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Article

Adoption of big data analytics (BDA) technologies in disaster management: A Decomposed Theory of Planned Behavior (DTPB) approach

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MANAGEMENT | RESEARCH ARTICLE

Adoption of Big Data Analytics (BDA) Technologies in Disaster Management: A Decomposed Theory of Planned Behavior (DTPB) Approach

Umer Zaman¹, Hasan Zahid^{2*}, Muzafar Shah Habibullah³ and Badariah Haji Din⁴

Abstract: Big data analytics (BDA) technologies have emerged as a cornerstone for predicting, preparing, and preventing natural disasters, that directly save millions of human lives. The current study takes the initial step to analyze various antecedents of using BDA technologies that support real-time and offline decisions, before the occurrence of a disaster event. The model has been underpinned based on the Decomposed Theory of Planned Behavior (DTPB) and offers generic, pro-active, and timely solutions for disaster management. A self-administered survey collected data from 361 active members of the National Disaster Management Authority and Response Units in Pakistan. Partial least square structural equation modeling (PLS-SEM) empirically tested the conceptual model and hypothesized relationships. The study findings provide significant evidence on the positive influence of attitudes, subjective norms, and behavioral control of disaster management officials on their intention to adopt BDA technologies. Using DTPB, the current study makes a unique contribution to the literature and offers invaluable insights to researchers,

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PUBLIC INTEREST STATEMENT

Disasters (natural or man-made) can be lethal to human life, the environment, and infrastructure. Disaster management is a crucial and urgent research issue. Disaster management is core concern for every country around the globe and government are facing many barriers in developing and implementing such strategies to avoid disaster before it happening. One of the most crucial problem is to utilize the current resources efficiently. Big data analytics (BDAs) provides a chance to solve the above problem. This piece of work investigated various factors to increase the intention of decision makers. Additionally, that can help the decision makers to predict the disasters on time by using BDAs techniques. The collaboration of the latest BDAs technologies provides a more proficient environment to perform effective analytics for extracting the required information used in disaster management applications. Moreover, policy should be made at the government level to promote latest techniques like big data analytics in order to handle disasters.

practitioners, and stakeholders in addressing some novel and preemptive measures in disaster management.

Subjects: Personnel Selection, Assessment, and Human Resource Management; Management of Technology; Hazards & Disasters; Administration and Management; Management & Organization

Keywords: disaster management; big data analytics (BDA); decompose theory of planned behavior (DTPB)

2. Introduction

For the attainment of sustainable development goals, quantitative measures should be taken with the use of the latest technologies e.g., big data analytics (BDA) to proactively overcome the impact of national disasters (Mulrow & Derrible, 2020). Disasters can cause sudden adverse or unfortunate extreme events which can result in great damages in the form of massive loss of human lives, infrastructural destruction, and environmental complexities. In the light of the recent outbreak of the pandemic COVID-19 which directly and indirectly affected human life, societies, and infrastructure. Indeed, the crises occurred from COVID-19 added foremost challenges for the individuals, government organization, and most important decision-making authorities (Al Eid & Arnout, 2020). Therefore, these unexpected crises are dangerous and a threat to institutes, individuals, and nations. The happening of these disasters is rapid, instant, and in a discriminant way. Disasters (natural or manmade) tend to cross the destructive magnitude, make difficulties for adjustments, catastrophic monetary losses and paralyze life (Shah, Seker et al., 2019). According to the latest report of the International Federation of Red Cross and Red Crescent Societies (IFRC, 2018), 3751 cases of natural disasters “i.e. flood, earthquake, landslide and tsunami” have occurred resulting in a monetary loss of 1658 billion USD along with 2 billion casualties. In the time frame of sixteen years (2000–2016), a total number of 7029 natural disasters have happened with the loss of 1.2 million casualties and 19.2 billion US dollar economical loss. Besides, 4613 disasters have occurred causing 140 thousand casualties with the financial loss of 3.5 billion US dollars in man-made disasters (EM-DAT The International Disaster Database).

Disasters events are considered a hot issue now a day because every single day the news channels mostly reported these disasters -related incidents (e.g., terrorist attacks, oil spillovers, nuclear meltdowns, transportation accidents, etc.). Therefore, the local governments, international governments, non-profit organizations, private organizations, and all other stakeholders have taken serious and constructive actions to solve these pressing issues. Managing these disasters requires a pro-active approach and its main objective is to reduce human suffering instead of profit-making (Gupta et al., 2016). Early warnings, gathering real-time data, estimation of prospective results or damages and effectively managing the situations with available resources are key functions of disaster management (Hristidis et al., 2010). These traditional disaster management systems cannot store and analyze multi-sourced data within real-time (Baham et al., 2017). To avoid these uncertain situations and to make timely and accurate decisions these disaster management processes will require reliable, accurate, pro-active state of the art technologies to upsurge the performance of old disaster management systems (Kapucu, 2006).

Big Data Analytics (BDA) is one of the prominent technologies used by various organizations around the world. BDAs are equipped with advanced automated management processes to predict timely and accurate results before the disaster occurrence (Yang et al., 2019). Therefore, the availability of accurate information from heterogeneous data sources, integration of the processes, and coordination of new technologies with old management systems can enhance the disaster management systems and increase the understanding of the decision-makers (Shah, Seker et al., 2019). The work of Esteves and Curto (2013) concluded that the BDA acceptance is still in an early stage and only the early adopters have the intention to use BDA in adopting various technologies. Secondly, the main problem is not in the implementation of the BDA system, rather the

transformation of processes, people, and culture. The decision-making authorities “i.e. human on key positions” do not want to transform the old traditional systems with the updated systems enriched with the latest technologies like big data, the internet of things, and social media, etc. Therefore, the present article indicates the intention to use big data analytics in disaster management as it is one of the most emerging disciplines in recent times (Akter & Wamba, 2019).

