



Review

A Systematic Review on Flood Early Warning and Response System (FEWRS): A Deep Review and Analysis

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Abstract: Flood is the major natural hazard in Malaysia in terms of populations affected, area extent, frequency, social–economic damage, and flood duration. This shows the importance of providing comprehensive and effective flood mitigation management, which requires government agencies to enhance their employment performance that involves technological innovation. A flood early warning and response system (FEWRS) is essential to ensure that all stakeholders receive the right information and are provided with necessary actions and response information to avoid loss of lives and property. It should have some effective usability features and success components of its strategic information access and display; existing FEWRS fail and often do not effectively provide information on flood disasters to reduce their impacts at a local level to save the population's lives. The measurement of information system (IS) success remains a top concern for researchers, managers, and practitioners. Therefore, this study seeks to provide a systematic overview of the most successful model of employment-related technical advancement for the management of flood disasters to improve its employees' performance. In addition, examined factors that affect the successful implementation of flood management approaches, based on a systematic literature review among IS, show interrelationship of success factors. Findings from the literature suggest that the DeLone and McLean (D&M) model is the most widely employed model, recorded in 28 studies (39%). Further description of the 28 studies indicates that the D&M was either adopted alone or integrated with other theories. Moreover, results suggest the D&M is has been applied alone 39% of the time and has been extended 29% of the time; in total, 68% of the time, D&M has been applied either alone or extended in the information system domain. Additionally, 22% of the time it has been integrated with other theories.

Keywords: information systems success; flood management; flood mitigation; flood early warning and response system success



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1. Introduction

Information Systems (IS) are formal, socio-technical, organizational tools designed to process, collect, store, and distribute information to support people and their business process [1]. They also entail techniques employed to help organizations achieve strategic advantage, business benefits, and financial gain by enhancing work performance and promoting productivity, and technological innovation has a strong innovative effect on support employment's management [2] and decision-making [3,4]. In terms of disasters, IS are used for communicating, planning, and facilitating disaster inquiries, as well as notifying and minimizing emergency incidents; many competing theoretical models, such as the classic technology acceptance model (TAM), diffusion of innovations (DOI), the DeLone and McLean (D&M) success model, and theory of reasoned action (TRA), coexist in the

literature on the acceptance and adoption of information systems, each focused differently and tested in several contexts [5]. The risk of flooding is the most common natural threat from disasters, which accounts for almost half of global natural disasters [6]. The flood threat is obviously more severe compared with any other weather-related disaster [7].

Over the years, there has been constant changing and evolving of IS as technologies continue to grow. Thus, several IS that have been deployed in business, which include the management information system (MIS), decision support system, transaction processing system, and expert system, are all important IS tools that can be utilized to support organizational operations [8]. However, this study is more focused on the MIS and decision support system. In the MIS, these systems assist management in problem-solving and making decisions [3]. Findings from prior studies [8,9] argued that the right utilization of IS will facilitate organizations in achieving competitive advantage.

Everett Rogers [10] put forward the diffusion of innovations theory in his 1962 book, *Diffusion of Innovations*. This theory focuses on the factors that decide whether members of a specific community or environment would implement an idea or an innovation, and to what extent individuals interact with particular system. Thus, Rogers stated that diffusion is a process by which the members of a social system communicate an innovation over a period of time through certain channels (systems). In addition, diffusion of innovation encompasses four essential factors that have an influence on the dissemination of an idea: (a) innovation, (b) time, (c) the channels of communication, and (d) the social system [10]. Rogers sees communication as “a process where participants build and exchange knowledge to achieve mutual understanding”. Therefore, communication takes place through channels that connect sources to the receivers. Rogers notes that “a source is a message originating from a person or an organization” [11].

Furthermore, a channel is the means by which a message is sent to the receiver from the source. Therefore, as diffusion includes at least the following elements of communication: an invention and two subjects (e.g., source and receiver). Therefore, since the flood early warning and response system (FEWRS) is one of the IS applications that provides important information for local authorities, disaster managers, and emergency services, the right information is provided with necessary response information to avoid loss of lives and property [12,13]. FEWRS comprises elements such as risk knowledge, dissemination and communication, response capability, and a monitoring and warning system. Therefore, there is a logical link between diffusion theory and FEWRS, as diffusion theory emphasizes the communication, and dissemination takes place through channels that connect sources to the receivers, which is involved in FEWRS. Therefore, the purpose of innovation theory is important to decision-making when it is intended to implement the new idea of FEWRS and to link the channel between an individual and the FEWRS, as the theory of diffusion seeks the purpose of the channel of communication between the system and an individual. Moreover, the focus of diffusion research has been on five aspects: (1) the characteristics of a concept that can affect its adoption, (2) the decision-making mechanism that occurs when individuals consider implementing a new idea (e.g., system, information, and service quality), product, or practice, (3) the characteristics of individuals that make them likely to implement innovation, (4) the implications for individuals, and (5) the communication channel in an adaptation process [11].

Rogers, therefore, believed that the process of spreading innovation was based on human resources and that it must be widely adopted in order to sustain an innovation itself. The theory of innovation diffusion identifies five innovation adopter categories: innovators, laggards, the early majority, the late, and early adopters. While the diffusion of innovation depends on the social-cultural context, it is also a function of the making process of the type of innovation. Since information flows through networks, whether the innovations are adopted is determined by the networks and the roles of opinion leaders. Apart from opinion leaders, their personal interactions affect the actions of prospective adopters; apart from the diffusion process, there are other intermediaries, called reform agents and gatekeepers.

In addition, flood hazards and flood threats are interrelated, and decision makers are obliged to consider these two dependent principles [1], where hazard applies to a serious disturbance occurring over a period of time. The hazard affects the way of life of a society or community and leads to environmental, human, economic, and material losses that obviously surpass the capacity of the society concerned to use its natural resources [14]. Although there are many types of natural disasters, including floods, volcanoes, tsunamis, cyclones, earthquakes, and tornadoes, this research is concerned primarily with flood-related disasters. The natural disaster triggered by floods leads to deaths, economic losses, and property damage, as opposed to other natural hazards [12,15]. Likewise, in the context of this study, FEWRS is one of the IS applications that provides local authorities, disaster managers, and emergency services with the necessary response information to avoid loss of lives and property [12]. This information is then disseminated to the public in order to have ample time for successful mitigation steps before the disaster occurs [13]. Findings from the literature [16–20] highlighted that fewer studies that examined IS success by exploring factors that affect the success of FEWRS. Aldholay et al. [21] argued that IS implementation success or failure is mostly determined by user acceptance and level of success. Thus, assessment of IS success is an essential concern for practitioners, researchers, and IT managers [21,22]. Very few recent works attempted to explore the possibilities or influences influencing FEWRS integration.

Therefore, FEWRS needs to reduce flooding to an appropriate degree for disaster management based on various phases. Developing countries like the Philippines, Malaysia, and Indonesia have periodically been hit by disasters ranging from floods and droughts to earthquakes [23]. In the Asia-Pacific region, major disasters have often occurred [24]. This is due to global warming, climate change, and other natural and man-made phenomena that impact every nation today, including developed countries [25]. There is evidence of occurrences such as tsunami disasters in Japan, a number of extreme weather events in the United States, and New Zealand earthquakes. Furthermore, existing FEWRS do not effectively provide information on natural disasters in reducing the impacts of such disasters in local context [1,26].

Over the years, FEWRS has developed to be part of the early warning system (EWS) for disaster management and control. Hence, findings from prior studies [22,27–31] suggested that, although existing FEWRS have been improved, there is a need to integrate different approaches and theories to facilitate disaster management for FEWRS [27–30]. Moreover, existing FEWRS are ineffective in mitigating flood disasters successfully in regards to pre-disaster, during disaster, and post-disaster [32,33]. Previous work has successfully adopted the DeLone and McLean (D&M) model to examine IS success in different domains such as e-learning [17], learning management systems (LMSs), project management [16], health management [18], and online banking [34]. However, there is a lack of studies that employed FEWRS in management's information systems domain.

