Towards Utilizing Cloud Health Information Systems: A Proposed Model

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Abstract: It is commonly perceived that the value of healthcare services constantly increases in developing and developed countries to which healthcare providers are currently becoming more challenging. Consequently, taking on advanced health information systems to reduce healthcare cost and improve overall health quality is imminent in countries that are still in service utilization stage like Iraq. This as a result, led researchers to consider the potential of cloud computing as a prominent technological solution for providing the necessary platform for health information technology services to be transformed and managed over the internet. This allows the healthcare professionals to access, manage and retrieve patient’s health records in a reliable and flexible way. However, cloud computing has also introduced a set of challenges in healthcare contexts which varied from one country to another depending on its current technological state and resources. The researchers shed light on these challenges in the present study by surveying the literature about the current antecedents that may face the Iraqi health sector to utilize cloud health information systems. The literature showed that using other models is not recommended as it implies different needs that make it difficult to fit certain cultural or geographical conditions as it in Iraq. As a result, this research proposed a model of utilizing cloud health information systems in Iraq. The organizational structure and system factors have been investigated as the main antecedents that may affect the perception of the healthcare professionals (individuals) towards utilizing cloud services in their hospitals.

Key words: Health information system, health informatics, cloud computing, cloud health information system and model, commonly perceived, healthcare services constantly

INTRODUCTION

Health information systems are mainly implemented in the health sectors to provide sufficient assistance for public services, research activities and teaching. The applications involving effective computing in the health sector make it easy for healthcare professionals to monitor and manage patient’s health records anytime (Fernandez-Cardenosa et al., 2012; Hatch and Culliffe, 2013). As for the situation in the Iraqi healthcare sector, Hameed et al. (2015) identified the present issues faced by the health sector in Iraq in order to provide the medical management services because of the inappropriate technology utilization in which no information sharing procedure is executed.

The cloud computing considered as a fresh technology utilized in healthcare sectors in order to be able to manage, maintain and retrieve health records. This is back to its features that let the healthcare professionals access patient’s records anytime anywhere in order to monitor their health status. Furthermore, the cloud services utilization in health information systems can offer an alternative way to share the health records among hospitals and the activities within hospitals as well. Therefore, Movafaghi et al. suggested full physical cloud computing techniques utilization to improve the effectiveness as well as the performance related to cyber physical services in Iraq.

According to Kadhim and Hasan (2017), the Iraqi healthcare members poses a negative perception regarding the current technologies effectiveness in managing as well as maintaining a huge volume of health-related records in a timely manner. Additionally, they identified the lack of accessibility to effective computing in order to assist healthcare professionals in carrying out several activities associated with records sharing and retrieving.

However, as the revolutionary for providing novel methods of delivering and implementing as well as running services is a must be, certainly, there appears that there is limited understanding of the low usage of these services in developing countries (Sant’Anna et al.,
This could be due to the dynamic configuration of cloud-computing that provides a utility computing which includes various functionalities that are generally used to help to manage organization records in a distributed, ubiquitous and pervasive methods supporting many platforms, systems and software applications at independent areas.

The absence of understanding the current healthcare status to be able to deploy technologies would make it challenging to utilize new health information systems in terms of scaling, low cost and dynamicity. In addition, the current Iraqi situation tends to make it harder to adopt a specific technology without earlier suitability examination in the usage context (Abdullah and Hassan, 2015). Moreover, the level of understanding of the workers considered low, since, it is a fresh technology in Iraq (Ghani et al., 2016). On top of that, health records in the Iraqi public hospitals consist of various kinds of data that keep increasing in volume, velocity and also variety progressively. This led to several major issues from two perspectives, low IT integrity and data complexity. For that reason, it is important for the health institutions to manage and maintain these health records. Hence, cloud computing services can be utilized to supply a reliable service for managing and maintaining health records.

Reviewing the literature revealed that the majority of previous models developed to assess the cloud utilization in health were limited to certain countries (Hsieh, 2015; Lai and Wang, 2015; Lian et al., 2014; Lian, 2017; Ratnam and Dominic, 2014; Zhang and Liu, 2010). This can be due to different environmental needs and structural variation which varies from one country to another.