Despite an array of prior studies regarding this area, there are several literature gaps in which the existing study intends to contribute. The first research gap is evident in the relationship between the BDAs and disaster management. Prior literature related to big data analytics and disaster management is diverse and fragmented (Akter & Wamba, 2019). Therefore, the present research has been conducted to open up new opportunities for timely and effective disaster management in the domain of big data analytics. Secondly, various theories in the extant literature have been incorporated by the researchers like big data analytics theories (Akter & Wamba, 2019; Schläfke et al., 2013), organizational ambidexterity (C. A. & Tushman, 2008), the resource-based view (Barney, 1991), dynamic capabilities theories (Teece et al., 2016), cloud computing theories (Wiley & Sons. Chang, 2015), value and productivity theories (Akter et al., 2016). Nevertheless, very limited studies have incorporated behavioral theories to explore the intention to use big data adoptions in disaster management settings (Akter & Wamba, 2019). Consequently, in the present empirical study, the decomposed theory of planned behavior (DTPB) has been used to investigate the behavioral intentions and bridge this theoretical gap. Moreover, the prior literature lacks focus as the majority of the research and contributions came from developed countries like the United States of America, Australia, France, and the United Kingdom. Thus, a lesser number of researches have been conducted in developing countries like Pakistan, India, Sri Lanka, Maldives, Arab countries, Saudi Arabia, and Iran, etc. (Akter & Wamba, 2019). To fill this contextual gap, the current study has been conducted in the Pakistani context. World

Disaster Report (2015) revealed that the situation is alarming for Pakistan as the number of reported people killed and affected by disasters has increased from 6209 to 82,802 and 18,521,926 to 49,784,339 respectively. The incremental ratio is higher as compared to the other south Asian countries. Hence, there is a dire need to build a mechanism by using the latest technologies i.e. BDA to respond pro-actively to reduce these significant losses. Finally, the BDA applications in disaster management offer new directions, for scholarly investigations in an under-researched area. Based on research methodologies, very few empirical studies have been conducted by prior researchers as compared to review papers, conceptual papers, analytical and/or methodological research papers (Akter & Wamba, 2019), hence creating a necessity and urgency for conducting this research.

3. Literature review, conceptual framework, and research hypotheses

Despite the various technological adoption theories, Taylor et al. 1995 has developed the decomposed theory of planned behavior (DTPB) based on the technology of acceptance model (TAM), innovation diffusion theory (IDT), and theory of planned behavior (TPB) in the study titled “Understanding Information Technology Usage: A Test of Competing models”. Besides, the constructs of attitude, subjective norm, and perceived behavioral control have been decomposed by the researcher to increase understanding. Several prior studies have employed various technology adoption models like the theory of reasoned action (TRA), a theory of acceptance model (TAM), the diffusion of innovation (DOI), unified theory of acceptance and use of technology (UTAUT) to investigate the behavioral intention towards information technologies (Bélanger & Carter, 2008; Hung et al., 2009; Nripendra P Rana & Dwivedi, 2015; Nripendra P Rana, Dwivedi, Lal et al., 2015; Nripendra Pratap, 2015; Nripendra P Rana et al., 2017; Nripendra P Rana, Dwivedi, Williams et al., 2015; Zahid & Haji Din, 2019). Therefore, very few studies have employed the decomposed theory of planned behavior (DTPB) in technology adoption (Nripendra et al., 2015).

The study conducted by Rana, Dwivedi, Williams et al. (2015) suggested adopting the latest technologies like big data analytics, artificial intelligence to investigate behavioral intention. Also,

the study had reported significant results among the proposed relationship by using DTPB. On the empirical research conducted by Zahid et al. (Zahid & Haji Din, 2019) has strongly recommended employing DTPB in the behavioral intention studies with the online and latest industry 4.0 technologies. The results showed a positive influence of “attitude, subjective norms, perceived behavioral control, and their antecedents” on intention. Rana et al. (Rana, Dwivedi, Lal et al., 2015) have given the call to future researchers especially in developing countries or South Asian countries to conduct studies on the behavioral intention by using DTPB and the latest technological techniques. In recent times, very few studies have used behavioral theories in big data adoption in general and disaster management in particular. In the line of the present study, the determinants of big data intention “attitude, subjective norm and perceived behavioral control” have been hypothesized as H1; H2, and H3 to understand the influence of big data technologies in disaster management. Additionally, these three determinants are decomposed by various antecedents to deeply understand the impact on intention as the trademark of DTPB. Therefore, attitude is decomposed by “performance expectancy, effort expectancy, and compatibility” and hypothesized as H1a; H1b, and H1c. Besides the other two antecedents’ subjective norm and perceived behavioral control are decomposed by “mass media influence and self-efficacy, facilitating condition” as H2a; H3a and H3b. As per the recommendation of Taylor et al. (Taylor & Todd, 1995), the conceptual model is based on the DTPB model and the three determinants of intention are decomposed and hypothesized to determine the better understanding of the proposed variables “attitude, subjective norm and perceived behavioral control”. So, these three determinants of intention influence the intention among the decision-making authorities by using big data analytics technologies to manage the disaster. The proposed relationships among the variables of the study are discussed in the next section.

3.1. Development of hypotheses

Venkatesh et al. (2003) defined performance expectancy as “the individual believes

that the particular system will assist him/her to improve in his/her job performance”. Additionally, the

performance expectancy is similar to the other constructs like perceived usefulness (Taylor & Todd, 1995), usefulness and extrinsic motivation (Davis, 1989), usefulness and job fit (Thompson & Moore, 1991), relative advantage (Davis, 1989) and usefulness and outcome expectations (Compeau & Higgins, 1995). Several studies have reported that performance expectancy significantly influences the attitude in the technology adoption studies (Al-Sobhi et al., 2011; Hsieh & Shannon, 2005; Hung et al., 2009; Lin et al., 2011; Venkatesh et al., 2003; Zahid & Haji Din, 2019). Therefore, in the line of the present study, the following hypothesis is formulated;

H1a: “Performance Expectancy has a significant and positive effect on attitude towards disaster management”

Effort expectancy is defined as “the magnitude of ease linked to a system’s usage and particularly the perceived ease of use and complexity” (Venkatesh et al., 2003). Additionally, the concept of effort expectancy is seized with other constructs from various prior technology models like complexity in the diffusion of innovation (DOI), perceived ease of use in the theory of acceptance model (TAM and TAM2). Likewise, the construct of effort expectancy is considered as a strong predictor of individual attitude towards the behavioral intention of technology adoption (Dwivedi et al., 2017). Several studies from the past literature have shown the significantly and positively influence of behavioral attitude in technology adoption literature

H1b: “Effort Expectancy has a significant and positive effect on attitude towards disaster management”.