Many countries have implemented several effective methods to minimize flood-associated hazards due to the increasing danger of severe floods. For instance, in the USA, there are polices that entail the combination of both structural and non-structural measures in building many reservoirs and embankments, as well as forecasting and insurance systems that help to address flood scenarios [35]. In Italy, the government has established systems for complete civil protection and real-time torrent debris flow monitoring. These systems comprise a forecasting and early warning system, which has warning and monitoring capabilities. Likewise, in Japan, a disaster management administration system is in place that is linked to local autonomy and government at all levels to establish a community-based early warning system [36]. The European Union has proposed a real-time guide for accurate flood prediction, which incorporates a numerical rainfall model, hydrological models, and a flood forecast model. However, all of these technologies and systems utilized do not possess the capability to adequately mitigate disaster damages. Additionally, there are fewer studies that addressed the utilization of FEWRS in management's information systems domain.

To determining the relevant factors, this review aims to give a systematical review of the most successful model in technological innovation on employment for handling flood disasters' management to support the employment for their performance. The FEWRS often are not effective and fail to provide information for emergency services, disaster managers, and local authorities. Limited prior research has attempted to examine the possibilities or factors affecting FEWRS integration [12,37]. Thus, FEWRS is an approach to help minimize and reduce risks caused by the aforementioned disasters [1]. Moreover, FEWRS can be deployed to reduce hazards and disasters such as flood, since this system provides immediate information and responses. The remainder of this paper is organized as follows: Section 2 contains the method of this research. Section 3 provides the results and statistical information of articles. Section 6 presents the implications, and lastly, Section 7 contains the conclusions and future direction.

2. Methods

The current section shows the scan, selection, filtration, and read process procedures. The most popular search engines, namely, IEEE Xplore, Scopus, ScienceDirect (SD), and Web of Science (WOS), were used in the search for the articles in the present study. These five directories cover a broad variety of journals and conference publications relating to the area of study. These also feature ease of use and the ability to generate complex and simple search queries. Since these databases are subscription-based, we used the University Malaysia Pahang (UMP) library as an access point, and the search was conducted on 20 May 2019, at the University Malaysia Pahang. The main keywords formed the search query ("IS Success Model" OR "IS Success Factors", "IS Adoption", "Technology Adoption"). The search query is presented in Figure 1. For these five repositories, the queries were performed using the expert's search method. The quest range included only the selection of journals and conference papers (2014–2019); we have limited our focus to English works. Therefore, the search approach was based on preferred reporting items for systematic reviews and meta-analyses (PRISMA), which are summarized in Figure 1.

As mentioned above, the five databases have been used in this analysis. These databases can include large numbers of journals, and journals may be placed in two different databases; thus, duplication could occur. Therefore, after the search procedure, the articles duplicated in the five selected databases were removed. Two iterations of the intensive search were conducted in the selection of relevant articles. The first filtration focused on excluding unrelated articles by scanning the titles and abstracts. The second one involved intensive "full-text reading" for all the pertinent articles. All rounds were carried out using similar eligibility criteria. Then, the third iteration screened the final set of studies to determine the facets and applications of IS success and omitted any studies that did not meet the research objective. The final set of articles concerned all research that focused on IS success. Important information used in writing this analysis, which was collected during full reading from the relevant articles, was saved in an Excel file. Only studies that fulfilled the inclusion criteria listed in Figure 1 were included. The criteria of exclusion were as follows: non-English articles, non-English papers, and research not relevant to areas of IS success. The list of relevant papers is organized in an Excel sheet file and EndNote library. In the process of the "full-text reading", several significant highlights and details were extracted from the surveyed papers. The authors intended to collect valuable information and details that allowed them to provide a detailed picture of all the characteristics and aspects of IS success, such as important motives, obstacles, suggestions, and important information regarding the methodological aspects. All the important information was extracted from the relevant articles (the examples), presented in Figure 2, based on the objective of this review.

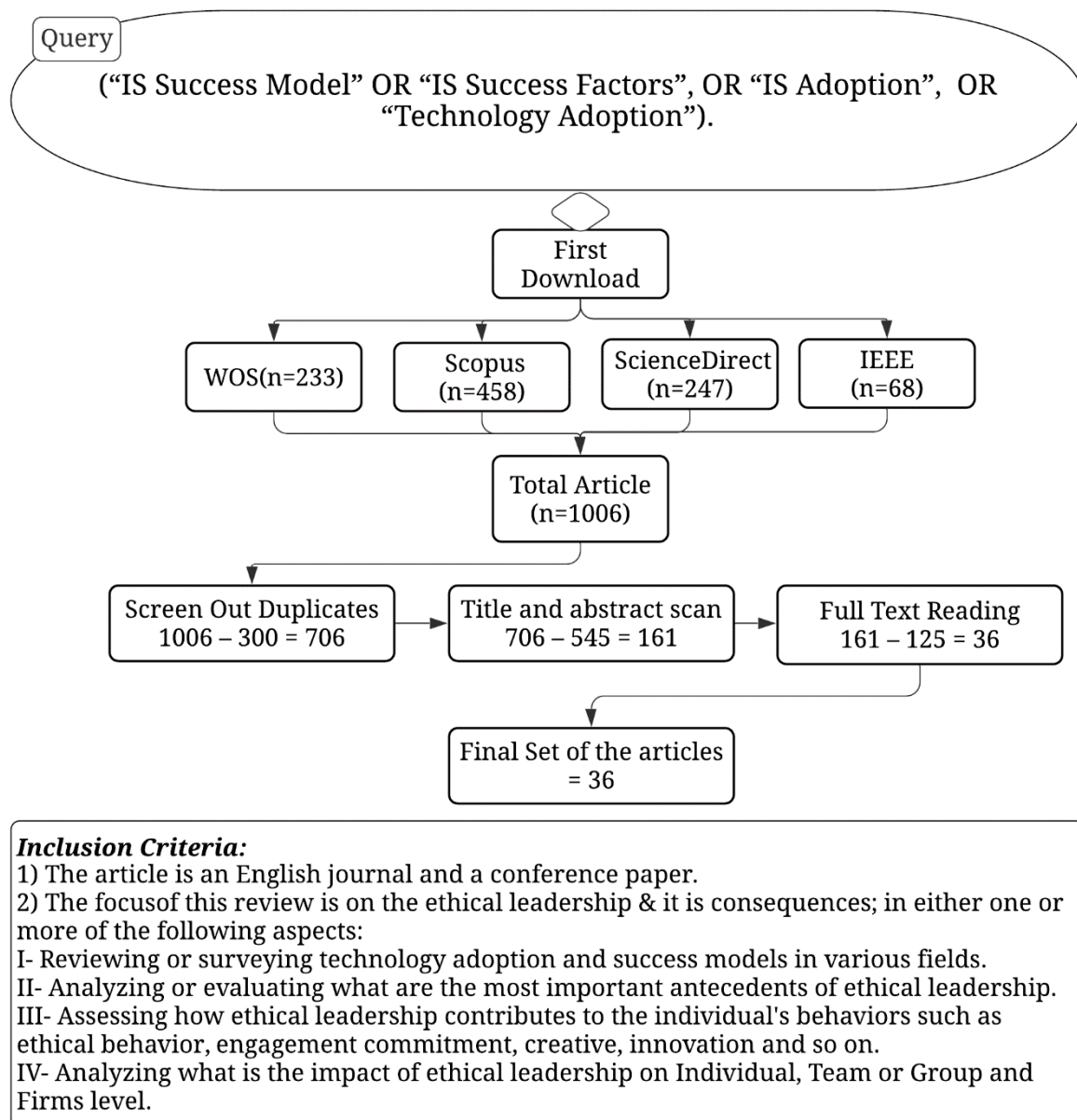


Figure 1. Flowchart of study query, selection, and inclusion criteria.

| | | Reference 1 | Reference 2 | Reference 3 |
|----|---|-------------|-------------|-------------|
| 1 | Article Title | | | |
| 2 | Author' Name and Year | | | |
| 3 | Journal Name | | | |
| 4 | DataBase Used: (Web of Science (WOS) Scopus, ScienceDirect (SD) and IEEE Xplore | | | |
| 5 | Article Type/Study | | | |
| 6 | Method/Approches | | | |
| 9 | Sample Size | | | |
| 11 | Country | | | |
| 15 | Limitations | | | |
| 16 | Future Research | | | |
| 17 | Notes | | | |

Figure 2. Scanned attributes of full-text reading.