The reason behind devoting to the applications of cloud computing in this research are the expensive software cost, inflexibility and complexity issues of the traditional EHR (Electronic Health Records). As a result, this raises the need for making use of an inexpensive service that provides the health sector a flexible solution for managing and maintaining health data remotely. Furthermore, the Iraqi public health sector depends on its own computing infrastructure. Thus, the data resides on-premises which puts it under environmental and human threats altogether.

As a result, guaranteeing a successful cloud computing utilization in the context of healthcare requires careful awareness to numerous factors from various perspectives that could include technological IT factors, organization characteristics that introduces the particular technology as well as the individual’s response (within the organization) to the new technical tools (Li et al., 2013).

MATERIALS AND METHODS

In this study, literature survey has carried out in order to gather related information needed to determine successful determinants in utilizing cloud health information system for the Iraqi public healthcare sector. In addition, to review the related theories needed to construct the proposed model of this study.

Theoretical understanding: The construction of the study model is supported by three main theories named the organizational theory, diffusion of innovation theory and the theory of reasoned action. The researcher's review of the literature revealed that these theories could be used to explain the association between the organization structure, system and individual factors for utilizing cloud computing services in the Iraqi healthcare sector.

The organizational theory consists of four main components that are assumed to influence the environment. These are culture, organization structure, technology and social structure. Hatch and Cunliffe (2013) stated that knowledge distributed throughout the organization has the potential to influence the individual's ability to work as well as the consequent outcomes which are usually identified through environmental settings such as physical structure, social structure, technology and culture as displayed in Fig. 1. Therefore, comprehending these aspect's effects throughout the organization theory will help describe the existing lack of technology and structure within Iraqi hospitals to utilize cloud computing services. In general, organization improvement and change are essential elements associated with human resources and require a deep

![Fig. 1: Organization theory (Hatch and Cunliffe, 2013)](image-url)
understanding of organizing and organizations, the theory of organization can deliver the contents with regard to executive training courses. Hatcher and Cunliffe (2013) highlighted the communication effects on organizational perspectives in order to conduct efficient learning or managing tools to be able to design effective communication systems or to deliver an appropriate mean of the network that reflects an organization's needs. This is somehow seen to be relevant to the network capability that an organization may offer to its individuals.

Since, this study is mostly emphasized on organizational structure and technological one, the researchers have considered its relation to the present study's factors. The relationship between the environment and organizational structure is perceived to be an essential component for promoting one's behavior. Meanwhile, the association between organizational structure and changes in one's behavior has been addressed to influence individual's use of technology. As such, it is assumed that a lack of structural organization can cause the healthcare sector in Iraq to pose low coordination which may result from the inefficient use of resources along with the lack of response to internal and external environmental changes. On the other hand, the Diffusion of Innovation Theory (DOI) by Rogers (2010) is also used here to explain how a certain utilization of technology can drive one's adoption and use of that technology. It explores the way of exchanging ideas among individuals in an organization or others. This theory can be used to emphasize how cloud computing services adoption is caused by the interaction among healthcare members through interpersonal networks. It is assumed that innovation from utilizing technology is typically carried through the communication of several channels in the social system based on solid relationships between individuals (leadership attitude toward change), internal organizational structure (centralization, interconnectedness, complexity, number of employees and organizational slack) and external characteristics (system openness) of an organization. Figure 2 shows the DOI Theory.

In Fig. 3, the components of Theory of Reasoned Action (TRA) that was originally developed in the field of social psychology by Ajzen and Fishbein (1980) which explains how individual's behavior is driven by the function of their intentions to use or adapt technology. The theory was constructed based on the views of many previous scholars like Ajzen and Fishbein (1973, 1977) to help us understand people's attitude toward the behavior when using. In this study, the researchers considered the role of this theory in associating healthcare member's behavioral control to their behavioral beliefs and adoption of health information system based cloud. This is mostly evident from the role of TRA in
Fig. 4: Illustration of the theoretical model

regulating individual’s behavioral changes to construct the normative beliefs and the motivation to comply with the offered services. According to Madden et al. (1992), in the event that an individual perceives his/her outcome of behaviour is positive from certain use, then it can be said that his/her behavioral control will be also positive towards performing that behaviour. However, this is not the case when the behaviour is negative. The positive behaviour therefore is strongly associated with the amount of control an individual process that accrues the required sense of motivation to meet the expectation of the task.