The concept is defined as “the degree to which the innovation fits with the potential adopter’s existing values, previous experience, and current needs” (Rogers, 1983). Several researchers from

the prior literature have reported that in the technology adoption studies have a significant and positive impact on behavioral attitude leads towards the intention (Esteves & Curto, 2013). According to the findings of Esteves and Curto (2013), compatibility has a significant and positive influence on big data adoption. Importantly, the existence of various information systems “like e-commerce platforms, enterprise resource planning (ERP), business intelligence (BI) and customer relationship management or product lifecycle management (PLM)” are some influence factors towards the adoption of big data analytics. Therefore, the following hypothesis is formulated extracted from the abovementioned discussion;

H1c: “Compatibility has a significant and positive effect on attitude towards disaster management”

Nor and Pearson (2008) defined mass media influence by “The mass media influence defines as “the influence or pressure from the mass media to perform the behavior”. Numerous previous studies have reported the significant and positive impact of mass media on the subjective norm towards the intention to use in technology adoption studies (Bhattacharjee, 2000; Nor, 2005; Rana, Dwivedi, Lal et al., 2015, 2015; Weng et al., 2015; Zahid & Haji Din, 2019). The above-mentioned literature has shown that there are very few studies that are conducted on the mass media influence on the subjective norm in big data analytics adoption in disaster management systems. Therefore, the following hypothesis is formulated to empirically investigate the correlational relationship;

H2a: “Media has a significant and positive effect on subjective norm towards disaster management”

Self-efficacy is defined as “the confidence one feels about performing a particular behavior, including confidence in overcoming the barriers to achieving that behavior”. Numerous researchers have reported

that self-efficacy has a significant impact on behavioral intention through perceived behavioral control (Bhattacharjee, 2000; Hung et al., 2006, 2009; Nor & Pearson, 2008; Rana, Dwivedi, Lal et al., 2015, 2015). A few numbers of prior empirical studies have investigated the relationship of self-efficacy on perceived behavioral control leads to big data adoption in disaster management settings (Esteves & Curto, 2013). Therefore, to bridge this gap the following hypothesis is formulated;

H3a: “Self-efficacy has a significant and positive effect on perceived behavioral control towards disaster management”.

Venkatesh et al. (2003) have presented the definition of facilitating conditions as “the degree to which an individual believes that he/she has the essential knowledge and technical expertise that will support him/her while using the e-government system”. Facilitating condition is considered as one of the main construct and key constitution of perceived behavioral control (Bhattacharjee, 2000; Dwivedi et al., 2017; Hung et al., 2006, 2009; Nor & Pearson, 2008; Rana, Dwivedi, Lal et al., 2015, 2015; Schaupp & Carter, 2010). Numerous studies from the past literature have shown the significant and positive influence of facilitating conditions on perceived behavioral control towards the behavioral intention in technology adoption studies. Less literature is available to investigate the co-relational relationship of facilitating conditions on perceived behavioral control leads to big data adoption in disaster management settings (Esteves & Curto, 2013). Therefore, in the present study, the author hypothesized that facilitating conditions will have a positive influence on the intention to adopt big data analytics.

H3b: “Facilitating conditions have a significant and positive effect on perceived behavioral control towards disaster management”.

Attitude is defined by Ajzen (1991) as “the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question”. Numerous past studies have reported attitude as a significant and positive predictor of behavioral intention in the various technology adoption settings (Aziz et al., 2013; Rana, Dwivedi, Lal et al., 2015, 2015; Shih & Fang, 2004). The aforementioned literature indicates conclusively findings on the relationship between attitude and technology adoption services. Though, there is a need to conduct more empirical studies in diverse settings to further investigate this relationship. Hence, the following hypothesis is developed based on further scholarly call as follows;

H1: “Attitude towards disaster management has a significant and positive effect on the intention to adopt big data analytics”.

Subjective norms are defined as “Subjective norm is perceptions of social pressures to perform or not to perform a behavior in question”. The prior researchers believed that the subjective norms are a robust forecast of intention in different technology adoption studies (Bhattacharjee, 2000; Rana, Dwivedi, Lal et al., 2015, 2015; Zahid & Haji Din, 2019). Numerous studies have argued for the adoption of big data tools for the assessment of the requirements to take affirmative and timely decisions making (Kambatla, Kollias, Kumar, & Grama, 2014; Minelli, Chambers, Dhiraj, 2013). In the line of the present study, the intention to use big data adoption was investigated to timely take positive decisions in disaster management settings. Therefore, from the above discussion to test the relationship among the subjective norm and intention to use BDAs following hypothesis is formulated;

H2: “Subjective Norms towards disaster management has a significant and positive effect on the intention to adopt big data analytics”

Perceived behavioral control is defined as “the perceived ease or difficulty of performing the behavior or people’s perceptions of their ability to perform a given behavior”. Several studies have reported the significant influence of perceived behavioral control on intention in technology adoption (Ajzen, 1991; Crespo & Del Bosque, 2010; Hsu et al., 2006; T Ramayah et al., 2010; Thurasamy, 2009; Rana, Dwivedi, Lal et al., 2015, 2015; Zhang et al., 2012). Nevertheless, technology adoption in the various sectors especially in the public sectors is still a new concept in the developing world. Consequently, the following hypothesis is proposed;

H3: “Perceived behavioral control towards disaster management has a significant and positive effect on the intention to adopt big data analytics”.

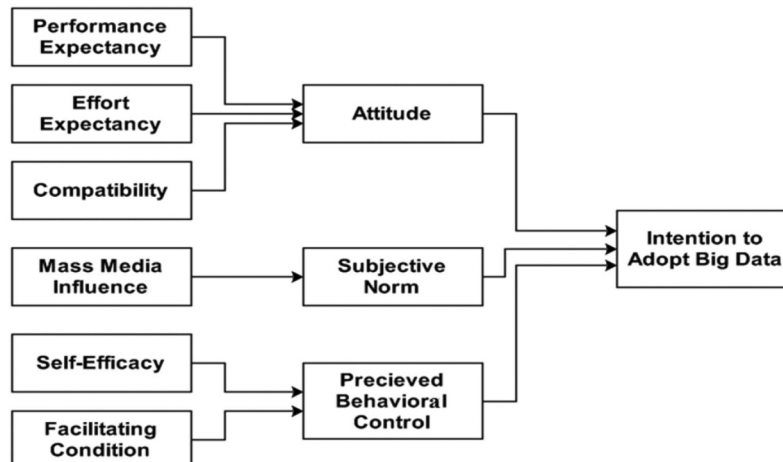
Venkatesh et al. (2003) defined performance expectancy as “the individual believes

that the particular system will assist him/her to improve in his/her job performance”. Additionally, the

performance expectancy is similar to the other constructs like perceived usefulness (Taylor & Todd, 1995), usefulness and extrinsic motivation (Davis, 1989), usefulness and job fit (Thompson & Moore, 1991), relative advantage (Davis, 1989) and usefulness and outcome expectations (Compeau & Higgins, 1995). Several studies have reported that performance expectancy significantly influences the attitude in the technology adoption studies (Al-Sobhi et al., 2011; Hsieh & Shannon, 2005; Hung et al., 2009; Lin et al., 2011; Venkatesh et al., 2003; Zahid & Haji Din, 2019). Therefore, in the line of the present study, the following hypothesis is formulated;

H3: “Perceived behavioral control towards disaster management has a significant and positive effect on the intention to adopt big data analytics”.