3. Results and Statistical Information of Articles

Flood disaster can be categorized into three main stages, which are pre-disaster, during disaster, and post-disaster, as suggested by [38], where all stages are important and should be addressed in any FEWRS-based approach. In addition, advance warning and pre-planning can be included in FEWRS, since it can significantly reduce damages caused by the impact of flood. Additionally, the adoption of FEWRS provides inhabitants timely information so that they can be prepared for natural disasters such as tsunamis, tornadoes, or flood. FEWRS also provides a quick response to minimize damages before the disaster occurs [38]. Similarly, early warning systems can be deployed to predict and provide time for local government to evacuate residents before disasters such as flood occur [39].

Researchers such as Sättele et al. [38] maintained that FEWRS should be more centered on the pre-disaster stage. This is because the pre-disaster stage provides an effective stage for the system to include overall scenarios for flood events and provides real-time access to information related to flood mitigation and prevention. Academics in the IS domain, such as Baudoin et al. [12], argue that information systems can be useful in terms of emergency as important tools that can be utilized to improve the efficiency and effectiveness of disaster-handling activities. Figure 3 shows the framework for the flood and early warning system, which comprises natural and manmade disasters, where the natural disasters include flood, cyclones, tsunamis, and earthquakes. This research focuses on flood by employing the early warning and response system as a mitigating tool to reduce damages from flood disaster, which aligns with the information systems' domain in applying an early warning and response system to flood [40,41].

Figure 3 depicts the framework for flood and the early warning system, where an example of such an information system is the FEWRS, which provides information on the factors that impact the success of information systems in addressing natural disasters [1]. According to Baudoin et al. [42], information-based disaster approaches such as FEWRS possess the capability to forecast and provide recommendations on natural disasters based on factors that contribute to successful disaster management [12,42–44]. Hence, it is imperative for information-based disaster tools to predict disaster and also provide ample time for decision makers and the community to respond to evacuation. Furthermore, in

order for information-based disaster systems to be fully effective, it is crucial to deploy a response component in the early warning system to increase the performance of the system [1].

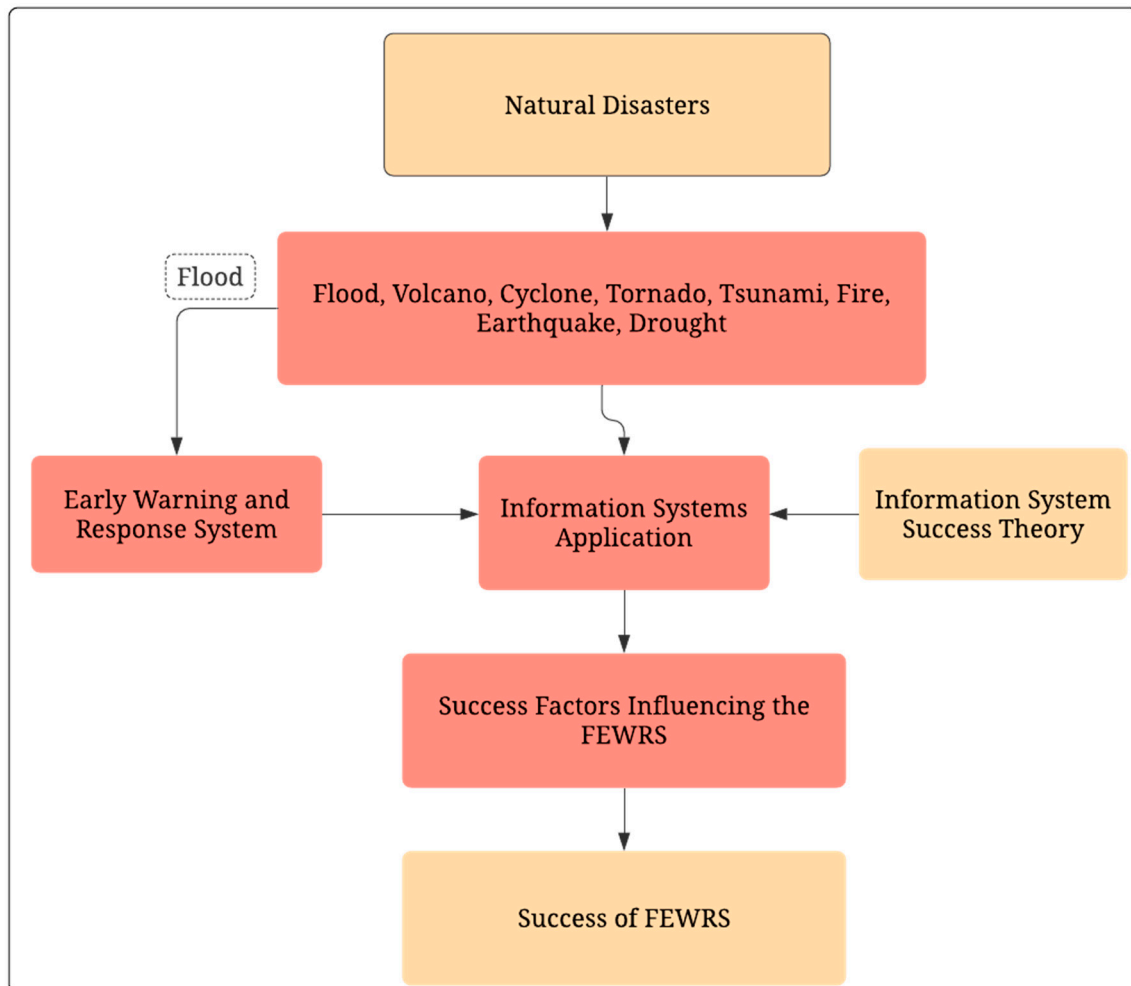


Figure 3. Framework of the flood early warning and response system.

3.1. Flood Early Warning and Response System (FEWRS)

Flood disaster and risks associated with flood are related to each other; consequently, these two related concepts are mainly adopted by decision makers in FEWRS to mitigate flood to an acceptable level as part of disaster management, based on different phases [1,45]. FEWRS aids in supporting decision making at different stages of the disaster management cycle to improve the current situation and alert inhabitants [46]. According to Oktari et al. (2014), four operational elements are considered in a typical early warning system, and these include risk knowledge, dissemination and communication, response capability, and the monitoring and warning system. Figure 4 depicts the four FEWRS factors: there is a close connection between these factors, and the failure of any of the four elements can result in a complete system failure [43].



Figure 4. FEWRS factors [30].

Figure 4 shows the FEWRS factors, where risk knowledge is the first element that provides the necessary platform for the operation of early warning systems. It requires a holistic approach and requires knowledge of exposure-, hazard-, and vulnerability-related factors. Moreover, risk knowledge aims to reduce risks rather than controlling hazard [47,48]. The second component is the monitoring and warning system, which is the core of early warning systems. This component addresses inherent uncertainties related to hydrodynamic, meteorological, and hydrologic issues in the deployment of warning reports, which are probably natural. Thus, the warning system should include monitoring, hazard knowledge, a warning service, and communication and response capabilities, where any failure or weakness in any one of these elements could lead to the failure of the complete system [49]. These elements are important and are employed by the general public and private relief agencies that aim to provide a quick response to the society in the situation of a sudden flood [50].

3.2. Information Systems Success (ISS) Models

Currently, information systems are considered as one of the important components for successful decision making in companies. Thus, these information systems are utilized by decision makers when they make decisions regarding the usage and development of specific system. Accordingly, over the years, several theories and models, such as the D&M success model [51], the technology–organization–environment (TOE) framework [52], and the technology acceptance model (TAM), have been adopted by researchers to investigate information system use. Likewise, over the years, several theories have proposed to describe the developmental changes employed by practitioners when performing organizational operations to study human nature when adopting such theories to examine human behavior and motivation [53]. Therefore, several theories and models have been put forward in the IS context for the explanation and prediction of user behavior towards technology usage. Thus, in the next section, a few theories and models previously adopted in prior information system success studies are reviewed.