Based on these theories, the researchers constructed the understanding of the relationships between research variables. The effect of system and organization structure factors on healthcare professional’s behaviour to utilize cloud health information systems was examined in this study. Hence, the research theoretical model is shown in Fig. 4.

Model’s variables: This study demonstrates the variables used to formulate the proposed model and its relation to the context of this study.

Cost effectiveness: Cost effectiveness refers to the assessment of emerging new technologies, on a one-by-one basis (Jena and Philipson, 2009). The initial review of the literature showed that cost effectiveness has almost always been addressed as a key factor in studies that are concern about technology adoption (Laupacis et al., 1992). For new adoption and use of technology in an organization, it is evident that partial integration of technology can be costly and often unaffordable (Jena and Philipson, 2013). Thus, it is expected that user’s perceptions of the low cost of health information systems based cloud computing services will positively affect their perceived confirmation and behavioural control to the actual use of it.

Hardware modularity: Is one of the commonly discussed organizational elements that affect environment adoption and use of technology in which Byrd and Turner (2001) highlighted its importance in providing a flexible IT infrastructure that can be flexible to change in order to suit the evolving needs of the organization. On the other hand, ensuring a sufficient hardware modularity in an organization is assumed to improve the scalability of healthcare applications by embedding the necessary machines to develop and debug various health related issues from a single department to multiple one (Sharif, 2014). As such, providing healthcare members with the sufficient hardware equipment may significantly contribute to increasing their confirmation of its effectiveness in managing and communicating medical data across departments (Halilovic and Cicic, 2013). Confirmation is defined as the degree to which user’s expectations of using technology were consistent with their experiences (Stone and Baker-Eveleth, 2013) which influence user’s continuance intention to use technology (Oghuma et al., 2016). Hsu and Lin (2015) stated that perceived user confirmation of service usage is mostly corresponding to the environmental components that would typically stimulate the intention to utilize and use technology. This concern was further examined by Susanto et al. (2016) to which they annotated the role of environmental structure which involves available resources in promoting user’s confirmation to continue use in the future. Meanwhile, previous studies have also
explored the impact of hardware modularity state to provide the necessary control for users to manage and perform their tasks. Perceived control refers to the personal belief about the extent to which one perceives the environment to provide the necessary elements to control the task in a certain situation (Skinner, 1996). The literature showed that perceived control of environmental elements is commonly used to shape and assimilate specific theories of control such as locus of control, self-efficacy and self-competence (Hajli and Lin, 2016).

Software modularity: It is evident from the literature that software modularity is an essential measure for reducing connectivity between program parts which in turn reduces code complexity. The process involved in performing multiple tasks in a system is somehow relevant to the modularity of the design of a process development and comprehensibility (Gershenson et al., 2003). Sant’Anna et al. (2007) addressed the importance of software modularity in allowing individuals to run and use technology. Modularity of software represents the standardization of units for flexibility and variety when use (Melton and Tempero, 2007). Earlier studies addressed the association between software modularity and individual usage behaviour with regard to the complexity and capacity of the available resources. For instance, Sun et al. (2015) stated that having up-to-date software can help the organization to maintain proper utilization of technology based on its IT infrastructure flexibility which conforming to the way that applications can be reconfigured with minimal effort. On the other hand, Green et al. (2004) highlighted the link between software modularity in terms of quality, productivity and repeatable processes in altering individual’s control of the main process. From these, it can be concluded that software may significantly contribute to individual’s reaction to utilize cloud health information systems. Furthermore, the lack of studies of software modularity effect on healthcare professionals in Iraq was one of the key motivation for the researchers in this study to consider it.