Figure 1. Conceptual framework of Intention to Adopt Big Data.



Based on an extensive review of mainstream literature, the study's conceptual framework is presented in Figure 1.

4. Research methodology

The present study uses a hypothetic-deductive approach which involves the testing of hypothesis centered on the established theory Cavana et al. (2001). Besides, the co-relational association of each exogenous variable was investigated and the involvement of the researcher is minimal. The unit of the analysis were individuals. The data was collected from March 2019 to August 2019 using the cross-sectional method. A self-administrative questionnaire was used for the collection of data from the respondents. The respondents of the study were the employees of Rescue 1122 services and employees of the National disaster management authority (NDMA) at the district level of Punjab, Pakistan. Punjab is the biggest province of Pakistan population-wise (110 million population) and having thirty-six districts. In Rescue 1122, employees from the selected departments are considered (like planning and development, law wing, management, and operations department) as they are well aware of big data analytics (BDA) and disaster management. Due to the internal policies of the government departments, the complete list of the employees was not available or shared by the government departments. Therefore, the sampling frame was not available for the researcher. As per the recommendation of Zahid and Haji Din (2019), once the sampling frame is not available then the probability sampling cannot be employed. Thus, the non-probability sampling technique (convenience sampling technique) was employed to collect the data from the proposed respondents.

According to Calder et al. (1981) when the priority is theoretical generalizability rather than population generalizability then non-probability sampling is appropriate and deemed acceptable. Also, Quoquab et al. (2018), non -probability sampling should be employed when the employees are available and willing to participate in the survey disaster management authority (NDMA) at the district level of Punjab, Pakistan. Punjab is the biggest province of Pakistan population-wise (110 million population) and having thirty-six districts. In Rescue 1122, employees from the selected departments are considered (like planning and development, law wing, management, and operations department) as they are well aware of big data analytics (BDA) and disaster management. The determination of the sample size in the existing study was based on some statistical analysis suggested by prior researchers. Therefore, as per the recommendation of Hair et al, (2010) the rule of thumb of one to five ratio (1:5). Also, Kline has recommended the sample size of "10 or 15 cases per parameter" depends on the complexity of the proposed conceptual model. Hair et al. (2006) argued that the sample size of ten to one ratio (10:1) must be followed to run confirmatory factor analysis (CFA) and structured equation modeling (SEM). In the line of the

present study, the self-administrative questionnaire was used to collect the data from the respondents.

The questionnaire consisted of two parts. The first part (Section A) represented the demographics of respondents and the second part (Section B) consisted of forty-one (41) questions or items to measure the variables of the study. Five demographic items were measured, namely age, gender, education, job title, and level of job, including one control question “i.e. Do you have an understanding of the role of big data analytics in disaster management?”. Besides, five items of intention were adapted from Taylor and Todd (1995), four items each for attitude and subjective norm were adapted from (Nor & Pearson, 2008). The four questions were adapted from Shih and Fang (2004) for perceived behavioral control, four items each were adapted from Dwivedi et al. (2017) for performance expectancy and effort expectancy. Compatibility was measured with four items adapted from (Nor & Pearson, 2008). The four questions from Al-Ajam & Md Nor. 2015 for mass media influence. Self-efficacy was measured with five items adapted from Armitage & Conner, (1999) and the facilitating condition was measured with three indicators (Thompson & Moore, 1991), the constructs of the study with the number of items and sources are discussed for further understanding and in all the items or questions of study have been reported. Out of forty-one items, four (4) items were deleted which was 10% deletion of the whole items of the questionnaire. The constructs were measured with seven Likert scales “ranging from strongly disagree (1) to strongly agree (7)”. The draft of the questionnaire was reviewed by academic and industrial experts to rectify the possible problems

to clarify and enhance accuracy. After getting suggestions from the experts, wording and few items were modified and the final questionnaire was drafted for data collection.

4.1. Profile of the respondents

In the existing study, the respondents were asked about personal information like gender, age, education, job level “i.e. entry-level, middle level, managerial level, and top-level”. The findings of the current study revealed that male respondents were 83% and females were 17% shown in Figure 2(a). Also, the age of the respondents various in five subcategories like “up to 25 years were 15%, 26 years to 35 years was 12%, 36 years to 45 years were 37%, 46 years to 55 years were 33% and 56 years to 60 years 3%” shown in Figure 2(b). The education level of the respondents was categorized into three subcategorized like “53% were bachelor, 42% were master or masters of philosophy and 5% were the doctor of philosophy” as shown in Figure 2(c). The job level of

Figure 2. Demographic results of the respondents. (a) Respondents' Gender (b) Respondents' Age (c) Respondents' Education Level (d) Respondents' Job Level (e) Control Question 1.