3.2.1. Theory of Reasoned Action (TRA)

The theory of reasoned action (TRA) was formulated by Ajzen and Fishbein [54]. TRA was developed in the area of social psychology to improve the explanatory and predictive nature of the expectancy–value theory. TRA mostly explains the consciously intended behaviors’ determinants, and has been applied to investigate human behavior by researchers in the social psychology discipline [55]. TRA has been used in many fields, such as internet banking and information security culture [56], and green information technology [55]. It has been developed to be very useful in guiding studies of information systems, especially those dealing with the adoption of technological innovation [56,57]. As

it aims to explain the relationship between attitudes and behaviors within human action, TRA has been commonly used in the adoption of technology and as a basis for such studies in a number of research fields, and is mostly cited in IS studies [57,58]. Ajzen and Fishbein developed TRA to describe the relations between people's beliefs, perceptions, norms, expectations, and behaviors. In this study, this theory focuses on the desire of people to engage in some behavior, such as the acceptance and use of new technologies. TRA states that the action of an individual is defined by the behavioral intention of the person to conduct it, and the purpose itself is determined by the behaviors of the person and his or her subjective norms. The subjective norm refers to the understanding of the individual that most people who are important to him think that he should or should not perform the actions at issue [55].

TRA cannot be adopted for FEWRS because it intends to explain the relationship between behaviors and attitudes within human action.

Furthermore, there are other important theories that may also be employed, such as the DeLone and McLean success model [59] the unified theory of user acceptance of technology (UTAUT), which includes four main constructs (social influence, performance expectancy, facilitating conditions, and effort expectancy), which are the main determinants of consumers' behavior and usage intention, theory of planned behavior (TPB), The behavioral intention of an individual should not be the exclusive determinant of actions where the regulation of the action of an individual is insufficient. TPB can describe the association between behavioral intent and actual action by adding "perceived behavioral control". Additionally, another theory is the diffusion of innovation theory (DOI), which discusses adoption of IS as a social construct that gradually enhances [17].

3.2.2. Theory of Planned Behavior (TPB)

Scientific research on "behavioral interferences" aimed at understanding behavioral changes that can be influenced by many of their determinants, behavioral perspectives, and attitudes [60]. The variances in these factors result in changes in behaviors given adequate control under appropriate conditions [60–62], the original basis of TPB, and this covers the deliberate intention of individuals to act to postulate and promote. However, it is not qualified to be explained by TRA or a high-level study of the social psychology model.

TPB is the extension of the original TRA [63], which performs well for concrete intention behavior, developed to recognize the role of attitude in the performance of behavior and subjective norms. Attitude can be characterized as the perception of a task correctly and incorrectly and is determined by the expectation of consequences following the task. Subjective norms may be described as an interpretation of the others perceptions of the behavior concerned [22,63]. Figure 5 shows the TRA model.

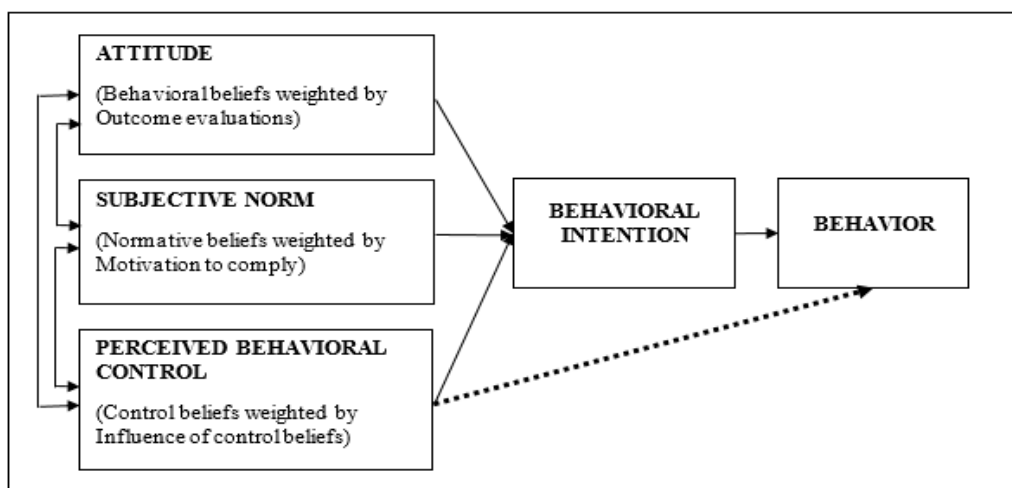


Figure 5. Theory of planned behavior (TPB).

3.2.3. DeLone and McLean Model (D&M)

DeLone and McLean [59] conducted a comprehensive analysis based on the effectiveness of IS and its achievement by practitioners and academics. In order to evaluate the performance of an IS, the researchers considered six concepts: “system quality, information quality, usage, user satisfaction, individual impact, and organizational impact” [51]. System quality investigates the characteristics of the system, while information quality deals with the desired type and characteristics of the information and user satisfaction/use deals with the system’s contact with end-users. The effect of the product’s information and how it affects managerial decisions are analyzed individually. The organizational effect factor is related to the effects on organizational efficiency of the information product.

DeLone and McLean later updated their success model due to difficulties in recognizing multidimensional aspects of “usage”, now referred to as “intention to use”. The intention to use was seen as combining elements of attitude and behavior. Although some studies have questioned “usage”, DeLone and McLean (2003) emphasize that in most situations, the use of a system is simply an appropriate indicator of performance. The updated model now includes device efficiency, while the net benefits are now referred to as individual and organizational impacts. According to DeLone and McLean (2003), net benefits raise concerns, because it is important to decide who the benefits are intended for and what qualifies as a benefit, and it must be whether the benefits are measured from the perspective of the person or from the perspective of the industry. This shows, therefore, that the net benefits dimension is broad and should be applied accordingly, according to the study context.

The DeLone and McLean IS success model is a theory that provides comprehensive understanding of IS success by explaining, describing, and identifying six critical variables that influence the success of information systems [51]. Figure 6 depicts the D&M model.

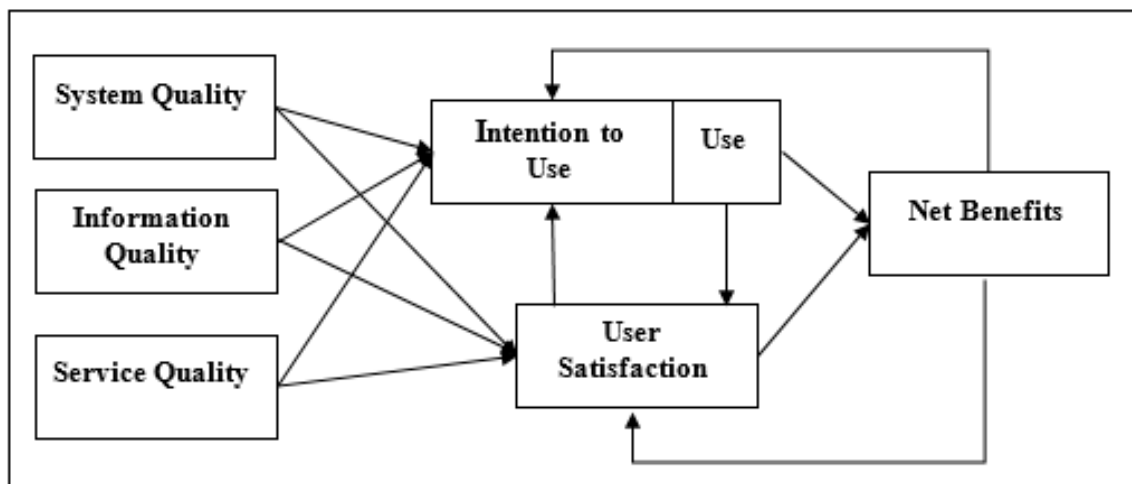


Figure 6. The DeLone and McLean model, adapted from [51].

