed to users by the "X-Igent Panic Button" mobile app. Related research examine the impact of self-image and functional relevance on mobile app usage intention by extending the TAM[18]. Mobile app design and social media campaigns can be utilized to influence smartphone users to adopt location-based

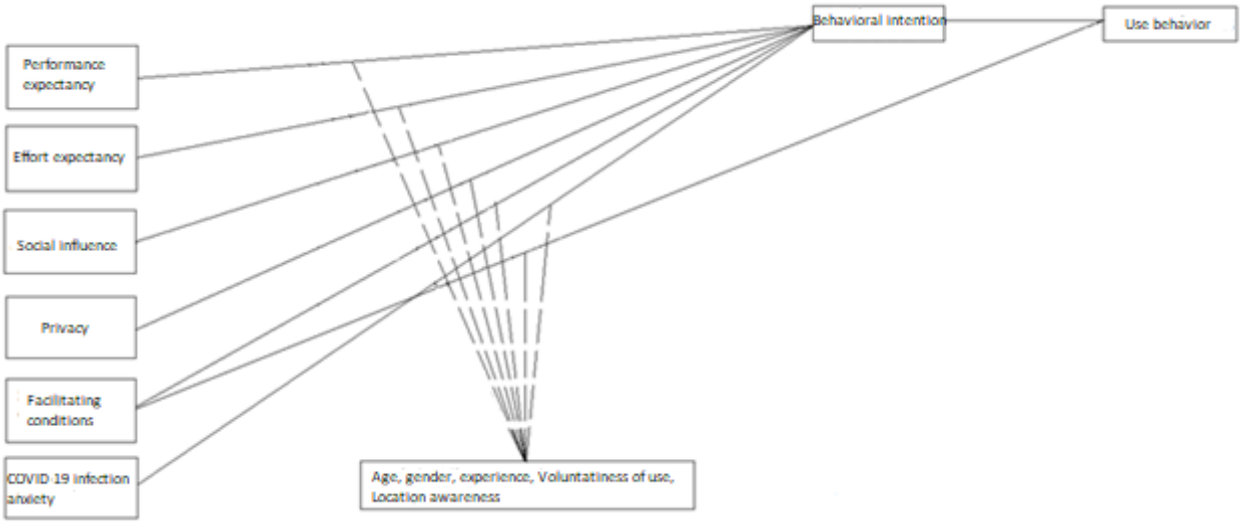
mobile apps[15]. Gratification, satisfaction theory and the information systems success model are used to investigate the main adoption factors of location-based mobile applications for tourism[12]. Moreover, the acceptance and usage factors of the Foursquare app are similarly examined. The Privacy Calculus model is utilized[19] to highlight the factors that influence the acceptance and use of applications related to food industry. Relevant research examine personalized services with two sets of variables[20]. One group includes personalized location-based features that intrinsically motivate to use a service, while other include features that motivate a person to use a service. It also examines how individuals' initial perceptions of mobile services influence the development of intrinsic and extrinsic motivation. On a different approach an extension of UTAUT introduces new variables into the already existing model[21]. Other research introduce hedonic motivation, habit, application experience, and price value[21]. On related research, stress and self-efficacy are introduced and are examined as factors of acceptance of location applications in m-commerce[22]. Specifically, "looks for the utilitarian value that adopters are looking for", they examine the factors instant connectivity, contextual value, and hedonic motivation, customer habit and types of risk such as financial, performance and security[23]. Research introduces privacy policy, privacy control, and privacy concerns, personal innovativeness[24] and entertainment variables, informativeness, irritation, credibility, personal relevance, incentive, subjective norms, assisted self-efficacy, unassisted self-efficacy efficacy), controllability[25].The research problem of digital solutions to address the pandemic has been addressed by papers by exploring the limited effectiveness and scope of government COVID-19 location-based mobile apps, using the German COVID-19 Detection App (Corona-Warn-App) as an example[26]. In 2021 they combine fairness theory, dual calculus theory, protection motivation theory, theory of planned behavior, and Hofstede's cultural dimension theory displays variables such as expected privacy policy effort and expected industry self-regulation effort[8]. At the same time, collectivism, uncertainty avoidance, attitude, perceived seriousness, perceived vulnerability are introduced. Additionally, applications are introduced that represent the threats and risks that the user perceives, such as perceived vulnerability and perceived severity. The Health belief model, and the Pollfish platform were utilized in 2021 to create a questionnaire and choose to use fewer variables including self-efficacy, destination safety, perceived trust, trial safety that are associated with the intention to use COVID-19 location-based mobile apps[9]. The variable perceived susceptibility measures the user's perceived risk of contracting COVID according to Health Belief Model. Similarly, perceived severity is a factor measured in research on coronavirus apps[10]. Perceived benefit on the other hand is a factor that is measured and affects the acceptance and use of applications as well as perceived barriers which examines whether these applications affect the privacy of users. The above variables are directly related to behavioral intention[10]. Finally the variables of the unified theory of acceptance and use of technology, performance expectancy, effort expectancy, social influence, facilitating conditions, age gender, education, with the