Internet network: The internet connection is the main aspect that shapes a network within the organization. The literature revealed that most developing countries are still facing internet related challenges due to the poor telecommunication capabilities and the erratic power supply (Lawrence and Tar, 2010). This led us to conclude that applying and utilizing advanced technology in most developing countries is not an easy task which can be reasoned to the lack of network infrastructure, especially among government institutions, people and technology vendors. Thus, the success of cloud health information systems in Iraq can be said to rely on a number of technology infrastructures. Network in this study represents the telecommunication infrastructures needed to link various health departments and users within states and country. However, the limited access to adequate basic infrastructure made it difficult for healthcare members to communicate and share medical data across departments (Aziz et al., 2009). This as a result, led the researchers in the present work to consider the role of the network in driving healthcare member’s utilization of cloud health information systems. In most developing countries, unreliable connections to the network would result in limiting internet bandwidths offered by many internet providers with consequent low connections. Here, the researchers define the network as a computer service that facilitates the exchange of data and information from one place to another. It presents the availability and capability of internet to allow person manage and modify data through different channels. After all, it is evident from the literature that quality of the network is one of the critical factors affecting a new technology adoption (Schultz and Orlikowski, 2004). Previous studies like Hall and McCauley (1987) stated that organization should consider the network quality when it comes to adopting computer network. This assumption was also supported by Steinbart and Nath (1992) who suggested that computer network is a key element that drives the management of an organization. According to Chih-Chien et al. (2005), the network may positively influence user’s usage experience because of its role in shaping IT usage decisions. In addition, current views of the network in facilitating IT-related utilizations are primarily looked at as a mean to provide users with the measures for increased job efficiency in the workplace.

Training availability: The key goals of utilizing telemedicine in most developing countries are to establish the necessary antecedents of telehealth tools and technologies in order to help promote the delivery of healthcare services to the population using telecommunication technology (Alpay and Russell, 2002). This includes increasing healthcare member’s access and control of medical data and to provide training of healthcare providers. Previous studies repeatedly elaborated the role of training and available resources in driving one’s decision to utilize services (Elley et al., 2008; Mantovani et al., 2003; Safie and Aljunid, 2013). Hence, it can be said that training is one of the key drivers for cloud health information systems to which it may offer the means to effectively use services among telehealth members including patients, healthcare services providers.
and physicians (Ackerman et al., 2010). Training is identified as the available resources that organization provides for individuals to attain the knowledge required to operate and use technology (Fetersome et al., 2016). Previous studies asserted that allowing members to learn the technical knowledge usually requires from an organization to adapt a complex innovation. According to Venkatesh and Speier (2000), training availability can affect one’s perception about technology use. Chau and Hu (2002) addressed the importance of providing the resources (including training) to make use of telemedicine technology in patient care and management. This was also supported by Bello et al. (2004) who stated that lack of structured training and computer accessibility may contribute to the poor knowledge of IT among healthcare professionals. In addition, training quality may positively influence healthcare member’s control of technology especially when interactive tutorials and sufficient support are given to them (Almier et al., 2004). Moreover, Lee (2010) asserted that lack of training resources in an organization would negatively impact user’s confirmation of their own technological expectations.

**Compatibility:** Rogers (2004) stated that compatibility of a system refers to how the current system fits the individual’s existing values, previous practices and current needs. In the context of this study, we defined compatibility as the degree to which the cloud health information system is consistent with healthcare professional’s work practices or preferences. The research in this study argues that determining the fit of health information system and individual’s needs are essential for shaping their usage behaviour of the system. However, system compatibility as a key facilitator in the Iraqi healthcare organization was not adequately examined. Yet, it is unclear which critical functionality of cloud health information system can facilitate healthcare professional tasks and which design can best fit their needs. As such, it can be stated that healthcare professional would appreciate the main elements of a health information system to their job’s characteristics which is more likely to be perceived as an enabler of their utilization of it. Wu et al. (2013) addressed the difference between application functionality and compatibility is that compatibility provides an organization with the required elements to process information. Along with this the literature showed that compatibility is an important aspect to consider when examining new technology adoption (Roberts and Wilson, 2002; Wu et al., 2013). Wu et al. (2007) stated that the compatibility of health information system significantly influences acceptance of healthcare professionals. This aspect was supported by Hung et al. (2014) to which they found that system compatibility is the first facilitator to shape a positive IT attitude and usage behaviour.