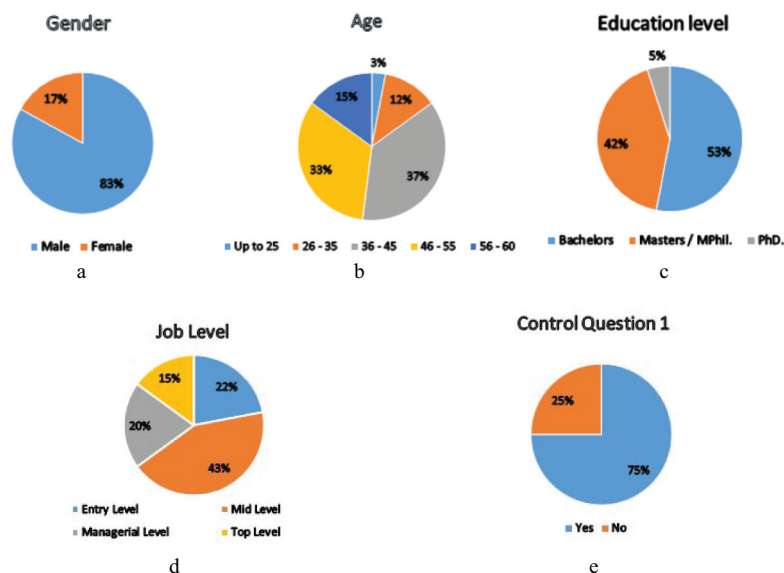
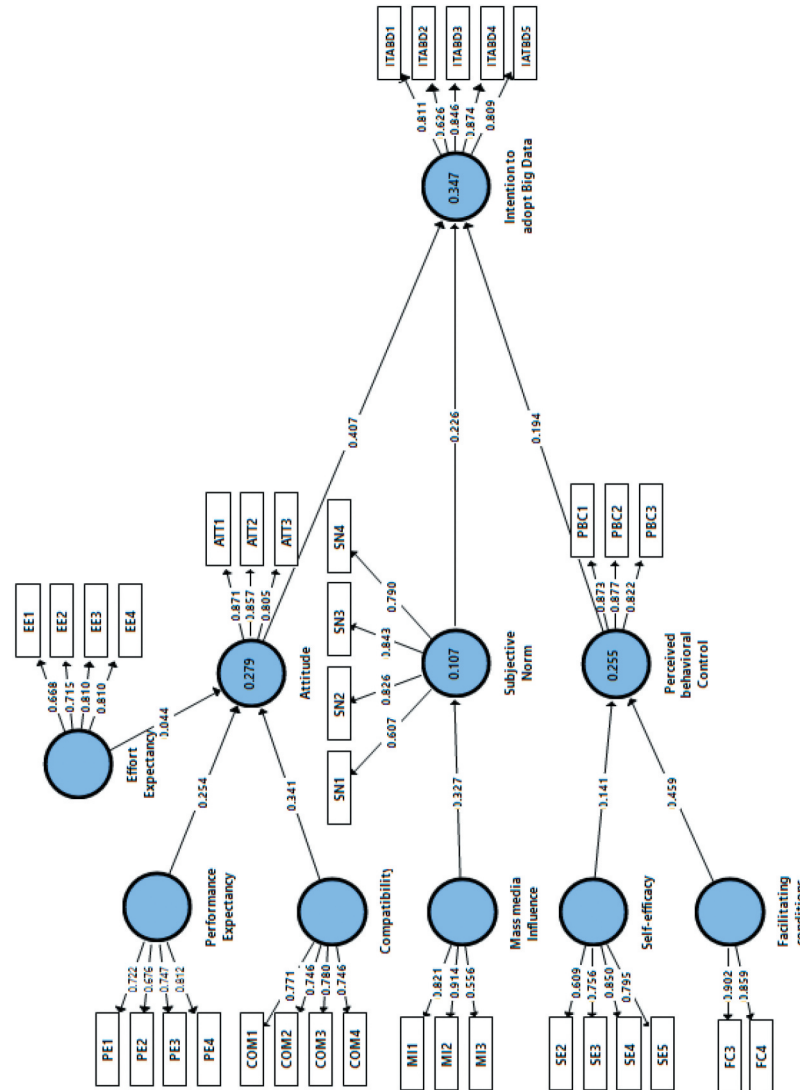


Figure 3. Direct path coefficient of the structural model (PLS algorithm).

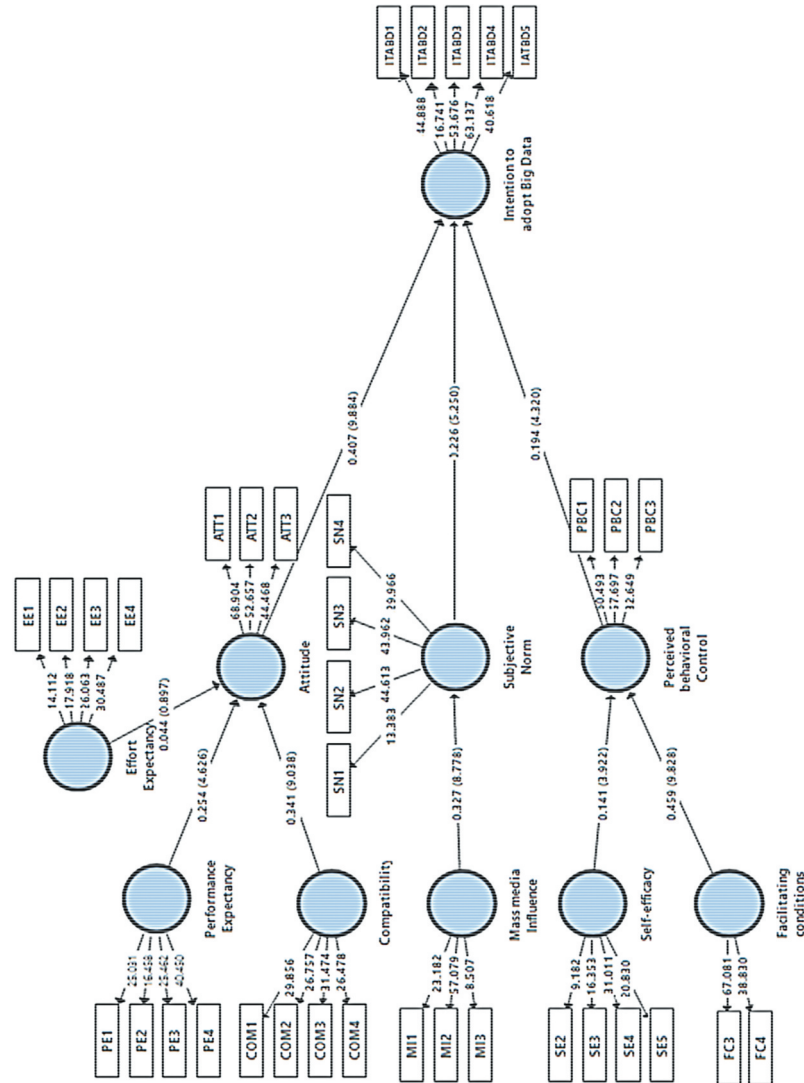


respondents was classified into four subcategorized like “entry-level 22%, middle level 43%, managerial level 20%, and top management 15%” as shown in Figure 2(d).

5. Data Analysis

In the studies of social and behavioral science, Structural Equation Modeling (SEM) is considered one of the important criteria while the selection of research methodologies (MacCallum & Austin, 2000). SEM is the most influential second-generation multivariate analysis technique which overcomes the limitations of the first-generation analysis technique (Zaman et al. 2019; Zaman U. 2020). SEM in terms of accuracy, efficiency, and convenience is far better than the tools of first-generation analysis techniques (Zahid & Haji Din, 2019; Zaman et al. 2019). According to Hair et al. (2014), validation of the measurement model and assessment of structural models are the two major components of SEM. Besides, SEM can test or build the proposed model and advances the development of the theory. SEM seeks to facilitate the various investigations like linear regression, testing of the hypothesis, confirmatory factor analysis (CFA), and variance (Jöreskog et al., 2001). Furthermore, structural equation modeling consists of two (2) approaches covariance-based SEM (CBSEM) and variance-based SEM (VBSEM) also called PLS-SEM. The main objective of PLS-SEM is to “to maximize the explained variance in the dependent constructs as well as to assess the quality

Figure 4. Structural model.



of data based on the characteristics of the measurement model". In the present study, the data were analyzed in two phases, first by employing Statistical Package for Social Sciences (SPSS) version23 and secondly by using the partial least square structural equation modeling PLS(SEM). The reason to choose PLS-SEM in the existing study as an analysis tool is that the study is more about prediction and theory development rather than theory testing and confirmation. Smart PLS 3.0 software is used