addition of COVID factors app privacy concern and COVID anxiety are leveraged, which in combination with health issues directly affect behavioral intention[10].

A Novel Conceptual Framework for COVID-19 Adoption

The basic theory created by this research expands the existing model of the unified theory of acceptance and use of technology by adding constructs that have already been utilized by previous papers. We aim to create a novel research framework that explains the adoption of COVID-19 location based mobile applications by the users of smartphones.

Conceptual Framework



PERFORMANCE EXPECTANCY

Performance expectancy is defined as "the degree to which the use of a technology will provide benefits to consumers when performing certain activities"[27]. A similar definition states "an individual's level of expectation or confidence that using a system/technology will improve their performance"[28]. It is also defined as an extension of the benefits that the user of location-based services expects to receive[10]. This factor is vital in many aspects of location applications such as social media, tourism, etc. for the use of location-based mobile applications[21]. If one can achieve a goal using location information through location-based mobile applications (eg finding the exact location and other useful information about the nearest restaurant, metro station or hospital), the performance expectation of location-based mobile applications may increase. Performance expectancy has been proved to be a positive influence on Behavioral intention to use m-commerce services[29].

EFFORT EXPECTANCY

Effort expectancy is described as "the degree of ease associated with using the technology by consumers"[30]. Perceived ease of use of an information system consists of user evaluations of the interface in terms of ease of use of input and output functionality, ease of

use of search and analysis procedures, and degree of complexity[31]. Previous studies have reported that a person will be more likely to behave in accordance with the expectations of others, especially when he will earn a reward for performing expected behavior or receive a penalty for not performing. Scientific research has found that effort expectancy is a determinant of behavioral intention and is stated that the rate of acceptance and use of a technology is higher if technology is easy to use[32]. Thus, it is hypothesized that if a user perceives mobile apps as easy to use, he or she may have a higher intention to use them and consequently have a positive impact on the usefulness of mobile apps.

SOCIAL INFLUENCE

Social influence was defined as "the extent to which consumers perceive that others (e.g. family and friends) believe they should use a particular technology"[33]. It is stated that social influence includes the following two categories: media influence and interpersonal influence[34]. Similarly Social influence refers to individuals" beliefs that they should use technology"[11]. Social influence is also defined as the "influence of other parties, both directly and indirectly, whose opinions are deemed as necessary by the user"[17] . Newspapers, magazines, internet, radio, tv and other media fall under the first category, while interpersonal contact with fellow human beings such as peers, friends, superiors etc. belong to the second category.

FACILITATING CONDITIONS

Facilitating conditions are defined as "consumers' perception, resources, and support they have for a behavior to occur"[17]. It is argued that people usually seek help when they encounter difficulty when using new technology[35]. They also demonstrate that consumers may avoid accepting and using a technology when facilitating conditions are insufficient. Facilitating conditions significantly affect effort expectancy to accept and use e-commerce[21]. The result is relevant to similar research where facilitating conditions investigating the acceptance of mobile internet technologies affect effort expectancy[36]. Furthermore, a study regarding mobile banking, has confirmed the previous research results[37].