**Complexity:** Oliveira et al. (2014) defined the complexity of the system as the extent to which the new technology is perceived to be relatively difficult to understand and use. It is evident from the literature that utilizing cloud services in healthcare domain may results in some challenging to those who are lack technological expertise and IT specialists (Ifinedo, 2011; Thiesse et al., 2011). This is because the easier it is to integrate cloud health information systems into Iraqi healthcare sectors, the greater the chance of its utilization. In addition, healthcare professional perception of system’s complexity is significantly relevant to the personal ability to pool resources instantaneously to achieve a certain task. However, the complexity of new functions and services in the cloud health information system can be challenging to a healthcare professional that lack technological expertise and IT specialists. The impact of system characteristics has been widely recognized in system and technology user acceptance research. Previous studies considered examining aspects related to the efficiency of data transfer, system functionality, interface design and system capacity as the main determinants of system’s complexity. According to Nor and Pearson (2007), the complexity of a system is associated mostly how an individual perceives technology to be relevant to self-experience. In addition, it is correlated with user’s mental efforts necessary to use a system. This may positively influence user’s control of the task and actions when processing medical data. As such, system complexity can be considered as the key criterion when making the decision to utilize cloud health information systems. Nwankpa (2015) asserted that complexity of a system depends on the user’s ability to optimize the usage of the system which may be obscured by the system know-how of end-users and the quality of expertise. On the other hand, the complexity and uniqueness of the system may results in additional behavioural challenges for users to effectively interface with the system (Ellram et al., 1999). This can be due to the direct impact of system complexity on one’s expectations and preferences of services.

**Data security:** The ongoing increase in utilizing new technologies in healthcare practices has resulted in modulating the conventional ways of dealing with patient information (Vincent et al., 2016). In today’s healthcare practices, healthcare professionals with multiple privileges want to have access to patient information on any device.
at any time in the cloud. As such, the importance of security of data in a cloud environment has been extensively discussed recently in many studies. Kong et al. (2013) carried out a literature survey to document the importance of security concerns to users usage and utilization of cloud computing. On the other hand, Lallmahmood (2015) described security as a threat which results in a condition sufficient to cause damage to network, resources or data in different formats. This includes security threats of destruction, disclosure, modification of data, denial of service and/or fraud, waste and abuse. Such threats are typically stimulated by outsiders or insiders when communicating or accessing the internal network, the communication channel or the user’s personal computer (Bellekens et al., 2016; Lake et al., 2014). With cloud computing serving as a convergence of storage and computing in a shared multi-user environment, security concerns, therefore are more feasible (Li et al., 2013). In most developing countries, security concerns are always ranked high (Thulani et al., 2009). From a health perspective, Tieu et al. (2015) stated that users of electronic health systems may not necessarily trust the applied security measures including the ability of outsiders and other healthcare professional to access their health information. This may positively affect their confirmation of expectation towards the healthcare system to which scholars like Vincent et al. (2016) addressed the featured security threats faced by users of health systems in cloud environment. These are illegitimate access, operation error, unauthorized modification, unavailability of process/services, information without guarantee of origin and denial of actions. Hence, the role of data security in promoting healthcare professional’s utilization of cloud information system was studied.

**Data privacy:** Privacy, a major impediment to the use of healthcare systems as acknowledged by many previous studies (Sajid and Abbas, 2016) which represents the control of medical data between the healthcare professional and others. Privacy concerns are typically associated with the security of information which mainly involves unauthorized access by external entities to which it poses one of the biggest challenges for eHealth systems. This concern was discussed in different developed and developing countries as the major challenge in allowing healthcare professional to access other patient’s data. In the context of the healthcare sector, medical data privacy is seen as healthcare professional’s claim to what extent, information about them and patients is communicated to others. Socamou et al. (2015) stated that the privacy of medical data may positively impact the way healthcare professionals perceive the system to be sufficient and usable for sensitive medical cases. This perception is believed to drive healthcare professional’s confirmation and perceived control of a system. Hence, previous studies recommended examining data privacy concerns when it comes to technology utilization in healthcare settings (Sahi et al., 2016).

**Confirmation:** Bhattacharjee (2001) identified confirmation as the perception of the congruence between expectation to use new technology and its actual performance. Confirmation is an important factor that describes one’s cognitive belief derived from prior use of technology which can influence subsequent technology use through other environmental factors. Roca et al. (2006) stated that expectation-confirmation can predict individual’s utilization of technology. According to Sorebo et al. (2009), the confirmation of individual’s expectation towards service or feature can be associated with his/her usage experience to the extent that favorable characteristics would positively drive the utilization and adoption. Larsen et al. (2009) explained how user’s confirmation of a technology can promote their motivation to continue use it with regards to other environmental and personal characteristics. In addition, previous studies showed the direct association between user’s behavioural confirmation of certain technology with their acceptance and utilization of a system (Lin and Wang, 2012). Brown et al. (2012) highlighted that negative disconfirmation will have a greater negative impact on outcome evaluations than positive disconfirmation to the extent that user may not likely use or utilize technology. Hence, the researchers in this study considered the ultimate role of expectation confirmation of healthcare professionals in Iraqi hospitals on their utilization of cloud health information system.