Figure 6 shows the D&M model variables; in IS research it is essential to have a well-defined outcome measure that will help in addressing practical world issues [64]. The D&M model is a useful framework that addresses the impact of IS success [65]. The D&M has been adopted in many fields and industries by IS researchers such as e-government, health care, e-learning, and e-commerce [18,21,66]. In this study, the D&M model is employed as a suitable model, as it mainly focuses on successful implementation of IS, which is aligned to the contribution of this study.

3.2.4. Technology–Organization–Environment Framework (TOE)

The technology–organization–environment (TOE) framework was proposed by [52] based on technological, environmental, and organizational factors within a firm to be explored to clearly define innovation adoption. The TOE framework describes the entire innovation process, from innovation development to adoption and implementation, within the context of the firm. Figure 7 depicts the TOE framework, which is based on three main variables (technology, organization, and environment) that influence the adoption of new information technology.

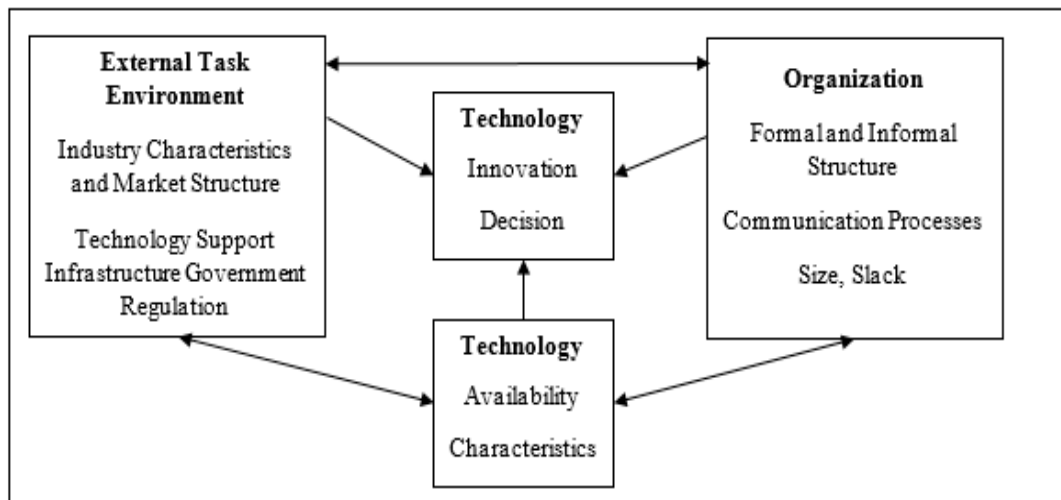


Figure 7. The TOE framework adapted from [52].

Figure 7 presents the TOE framework and associated variables and corresponding factors. In the TOE framework, the technological context includes the internal and external technologies that are relevant to the firm. Technologies may include both equipment as well as processes [67]; investigated technology use in firms is based on technologies available to the public but not yet in use in firms. The existing technologies in a firm are important in the process of adopting a new one, as they set a broad limit on the extent of technological changes that can be deployed by a firm [68]. Additionally, the organizational context is the resources and characteristics of the firm, including its size, extent of centralization and formalization, human resources, managerial structure, amount of slack resources, and connectivity among employees. Organizational structure has widely been studied to establish its relationship to the adoption of an innovation [68]. The TOE framework is an organization-level theory that explains that three different elements of a firm’s context influence adoption decisions. All three are posited to influence technological innovation. The TOE framework has been successfully employed in prior information system studies [69]. Thus, findings from previous studies suggested that TOE shows good results in terms of the technological aspect, but it cannot be adopted for FEWRS, because it does not focus on achieving information system success and effectiveness.

3.2.5. Technology Acceptance Model (TAM)

The technology acceptance model (TAM) was grounded by the theory of reasoned action (TRA) by Ajzen and Fishbein [54] and expectancy–value theory [70]. The latter continued to evolve further and worked to finalize the model with other researchers [71]. TAM variables comprise perceived ease of use (PEOU), and perceived usefulness (PU). The new TAM model integrates additional theoretical constructs in describing how cognitive instrumentals interpret and subjective norms influence usefulness and perceived intentions. Figure 8 depicts the TAM model.

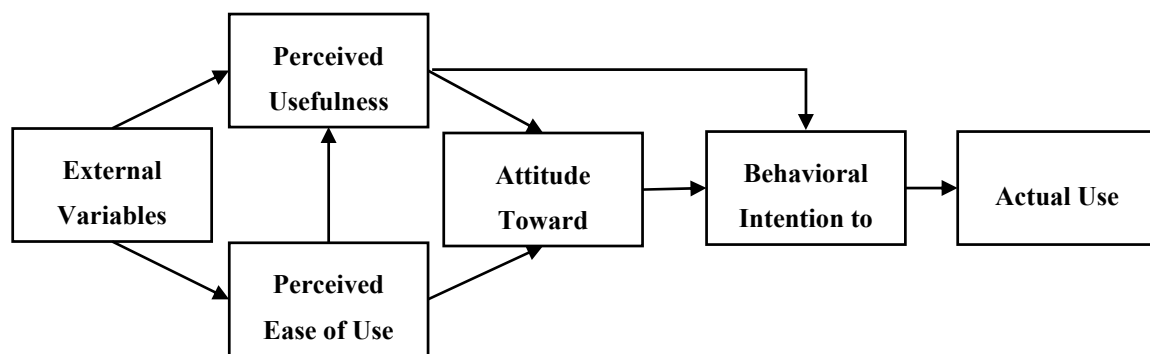


Figure 8. TAM model adopted from [71].

Figure 8 presents the TAM model and all variables, where a key variable in TAM is behavioral intent (BI), which influences the desired action to use the information system. The TAM model has been previously integrated with information system success by prior studies [72]. Additionally, TAM is a model that is suitable for new technology, based on the decision of how and why people adopt or reject a particular technology, which has been a prominent topic in the field of information systems [73]. Moreover, TAM is one of the most widely employed models used to examine innovation adoption. This model has been used in various studies to investigate the factors that affect the individual use of new technology [17]. Additionally, the TAM has been applied in various fields such as business intranets, text editors, and the Web [74]. In this study, the TAM cannot be adopted for the FEWRS, because this model has been used in various studies to examine the factors that can affect an individual's use of new technology [17,75], rather than successful implementation of information systems.

3.2.6. Unified Theory of Acceptance and Use of Technology (UTAUT)

The TAM is one of the most common and relevant models relating to technology use. This model was first developed by Davis in 1989 to explain the implications of predicting the propensity of users to accept and recognize an information system; later this theory was extended further by Venkatesh [76], calling the wider model, the unified theory of acceptance and use of technology (UTAUT), a more robust model. It attempts to find a common solution incorporating both perspectives on technology adoption [77,78]. The UTAUT is thus a recent extension demonstrating how emerging technology adoption works. Several new assemblies were developed to be taken into account, such as three new key variables, which are (1) facilitating condition, (2) effort expectancy, (3) performance expectancy, and (4) social influence, to find the factors that have a major and significant influence on the behavior or intention of individuals to adopt technologies. In addition, the extension of this model includes variables of experience, gender, image, and voluntariness of use, as moderators in the particular relationship. Figure 9 shows the UTAUT model.