5.1. Measurement model assessment

The measurement model is also known as the outer model in PLS-SEM is one of the element PLS path models (Hair et al., 2014). According to Hair Jr, Sarstedt, Hopkins, and Hair et al. (2014), "The measurement model of the constructs is used to describe the relationship between the construct and its indicators (rectangles)". In the assessment of the measurement model, the evaluation of the validity and reliability of the items (indicators) are considered (Table 1). In the first step, composite reliability (CR) is measured as the internal reliability of the construct. The composite reliability describes as "the degree to which the construct items consistently represent the same latent construct". Additionally, the composite reliability is considered more appropriate than Cronbach's alpha in the PLS path model (Hair et al.). In

Table 1. Construct Reliability and Validity

	rho-A	Composite Reliability (CR)			Average Variance Extracted (AVE)		
ATT	0.80161		0.88205		0.71392		
Comp.	0.7585		0.84605		0.57884		
EE	0.77338		0.83886		0.56714		
FC	0.72569		0.87328		0.77516		
ITABD	0.85565		0.89647		0.63672		
MMI	0.81945		0.81621		0.6061		
PBC	0.82165		0.89289		0.73553		
PE	0.73508		0.82874		0.54854		
SE	0.82466		0.84162		0.57395		
SN	0.77668		0.85343		0.59637		

the second step, the assessment of validity is evaluated. To assess the validity, two types of “convergent validity and discriminant validity” have been evaluated. Convergent validity refers to “the extent to which the consensus of the multiple items used in the research measure the same concept” and assessed through outer loadings of the indicators and average variance extracted (AVE). As per the recommendations of Hair et al. (2014), the cut-off value of AVE should be greater than 0.5. Besides, the loadings of the indicators from 0.4 to 0.7 should be considered (Table 2). Indicators with below loading of 0.4 must be removed (Hair et al., 2014). Discriminant validity measures “the degree to which the construct completely differs from other constructs, in terms of how much it correlates with other constructs, as well as how much indicators represent only a single construct” (Hair et al., 2014). To measure the discriminant validity, two methods heterotrait-monotrait ratio of correlations (HTMT) and Fornell-Lacker criterion are considered in the PLS path model (Hair et al., 2014). The difference between the two methods is that HTMT examined at the level of indicators and Fornell-larcker criterion is examined at the level of construct. In HTMT, if the values found less than 0.90 then HTMT criterion is fulfilled (Jöreskog et al., 2001). In the line of the present study, the discriminant validity was calculated by using the heterotrait monotrait (HTMT) ratio instead of other traditional methods, “like Fornell–Larcker” as HTMT has superior criterion (see in Figure 3) (Akbar, Ali, Ahmad, Akbar, & Danish, 2019; Zahid & Haji Din, 2019).

Table 2. “Discriminant validity (heterotrait-monotrait ratio, HTMT)”

ATT COM.			EE	FC	ITABD	MMI	PBC	PE	SE	SN
ATT										
COMP.	0.59									
EE	0.4	0.43								
FC	0.2	0.13	0.32							
ITABD	0.62	0.47	0.52	0.3						
MMI	0.63	0.38	0.4	0.47	0.636					
PBC	0.09	0.08	0.28	0.63	0.338	0.47				
PE	0.55	0.55	0.87	0.32	0.581	0.51	0.28			
SE	0.23	0.15	0.24	0.23	0.169	0.19	0.26	0.17		
SN	0.55	0.57	0.35	0.27	0.506	0.42	0.08	0.42	0.23	

5.2. Structural model evaluation

Numerous steps need to be measured for the assessment of the hypothesized relationships within the inner model after the reliability and validity of the outer model has been established. The assessment of the inner model involves the estimation of one latent construct with the other latent constructs. In the PLS path model, by running of PLS-SEM algorithm and bootstrapping the structural model is assessed (Chin, 2010). Various following criteria have been used for the assessment of the inner model like “Coefficient of determinants (R^2), the effect size (f^2), the significance of the path coefficient and predictive relevance (Q^2)”. The coefficient of determinants (R^2) refers to “the predictive power of the endogenous construct in the structural model”. According to Chin (2010), R^2 values of for endogenous latent construct are considered 0.75 (substantial), 0.50 (moderate) and 0.25 (weak). The predictive constructs of the study can be measured by using the effect size (f^2). According to Chin (2010), it “refers to the effect of exogenous latent constructs on endogenous latent constructs through the change of coefficient of determinants R^2 ”. As per the recommendation of Cohen (2013), the values of effect size f^2 can be determined as 0.12 (small), 0.15 (medium), and 0.35 (large). To determine the significance level of the path coefficient is another assessment of the structural model. In PLS-SEM, the bootstrapping procedure can determine the level of the significance of the proposed model. To avoid Type 1 error if the data is not normal or the inflation of t values, the bootstrapping procedure should be done. Bootstrapping is defined as a “resampling technique that makes a great number of sub-samples of the original data (with replacement) and estimates the model for each subsample”. According to Chin (1998), 500 re-samples are recommended to estimate a parameter. The examination of Stone-Geisser’s Q^2 is a method to assess the predictive relevance of the structural model (Chin, 2010; Hair et al., 2014; Henseler et al., 2009). The predictive relevance proposed that “the model must be capable enough to predict each endogenous latent construct’s data points of indicators”. In PLS-SEM, a blindfolding procedure is proposed to investigate or test predictive relevance. As per the recommendation of Hair et al. (2014), “The value of Q^2 that is larger than zero specifies that the structural model had predictive relevance (see in Figure 4).

6. Discussion

The first hypothesis of the study reports ($\beta = 0.407$, t-value = 9.884, $p < 0.05$) a significant and positive influence of the intention to adopt big data analytics in disaster management settings (Table 3). Therefore, the results of the existing relationship are consistent with the previous studies on technology adoption in various domains (Ayudya & Wibowo, 2018; Cai et al., 2019; Hasbullah, Osman et al., 2016; Khasawneh & Irshaidat, 2017; Teo et al., 2016). The conventional methods are considered not valid nowadays and technology replaced these methods for proactive and accurate decision making. BDAs help to build a positive attitude of individuals so that they can act accurately and before the time of crisis on decision making positions in disaster management. The second hypothesis of this study H2 estimated ($\beta = 0.226$, t-value = 5.250, $p < 0.05$) a significantly and positively impact the intention to adopt big data analytics in disaster management settings. Thus, the above-mentioned findings are dependable on prior literature conducted on technology adoption (Cai et al., 2019; Hasbullah, Khairi et al., 2016; Tao & Fan, 2017; Teo et al., 2016). Additionally, the society of Pakistan is based on collectivism and other opinions have an influential impact on one’s intention. Therefore, technology adoption especially big data analytics is an advanced tool and has a strong predictor of intention in disaster management settings.