PRIVACY

Privacy is defined as "the extent to which a person believes that using a particular system will expose the user's privacy"[38]. Both growth of the location-based services market and advances in location-based services technology have raised privacy concerns due to the potential misuse of location information[39]. Improved privacy policies and user-friendly technological features (e.g. do not track activity, GPS control) have greatly reduced privacy concerns, but still, is difficult for users to control their location information after companies collect and store their information. For example, it was alleged that Apple regularly recorded the locations of iPhone and iPad users in a hidden file on their devices, raising serious security and privacy concerns[40]. Location-based mobile apps are constantly associated with privacy concerns, which can serve as a major inhibitor to their expansion. Users show varying degrees of privacy concern depending on what degree they are being monitored[39]. Several studies have examined and demonstrated the negative impact of privacy concerns or privacy risk on intention to use in the context of location-based mobile applications, although

these studies were conducted in the early stages of mobile applications, before smartphones becoming essential[41].

BEHAVIORAL INTENTION

Behavioral intention consists a measure of the probability that an individual may use a particular application according to the Technology acceptance model[42]. The Theory of planned behavior posits that intentions lead to behavior[43]. However, intentions do not always guarantee behavior. For example, someone may intend to meditate daily but ultimately not follow through on their thought and act on it. There are several factors that influence the strength of the relationship between intentions and behavior.

COVID-19 INFECTION ANXIETY

Factors related to the coronavirus can affect users' acceptance and usage behavior of location-based apps. Within the framework and by studying the selected final research, we created a research framework specifically for the case of the coronavirus. For this purpose we added to the already existing research framework the variable COVID-19 anxiety of infection which has been confirmed by previous research to have an influence on Behavioral intention[44].

MODERATORS

Age has been shown to be a moderator variable for Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions[33] and from relevant research the same is true for Perceived ease of use[45]. Yang in 2005 argued that gender has a moderating role in consumer acceptance of information and communication technologies. Men and women have different perspectives on the decision to accept and use a technology[46]. Yang in 2005 stated that men tend to have a more favorable attitude toward mobile phone e-commerce. Also study showed that men are more likely to use e-commerce for mobile phones than women who perceive such transactions as risky[47]. In the experience variable it has been proved that there is a correlation with Expected Effort, Social Influence and Facilitating Conditions[48]. Finally, the Location Awareness variable has been used in previous research as a moderating variable but without being a moderator in the variables examined in this paper[23].

Conclusions

This research delineates a field of research and study that has developed in recent years with the emergence and evolution of smartphones. Location-based mobile applications are considered in the literature as evolution of location-based services and therefore their definition varies and changes over the years. In the framework of the research, the conceptual approach is done in the scope of information systems. Thus, the research initially contributes to the literature by highlighting the main and most modern conceptual approaches to the specific subject.

Based on the collected literature, a modern depiction of the field of location-based mobile applications and their grouping according to their respective functions is given. The reader knowing the past as well as the present of the existing field can better understand the current developments around the space and take advantage of functions that will improve their daily life, efficiency, and other aspects of their lives.

The paper's contribution to current research on the adoption of location-based mobile

applications lies in the fact that this study leverages Vekantesh's UTAUT by making a case study of the Coronavirus. Thus, this research confirms the main relationships of Vekantesh's theory by extending the existing theory using the factors of Privacy, Anxiety of infection, and Location Awareness. This extension is an element of its novelty as until the present time there was no other research that combines these adoption factors of mobile applications that deal with such a phenomenon as the coronavirus.

The ultimate aim of this research is to inform guidance for the future development and dissemination of location mobile based apps related to specific crisis concerns intended for health care and monitoring.

Future Work

Based on the research that were utilized on this paper, the variables used on the conceptual framework were considered representative and served its purposes. Therefore, another approach could include different variables potentially leading to different conclusions. For example, social influence, from another point of view can be divided into hedonic and utilitarian motivation of the user to download and use an application. Similarly, all the variables of the research model created, can either be separated into different variables or replaced by other as well.

This research provides the means for future research to derive new variables and build new theory to examine the phenomenon of adoption of such applications by adding different variables and create a new research framework on the research topic. By testing new variables on the conceptual framework, a different approach can be implemented to create a new conceptual theory for the adoption of COVID-19 location-based mobile applications.

Conflict of Interest:

None.

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