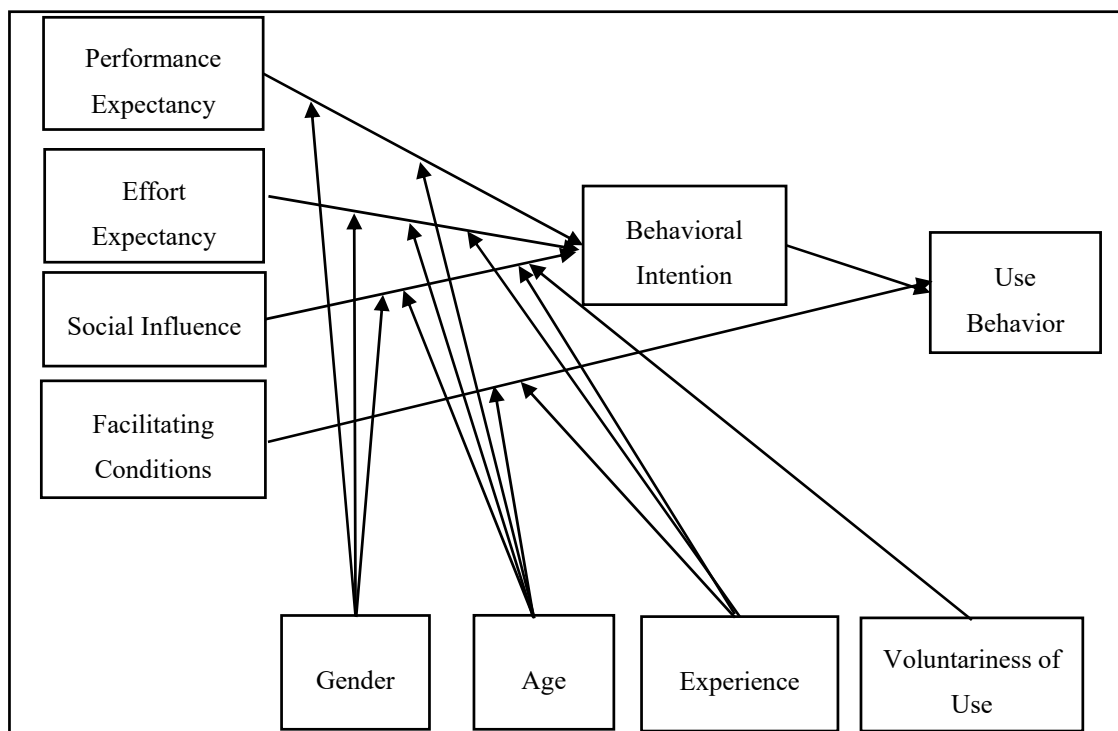


Figure 9. Unified theory of acceptance and use of technology (UTAUT).

3.2.7. Unified Theory of Acceptance and Use of Technology (UTAUT2)

Understanding the use of information technology and individual acceptance is among the most immature sources of research into information systems. There were several theoretical models, derived mainly from psychological and sociological theories [76], employed to clarify acceptance and use of the technology. A study and synthesis of eight theories/models of the use of technology led to UTAUT. UTAUT has distilled the essential factors and contingencies associated with predicting behavioral intention to use technology in organizational contexts. Thus, the UTAUT model was further extended to UTAUT2 as a comprehensive theoretical model, which explains the adoption and use of technology well, as shown in Figure 10.

3.2.8. Diffusion of Innovation (DOI)

Diffusion of innovation (DOI) was developed by E.M. Rogers, as one of the oldest theories in social science, in 1962 [79]. This concept emerged from communication to describe how an idea or commodity gains traction over time and diffuses through a specific population or social network. Rogers proposed that diffusion is the mechanism by which the participants in a social network transmit an idea over time [80]. The DOI premise is that four main factors influence the dissemination of a new idea. These factors are (a) an innovation to be disseminated, (b) communication channels, (c) time, and (d) a social system.

The roots of innovation theory's diffusion vary and span across many disciplines. DOI is attempting to clarify how, why, and at what pace new ideas and technologies are spreading. It is one of the theories that help to understand how eco-innovations are diffused. The theory focuses on the mechanism and circumstances by which technologies and ideas within larger social networks are diffused and embraced by users. The pace at which an innovation is adopted, according to Rogers [79], is highly dependent on the nature of the invention or its attributes. Rogers claims that there are five main features of innovations that affect their adoption rates: (1) complexity, (2) observability, (3) relative advantage, (4) trialability, and (5) compatibility [79], as shown in Figure 11.

Relative advantage refers to “the degree to which an innovation is perceived as better than the idea it supersedes”; however, compatibility is used to define “the degree to which innovation is perceived to be compatible with existing principles, past experiences, and potential adopters’ needs”. Trialability refers to “the extent to which an invention can be experimented with on a limited basis”, and complexity refers to “the extent to which an invention is considered to be difficult to understand and to use”. Rogers defines the last attribute of innovation, observability, as “the degree to which the effects of an invention are noticeable to others” [79]. What is interesting about these five qualities is the relationship between the successful propagation of innovation and the beliefs, norms, expectations, and behaviors of the community. Based on the five characteristics listed above, it is obvious how much an invention relies on its culture, system, or organization to be successfully implemented. The theoretical basis for diffusion has been studied in various disciplines, including agriculture, industry, healthcare, anthropology, sociology, and education, to investigate how change takes place within an organization, system, or society, the pace of change, and the motivation for such change [48]. The limitation of the DOI is that, although it offers a structure for evaluating innovation, it does not answer the management implementation issues in full [81].

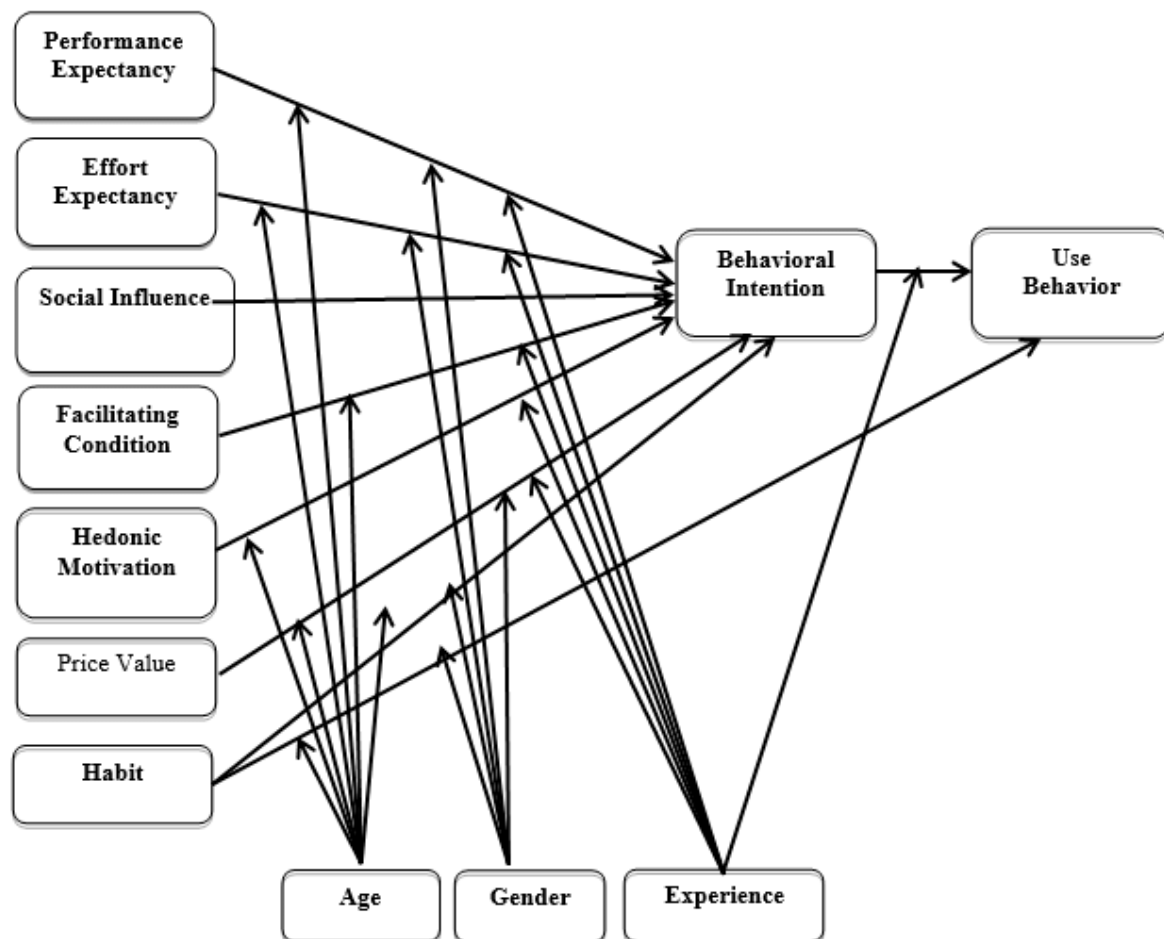


Figure 10. Unified theory of acceptance and use of technology (UTAUT2).