The third hypothesis of the existing study H3 anticipated ($\beta = 0.194$, t-value = 4.320, $p < 0.05$) and significantly and positively influence the intention to adopt big data analytics in disaster management settings. So, the findings are in line with past researchers conducted on technology adoption (Ayudya & Wibowo, 2018; Cai et al., 2019; Hasbullah, Osman et al., 2016; Khasawneh & Irshaidat, 2017; Teo et al., 2016). To make the right decision in key positions of any organization, the individual does not believe in available resources like information from others, time and financial resources but the confidence on the advanced technologies is also giving them the confidence to take pro-active decisions especially in the

Table 3. Result of Structural equation modeling (SEM) and hypothesis testing

Hypotheses	Relationship	Path	Std.	t	P-Support		R2	Q2	F2
					Value	Value			
H1	ATT >>	0.407	0.041	9.884	0.000	Yes	0.279	0.186	0.205
	ITABD								
H2	SN >>	0.226	0.043	5.250	0.000	Yes	0.107	0.057	0.064
H3	ITABD								
	PBC >>	0.194	0.045	4.320	0.000	Yes	0.255	0.174	0.057
H4	ITABD								
	PE >> ATT	0.254	0.055	4.626	0.000	Yes			0.048
H5	EE >> ATT	0.044	0.049	0.897	0.185	No			0.002
H6	Comp. >>	0.341	0.038	9.038	0.000	Yes			0.132
	ATT								
H7	MMI >> SN	0.327	0.037	8.778	0.000	Yes			0.120
H8	SE >> PBC	0.141	0.036	3.922	0.000	Yes			0.026
H9	FC >> PBC	0.459	0.047	9.828	0.000	Yes			0.272

disaster settings. Fourth hypothesis H1(a) projected ($\beta = 0.254$, $t\text{-value} = 4.626$, $p < 0.05$) and significantly and positively influence the attitude in disaster management settings. Consequently, the results are in line with the prior literature of various technology adoption studies (Cheng & Chan, 2003; Taylor & Todd, 1995). Easy access and better communication channels are possible through these advanced industrial 4.0 technologies like BDAs and the Internet of things (IoT). Also, the incorporation of BDAs in disaster management can increase the efficiency, lesser down the lead time, and has a significant impact on the cost with decision making authorities are in a position to take timely and accurate decisions. It is the need of time to actively take some decisions that can provide the above-mentioned benefits and provide ease that leads toward the individual attitude towards the intention to use BDAs in disaster management.

Moreover, the empirical results of the fifth hypothesis H1(b) reported ($\beta = 0.044$, $t\text{-value} = 0.897$, $p < 0.05$) a insignificant impact on attitude in disaster management settings. Accordingly, the prior literature on technology adoption research supported the current findings (Cheng & Chan, 2003). According to Pavlou (2001) effort expectancy influence indirectly through performance expectancy. As per the result ($\beta = 0.254$, $t\text{-value} = 4.626$, $p < 0.05$) performance expectancy has strong correlation with attitude. Therefore, it demonstrates that effort expectancy does not encourage the intention to use BDAs in disaster management settings. The respondents believe that the BDAs technique enhances the overall performance, effectiveness, productivity, and accomplish the task quickly but reluctant to learn, interact with these techniques. Moreover, understanding the problem of these latest technologies i.e. BDAs exists among the individuals. The findings discovered that the sixth hypothesis H1(c) predicted that ($\beta = 0.341$, $t\text{-value} = 9.038$, $p < 0.05$) and significantly and positively impact on attitude in disaster management settings. The abovementioned findings have empirical support in big data adoption (Esteves & Curto, 2013). The extension of various platforms like enterprise resource planning (ERPs), business intelligence (BI), customer relationship management (CRM), product life cycle (PLM), and various other sources that are providing real-time information are some factors helpful towards the individual attitude especially in the technology adoption like BDAs settings in disaster management settings. The following hypothesis H2(a) of the study has shown that ($\beta = 0.327$, $t\text{-value} = 8.778$, $p < 0.05$) and significantly and positively impact subjective norms in disaster management settings. Thus, the verdicts of the existing study have consistent with prior literature (Bhattacharjee, 2000; Woon & Kankanhalli, 2007). In disaster management settings, be aware before time, take timely decisions, the accuracy of information are some key indicators. Mass media like TV, radio, social media, newspapers, blogs, magazines, channels, and various websites help to be aware of upcoming events. Therefore, it can help to take affirmative decisions at the right time and with accurate information by using BDAs before the stage of the disaster.

The second last hypothesis H3(a) of the study anticipated that ($\beta = 0.141$, $t\text{-value} = 3.992$, $p < 0.05$) and significantly and positively influence perceived behavioral control in disaster management settings. Therefore, the findings of the proposed relationship are consistent with prior studies conducted on technology adoption (Ali et al., 2019; Recker & Saleem, 2014; Zahid & Haji Din, 2019). One of the foremost reasons for the existing result is the collectivistic society of Pakistan. In the developed countries especially the western countries the culture of individualism prevails, they always focus on individual goals rather than collective goals, individuals superficial themselves as an independent group. Interpersonal communication channels can create social pressure and have a huge impact on the decision making of any individual. Therefore, the decision-making authorities can adopt these advanced technology adoption tools to reacting timely and accurately before a disaster. The final hypothesis H3(b) estimated that ($\beta = 0.459$, $t\text{-value} = 9.828$, $p < 0.05$) a significantly positive influence on perceived behavioral control in disaster management settings. Hence (Ali et al., 2019; Rana, Dwivedi, Lal et al., 2015, 2015; Zahid & Haji Din, 2019). The government should play a vital role in the advancement of these sensitive matters like disaster management. Besides, the government should provide every single help and resource to the department so that they can upgrade them with all the advanced technologies. These enrichments in the

system can save lives and give strength to the decision making authorities to react actively in the time of crisis more effectively.

6.1. Theoretical and Practical Implications

In the line of the present study, proposed relationships have been empirically investigated to determine various antecedents “performance expectancy, effort expectancy, compatibility, mass media influence, facilitating conditions, self-efficacy, attitude, subjective norms, perceived behavioral control” of intention to adopt BDAs. The current study is among one of the pioneer studies that employed the decomposed theory of planned behavior (DTPB) and empirically investigated. The above-mentioned empirical relationships have explained thirty -five percent of the variance. Therefore, these proposed relationships have been proved with the findings of the existing study. Lastly, the empirical findings of the present study can help the decision-making authorities among the government sector to implement or use big data analytics techniques to counter the disasters pro-actively.