**Behavioural control:** Behavioural control is closely related to the term self-efficacy and it includes the perception of control over the performance of a behaviour. It refers to the beliefs one may attain from the normative expectations of technological utilization to comply with normative beliefs which may facilitate performance of the behaviour for better control (Ajzen and Madden, 1986). Cloud health information systems may impose a certain level of complexity to which it becomes difficult for users to take the necessary actions in a certain situation that reflects the external locus of control over extraneous (Bhattacharjee et al., 2008). As such, it can be said that healthcare professionals may perceive the cloud information system to be irrelevant to
their experience and skills to effectively operate and use its services. Parikh and Verma (2002) asserted that in order for an organization to ensure a successful utilization of technology, it needs to ensure that user’s or members pose an adequate level of control to which lower control may result in dissatisfaction and reduces system usage. Hence, the organization needs to ensure that the system is accompanied by instructors to encourage and assess users in system use. As a result, the researchers decided to examine the role of different system related factors in regulating healthcare professional’s control of cloud health information system in Iraq.

**Utilization of cloud health information system:** Cloud computing after all has been addressed as a sufficient source for providing effective IT services to which the power of healthcare devices can be utilized more efficiently through highly scalable hardware and software resources. In addition, cloud health information system can provide a promising business agility by the mean of using competitive tools through rapid deployment, parallel batch processing that process and manage user’s requests in real time (Hatch and Cunliffe, 2013). Here, we studied how certain organization structure and system factors may contribute to the utilization of cloud health information system in Iraqi hospitals by embracing the ideas encapsulated in green computing, since, not only are the computing resources used more efficiently, but further, the computers can be physically located in geographical areas that have access to cheap electricity while their computing power can be accessed long distances away over the internet. However, the need to understand the limited use of cloud services in the Iraqi healthcare sectors was one of the main drivers in this study. Many studies stated that utilization of technology is the core factor that ensures organization stability based on the fit between the technology and the tasks it supported (Goodhue and Thompson, 1995; Jaber et al., 2014).

**RESULTS AND DISCUSSION**

The study model has been designed depending on the factors resulted from the literature survey and a preliminary study conducted using a qualitative interview as a way to assess the main determinants and micro factors that have an effect on individuals to utilize cloud health information systems in the Iraqi health sector (Kadhum and Hasan, 2017) (Fig. 5).

From the literature survey, it can be noted that most factors identified were within the healthcare context. Therefore, these factors must be taken into consideration; some of these factors are related to the organizational structure in terms of cost effectiveness, hardware modularity, software modularity, internet network and training availability. Another four factors are related to the system in terms of compatibility, complexity, data security and privacy. These two aspects are found to influence individual factors in terms of confirmation and behavioural control to utilize cloud health information

![Fig. 5: Research proposed model](image-url)
systems in the Iraqi public healthcare sector. In addition, the moderator effect of experience and age was reported to play a key factor in driving healthcare professional’s behavioural control and confirmation based on the organization structure and system settings as shown in Fig. 5.

This research proposed to help examine the main influencing factors that possess an effect on the healthcare professionals to utilize cloud health information systems in the Iraqi public healthcare sector. This study was prompted by a real need to examine the requirements, challenges and gaps in utilizing this new trend technology.

The proposed factors and domains can be seen relevant to the context of this study as it all supported by the previous literature. The construction of the study’s model was supported by three well-known theories in which the combination of domains and the relationship between factors was supported by organization theory, Diffusion of Innovation (DOI) Theory and the Theory of Reasoned Action (TRA).

This research is a part of PhD research. The proposed model will be validated in the next research study that will use a quantitative research method and developing a questionnaire instrument to collect the physicians and technicians’ feedback about the proposed factors and finally the collected data will be analyzed to verify the final model.

CONCLUSION

The construction of the study’s model is based on three well-known theories namely, organization theory, diffusion of innovation theory and the theory of reasoned action. This help to combine and verify the relationship and effects among the proposed factors and domains in the model.

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