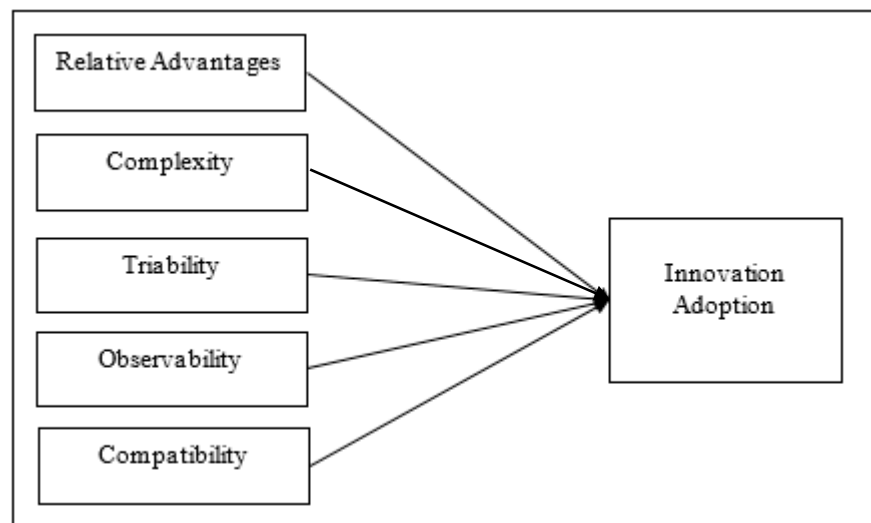


Figure 11. Diffusion of innovation theory.

4. Related Works

This sub-section reviews other studies that adopted information systems success models (ISSM) from different contexts such as in education, construction project management [82], e-government [83], healthcare [84], e-learning [17], e-commerce [85], and e-filing [86].

Accordingly, Table 1 depicts the review of models and theories employed by previous researchers in the information system success domain. A few studies were selected after being filtered by PRISMA criteria, which include studies that clearly mention information system success, studies that have empirical findings, and lastly, studies that were published between the years of 2014 to 2019. Thus, Table 1 shows that most studies adopted the D&M success model in many IS fields [51]. However, no studies explored the factors that affect the success of FEWRS.

Findings from Table 1 suggest that the D&M model is the most widely employed model, a recorded in 28 studies (39%) as shown in Figure 12. Further description of the 28 studies indicates that the D&M model was either adopted alone, such as in [83,87,88], or integrated with other theories [17,86,89]. Additionally, results from Figure 12 suggest the D&M model has been applied alone 39% of the time and extended 29% of the time; in total, 68% of the time, the D&M model has been applied either alone or extended in the ISS domain. Moreover, 22% of the time it has been integrated with other theories, such as TAM or TOE. For example, Lee et al. [90] examined the IS success model for disaster management, finding that system quality and information quality are major barriers to successful multi-agency decision-making and are a crucial background to IS effectiveness for efficient disaster management. Chen [91] evaluated emergency management engineering IS success factors based on the D&M model of the IS and found that five crucial performance factors are strongly related: internal management of the enterprise, product quality and supplier infrastructure, external technological climate, external policy climate, and information center collaboration and support capability.

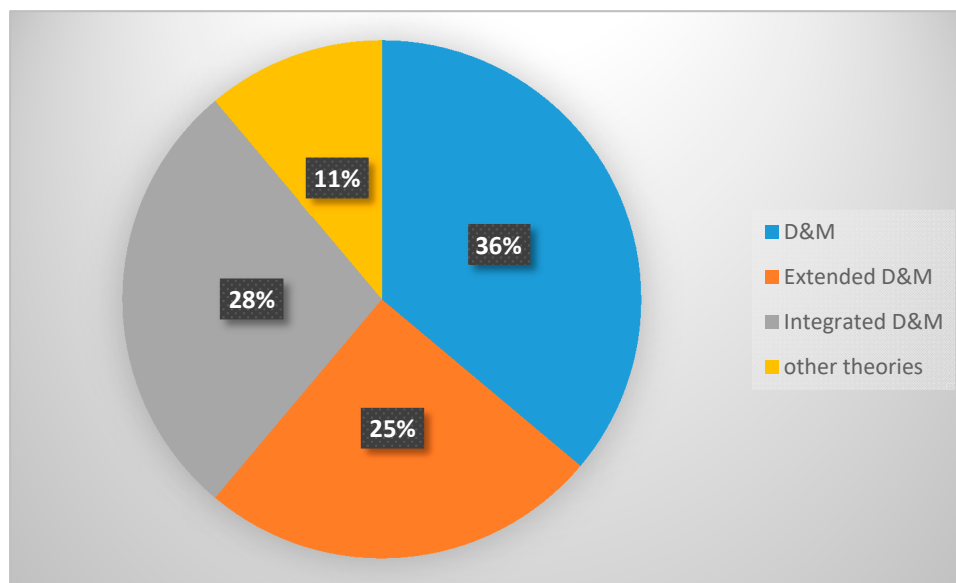


Figure 12. Top models used in ISS domain.

Table 1. Models and theories used on ISS domain (2014–2019).

| Author(s) | Model/Theory | Method | Purpose |
|-----------|--|-----------------------------|--|
| [18] | D&M Success Model | Quantitative, questionnaire | Evaluated the performance of a newly developed EMR-based information system by examining the changes in satisfaction scores for twelve KPIs. |
| [21] | Extended D&M Success Model | Quantitative, questionnaire | Examined the mediation role of transformational leadership in the D&M information system success model among students. |
| [92] | D&M Success Model | Quantitative, questionnaire | Examined the factors that prevent electronics records management system adoption and the relationships among them, as well as successful ERMS adoption among higher professional education institutions. |
| [72] | D&M Success Model, TAM, and UTAUT | Quantitative, questionnaire | Tested the conceptual model for predicting intention to use an information system as part of D&M information system success framework. |
| [93] | D&M Success Model, TAM, and UTAUT | Quantitative, questionnaire | Integrated TAM, UTAUT, and D&M model to provide proper antecedents for intention to use. |
| [85] | D&M Success Model, commitment–trust theory | Quantitative, questionnaire | Advanced the understanding of the success of e-commerce websites from a holistic perspective by integrating technical, transactional, and relational perspectives. |
| [86] | D&M Success Model, TAM, TPB | Quantitative, questionnaire | Utilized electronic tax-filing system using data from emerging nations. |
| [94] | D&M Success Model and new IT quality | Quantitative, questionnaire | Explained the relationship between the new IT application and educational equality. |
| [17] | Integrated D&M Success Model and TAM | Quantitative, questionnaire | Exploited the effect of usability towards use of e-learning. |

Table 1. Cont.