This study suggested that the antecedents “performance expectancy, compatibility, mass media influence, facilitating conditions, self-efficacy, attitude, subjective norms, perceived behavioral control” positively and significantly influence the intention to adopt BDAs. The empirical findings revealed that big data adoption techniques (BDAs) can synthesized information, better predict, and analyze the data, enhance the ability to proactively respond and plan. Besides, previous data like crowdsourcing “the ones provided by the disaster affected people” helped to take future decisions timely and effectively. While working with these latest technologies, the decision-makers will situationally well aware. Consequently, analytical results will help the government authorities to emphasize proper rescue plans, effective effort (time and space) for future disasters. As a result of adopting this conceptual framework, the decision-makers interconnected the various system across the government level. This interconnected network can help to share real-time and perceive data to take real-time decisions quickly. Every department of the government under the domain of disaster management is interlinked and assess, share, analyze data to take timely decision by using bid data analytics techniques. The data and information are widely assessed and authorized for all the stakeholders especially the decision-makers in disaster management settings. Therefore, the use of the BDAs technique not only use for data acquisition technology but provides the operative, intellectual, and goal-oriented communication among various stakeholders. Moreover, available resource information and location are automatically shared without any human interaction that can enhance the required task efficiency and accuracy.

6.2. Limitations and future recommendations

The current study is a cross-sectional study though, in future studies, the longitudinal study can also be investigated. Moreover, to get more generalized outcomes, the probability sampling techniques can be considered in future studies. The researchers can conduct qualitative or mixed-method studies and compare the findings with the existing research. Notwithstanding, Information technology (IT) experts and academicians can be included in future studies as respondents. Additionally, the adoption of various other technologies like the Internet of things (IoT), social media and unmanned aerial vehicle (UAV) and geographic information system (GIS), and remote sensing should be investigated in disaster management settings. Future researchers should incorporate the segmentation analysis in parallel to the SEM analysis to investigate which departments or individuals (segmentation) or most accepting of or resistant to the use of the big data approach in disaster management. Furthermore, the construct of Trust and mediating role of attitude, subjective norm, and perceived behavioral control in the same model should also be investigated on big data analytics to determine the causal aspect of the research.

7. Conclusions

Big Data Analytics (BDAs) has the potential for the transformation of disaster management systems by using the latest technologies to gain timely and accurate decisions. The foremost aim of this study is to investigate the antecedents of intention to adopt big data analytics in disaster management settings. Furthermore, the results can help to resolve the disaster-related problems pro-actively and accurately. The proposed conceptual model has been empirically investigated that contributes to the

existing body of knowledge and predicts the intention towards the usage of big data analytics among the disaster management systems. DTPB has been incorporated in the existing study to determine the factors having a significant influence on big data adoption in disaster management. The findings of the study revealed “attitude (performance expectancy and compatibility),

subjective norms (mass media influence) and perceived behavioral control (self-efficacy and facilitating conditions)” the significant predictors of big data analytics adoption in disaster management settings in the Pakistani context. Besides, the results have practical as well as theoretical implications. Theoretically, the proposed conceptual model adds new avenues in the existing literature by incorporating the DTPB and investigating significant predictors. On the other hand, practically the findings of the present study can help the decision-making authorities to take proactive and accurate decisions before the happening of disasters. The authorities can design such kind of strategies and implement these systems before the time of crises and to manage the disaster response more effectively.

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APPENDIX A (Questionnaire)

<p>Intention (INT.) BI1- In disaster management settings, I intend to use big data analytics in the future BI2- I will use big data analytics in disaster management settings in the future BI3- Given the chance, I predict I will use big data analytics in the future in disaster management BI4- It is likely that I will use big data analytics in disaster management in the future. BI5- I expect to use big data analytics in disaster management in the future.</p>	<p>Attitude (ATT) ATT1- Using big data analytics in disaster management would be a good idea. ATT2- Using big data analytics in disaster management would be a wise idea. ATT3- I like the idea of using big data analytics in disaster management. ATT4- Using big data analytics in disaster management would be pleasant.</p>
<p>Effort expectancy (EE) EE1- Learning to operate big data analytics in disaster management would be easy for me. EE2- I would find it easy to get the big data analytics in disaster management to do what I want to do EE3- My interaction with big data analytics in disaster management would be clear and understandable. EE4- I would find the big data analytics in disaster management easy to use.</p>	<p>Compatibility (COM) COM1- I think big data analytics services are compatible in disaster management settings. COM2- I think big data analytics services are compatible with the way I like to do disaster management services. COM3- I think using big data analytics fits with my disaster management preferences COP4- I think big data analytics services fit well with all aspects of my disaster management activities.</p>
<p>Performance expectancy (PE) PE1- Using big data analytics in disaster management would improve my overall performance PE2- Using big data analytics in disaster management would increase my productivity PE3- Using big data analytics in disaster management enhance my effectiveness PE4- Using big data analytics in disaster management would enable me to accomplish tasks quicker</p>	<p>Subjective norm (SN) SN1- People who influence my behavior think that I should use big data analytics in disaster management SN2- People who are important to me think I should use big data analytics in disaster management SN3- People whose opinion I value think I should use big data analytics in disaster management SN4- People who influence my decision think that I should use big data analytics in disaster management.</p>
<p>Mass media influence (MMI) MMI1- The mass media suggest that I should use big data analytics in disaster management MMI2- The mass media urge me to use big data analytics in disaster management MMI3- Mass media is full of reports, articles, TV, radio, newspapers and internet suggest that I should use big data analytics in disaster management MMI4- Mass media and advertising consistently recommend that I should use big data analytics in disaster management.</p>	<p>Perceived behavioral control (PBC) PBC1- I would be able to use big data analytics in disaster management. PBC2- I have the resources to use big data analytics in disaster management PBC3- I have the knowledge to use big data analytics in disaster management PBC4- I have the ability to use big data analytics in disaster management</p>
<p>Self-efficacy (SE) SE1- Whether or not I use big data analytics in disaster management is entirely up to me SE2- I am confident that I can use big data analytics in disaster management regularly SE3- I am very sure that I would be able to use big data analytics in disaster management next week. SE4- I am certain that I will be able to refrain myself from use big data analytics in disaster management that are not used SE5- If I wanted to, it would be very easy for me to use big data analytics in disaster management regularly.</p>	<p>Facilitating condition (FC) FC1- I have the necessary resources to use big data analytics in disaster management facilities FC2- I have the necessary knowledge to use big data analytics in disaster management facilities. FC3- I have enough internet experience to use big data analytics in disaster management</p>



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