| Author(s) | Model/Theory | Method | Purpose |
|-----------|---|---|---|
| [95] | Extended D&M Success Model | Quantitative, questionnaire | Trusted technology, trust in e-government in online tax filing system. |
| [96] | D&M Success Model and TAM | Quantitative, questionnaire | Examined the determinants of students' acceptance and satisfaction with blended learning in higher education. |
| [97] | Extended D&M Success Model | Quantitative, questionnaire | Examined the success of e-learning systems in the Tanzanian higher education context. |
| [98] | Extended D&M Success Model | Quantitative, questionnaire | Examined the antecedents of repurchase intention in online group-buying |
| [99] | Knowledge Repository Systems (KRS) model | Quantitative, questionnaire | Prepared a model to evaluate the success of technology applied to handle knowledge management in the use of a knowledge management system. |
| [100] | D&M Success Model | Quantitative, questionnaire | Enhanced the applicability of the DeLone and McLean IS success model in a new IS service in performing art industry. |
| [101] | D&M Success Model | Quantitative, questionnaire | Explored IS success theory in the context of reverse logistics (RL), qualify and motivate information quality improvement efforts and investment in emerging IS technologies to support RL functions. |
| [102] | D&M Success Model | Quantitative, questionnaire and pilot study | Carried out sequential revisions of an information system (IS) project framework across the research model development and its examinations. |
| [103] | D&M Success Model | Quantitative, questionnaire | Validated success factor perception disparity among system developers and two different system users. |
| [104] | Cloud delivery model | Quantitative, questionnaire | Examined the effect of relational, managerial, and technical IT-based capabilities on cloud computing success. |
| [82] | D&M Success Model | Quantitative, questionnaire | Explored state of an IS project success and to examine factors which affect the success. |
| [84] | hospital information systems (HISs) success | Quantitative, questionnaire | Assessed the success or failure of hospital information systems (HISs). |
| [87] | D&M Success Model | Quantitative, questionnaire | Tested the level of quality based on three variables; system quality, information quality, and service quality towards the intention of academic information system's users. |
| [105] | D&M Success Model | Quantitative, questionnaire | Understand mobile-tourism acceptance and usage. |
| [89] | D&M Success Model and TAM | Quantitative, questionnaire | Developed a tool for assessing the success of a web-based information system and evaluate it experimentally. |
| [88] | D&M Success Model | Quantitative, questionnaire | Examined the effectiveness of information technology in reducing corruption in China. |

Table 1. Cont.

| Author(s) | Model/Theory | Method | Purpose |
|-----------|---|-----------------------------|--|
| [106] | D&M Success Model, network externalities, and flow theory | Quantitative, questionnaire | Identified factors affecting continuance intention of mobile social networking service SNS. |
| [107] | D&M Success Model, KANO | Quantitative, questionnaire | Developed a set of priority of user requirements that can improve user satisfaction. |
| [108] | D&M Success Model, expectancy confirmation theory | Quantitative, questionnaire | Validated an integrated model of e-filing continuance usage. |
| [109] | D&M Success Model | Quantitative, questionnaire | Examined learner infrastructure capabilities into the field of information systems success. |
| [83] | D&M Success Model | Quantitative, questionnaire | Validated the user context of e government especially in the G2B system. |
| [20] | D&M Success Model | Quantitative, questionnaire | Develop a theoretical model of electronic word-of-mouth (eWOM) for the homestay lodging |
| [110] | D&M Success Model, TPB | Quantitative, questionnaire | Develop a new theoretical model to understand public perceptions about data science |
| [111] | D&M Success Model, Flow Theory, Expanded Information System Expectation-Confirmation Model (IS-ECM) | Quantitative, questionnaire | Propose a model for the continuous use intention of IOLEs that may contribute to the continuous use intention of MS Office IOLEs by students in higher education |
| [112] | D&M Success Model, TAM, Motivational Model (MM), Social Cognitive Theory (SCT), and Cultural Dimension Theory (CDT) | Quantitative, questionnaire | Integrated model to identify significant factors predicting tertiary students' mobile technology adoption intentions for student lecturer interactions. |
| [113] | Extended D&M Success Model | Quantitative, questionnaire | Provides a theoretical and empirical argument to measure travel website evaluation from a holistic point of view |
| [114] | Extended D&M Success Model | Quantitative, questionnaire | Developed for the evaluation of the success of the IS for small and medium enterprises (SME) |

5. Discussion

This research aims to assist management and others responsible for running the existing system to assess how well the system works or does not operate to the satisfaction of users. This would also help them move forward with what should be considered before, during, and after an information system is implemented. Therefore, the management of companies may implement more efficient approaches with very small budgets to achieve decision efficacy, productivity, and transparency of decisions [5]. Implementing every information system is expensive, in addition to the effort and time needed for its development. The IS scholars are also trying to recognize the variables that impact any system or technology's performance and efficacy to ensure its success. To better understand the performance and effectiveness of such systems, these factors need to be combined into one model. To achieve this goal, many IS theories/models have been evolved. Such theories include the D&M IS success model [51], DOI [79], and TAM [53]. Theories in other areas have been applied to measure the success of ISs; these theories include TPB, TRA, TOE, and UTAUT. Results show that D&M is the most suitable model to ensure the success of FEWRS measures. However, there is a lack of studies that employed FEWRS in managements' information systems domain.

Systematic literature reviews were carried out in this report. The systematic analysis refers to the examination of performance models that used the D&M as the key theoretical

construct. In all, 31 research papers were collected and analyzed critically. Items obtained are classified as follows: model/theory, methods, and purpose. Further description of the 28 studies indicates that the D&M was either adopted alone, such as in [83,87,88], or integrated with other theories [17,86,89]. Results suggest that in 36% of studies, the D&M model has been applied alone, in 25% of studies, it has been extended, and in 28% of studies, it has been integrated with other theories such as TAM, TOE, DOI, and TPB. In total, in 89% of studies, the D&M model has been applied either alone, integrated, or extended in the IS success domain. For example, Lee, Bharosa [90] examined the IS success model for disaster management, finding that system quality and information quality are major barriers to successful multi-agency decision-making and are a crucial background to IS effectiveness for effective and efficient disaster management. Chen [91] evaluated emergency management engineering IS success factors based on the D&M of the IS and found that five crucial performance factors are strongly related: internal management of the enterprise, product quality and supplier infrastructure, external technological climate, external policy climate, and information center collaboration and support capability.

D&M has undergone a number of improvements and upgrades in terms of FEWRS IS, which in effect has led to the efficient adoption of FEWRS [5]; such improvements and changes were typically achieved through either contextual or external factors expanding the model. Identifying the factors that affect FEWRS' success remains one of the ongoing and important issues highlighted by IS academics. To this end, extending the D&M to include other factors is still an open door for IS scholars to further boost the effectiveness of FEWRS [115,116].

6. Implications of the Study

Currently, existing FEWRS do not successfully and effectively provide information on flood disasters to reduce the impacts at the local level. However, prior studies argued that IS implementation success or failure depends heavily on performance level and user acceptance. Measuring IS success also remains a top concern for managers, researchers, and practitioners. Therefore, it necessary to identify and specify the factors that determine the success of FEWRS to mitigate flood disasters. Findings shows that the model of D&M has been adapted and extended in many fields of research, because it is mainly focused on effectiveness and success of the system, rather than on user acceptance of new technology like TAM or UTAUT.

7. Conclusions and Future Direction

Flood is one of the natural disasters that affects areas extensively due to frequent rainfall, which results in loss of lives and properties, and socio-economic damage. This study has systematically reviewed the models of IS success to investigate the factors that influence the success of FEWRS. Thus, the FEWRS is an important element to be considered in addressing flood mitigation management in support of employment's performance. There are few studies that investigate the factors that influence the flood success of FEWRS. Thus, this research fills the gap in exploring the models that can be adopted to assess the success and effectiveness of FEWRS for flood mitigation and management. Moreover, FEWRS ensures that all stakeholders receive the right information and are provided with the necessary response and action information to reduce the loss of lives and properties during flood disaster.

Findings of this research revealed that the D&M model is most used among the IS theories and models, as it is able to accommodate the identified factors to be considered in mitigating flood disaster in support of employee performance.

Furthermore, this study has reviewed IS theories and frameworks such as D&M, TAM, UTAUT, TOE, TPB, TRA, and DOI to find the most used theory that can be adopted in the FEWRS model in support of the employment's performance.

This research contains potential limitations. For this analysis, the evaluations of IS models are focused on the year 2014–2020. As such, the empirical findings are limited to a

given period of time. Based on the results of this study, the creation of a model that can be used for FEWRS based on the success factors discussed in this research will improve future research. Finally, in the future, the results of this review could help researchers develop a FEWRS model based on the most important factors identified from this report; the model may help improve the performance of flood disaster information management under a limited budget and increase transparency, effectiveness, decision making, and efficiency.

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