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Research Article

Investigating Factors Affecting the Acceptance of M-Government Based on Fuzzy Cognitive Map in Iran

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Abstract

The increasing importance of communication and information in today's society has necessitated the use of cutting-edge technologies in the field. This research focuses on the adoption of mobile government services and aims to identify the needs and effective components for successfully providing government services through mobile platforms. By analyzing the causal structure underlying the adoption of mobile government, this study offers insights into the key factors that influence users' attitudes and behaviors towards these services. The research employs a descriptive-survey research method to collect data from experts in the field of information and communication technology as well as university professors. A total of 10 individuals were selected as the sample through a non-probability snowball sampling technique. The data collection process involved conducting semi-structured interviews, allowing for in-depth exploration of the participants' perspectives and insights. To analyze the collected data, the research utilizes the fuzzy cognitive mapping method and USINET software. Based on previous studies on mobile government success, this research identifies several dimensions that are crucial for the successful provision of government services through mobile platforms. These dimensions include Mobility, Localizability, Security, Perceived Value, Ease of Use, Awareness, Trust, Privacy, Social Influence, and Usefulness. By considering these dimensions, policymakers and service providers can better address the needs and expectations of mobile government users. The findings of the research highlight the significance of users' perceptions of usefulness and ease of use in shaping their attitudes towards adopting mobile government services. Therefore, it is essential for government agencies to prioritize these aspects in the design and implementation of mobile government initiatives.

Keywords: M-Government, FCM, Iran

1. Introduction

The world of telecommunications has been transitioning rapidly over the past decade with mobile technologies enabling data services (Siau and Zixing, 2003). Around the world, governments are promoting mobile government at an increasing rate. M-government is defined as the government providing services and information through mobile devices and wireless communication networks such as mobile phones, PDAs and their supporting systems to businesses, citizens, government employees and non-profit organizations(Alotaibi et al., 2017).

In mobile government, information and services are provided to stakeholders (such as employees, citizens, businesses and other organizations) through wireless technologies and mobile devices without time and place limitations (Ishmatova & Obi, 2009). Public smartphone applications have emerged as a new channel to provide public information services as a new form of technology and as an innovation towards a smarter government. For this reason, it is in the interest of every government to make its public services more efficient and accessible to users(Wirtz & Birkmeyer, 2018).

In this case, according to Trimi and Sheng, (2008), it is convenient for citizens to access government service information 24/7 in a timely manner. In addition, mobile government can provide personalized services to users, facilitate user participation and increase interaction between government and citizens (Trimi & Sheng, 2008). Kushchu and Kuscu (2003) stated that Mobile government is a new research area with respect to electronic government. There is no certainty whether it will replace electronic government or if it is an alternative access channel. While mobile devices are very suitable for access from anywhere, anytime, they are not suitable for complex and voluminous information transmission. In time, more sophisticated mobile devices such as PDAs, Blakberrry pagers emerged, however they do not have the same number of features and services as PC-based Internet applications. Citizens may see m-gov as the tip of an iceberg, because they see only the the final delivery channel to the citizen (Üstün, 2007). While e-gov is a very significant step for governments to close the digital divide, wireless access, adoption of mobility, and providing improved services via mobile technologies is now inevitable (Kushchu and Kuscu, 2003). Kushchu et al., (2007) stated that wireless access and adoption of mobility will not be only over Global System for Mobile communications operators but also be via wide area government networks.

Unfortunately, despite the advantages of mobile government, providing public services in most developing countries is still done in a paper-based way. This method is inefficient because it leads to problems such as paper wastage, data duplication, difficulty in accessing and managing data, and data loss (Nkohkwo & Islam, 2013).

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According to the United Nations e-Government survey, in 2022, Iran is in the high level of the e-Government Development Index (EGDI) with a score of 0.6433. It has also ranked 91st among 129 countries. In addition, Iran's online service index (OSI) is equal to 0.4196 and the electronic telecommunication infrastructure index (TII) is equal to 0.73 . According to Mordor Intelligence, Across the Middle Eastern region, Iran has the largest population. Since the population is more, the demand for wireless telecom services will significantly grow. According to GSMA, the smartphone adoption rate in the country was 69% in 2021, and it is expected to reach 76% in 2026 . The Mobile cellular subscriptions (per 100 people) in Iran from 1960 to 2020 is presented in chart number 1. The growing trend is clearly visible in the chart. However, e-government and mobile government in Iran are not yet developed enough, and most government services are provided traditionally by citizens' in-person visits.

In Iran, citizens still prefer traditional methods for transactions with government departments. Evidence shows that Iranian citizens have not yet fully embraced m-government. Therefore, the Iranian government can use these mobile devices to provide government services through applications. However, few m-government applications have actually been adopted in Iran. In fact, the use of m-government programs in Iran is still in its early stages. This study attempts to identify the causal structure of mobile government enablers that influence the development of government services through smartphones in Iran. In this study, fuzzy cognitive mapping is used to design this structure. It is expected that the results of this study will help the decision-makers in the field of smart government in successfully implementing these programs. To achieve this goal, the research is divided as follows:

The continuation of the article is as follows. Section 2 describes the literature and theoretical foundations of the subject. Section 3 discusses the methodology. Fuzzy cognitive mapping method is presented in section 4. Conclusions are presented in Section 5.

2. Literature Review

The advent of mobile technology has enabled the government to move from e-government to mobile government(Bakhshimazdeh & Alikhasi, 2015). Although m-Government is a subset of e-Government, it is possible that m-Government services may become more popular than e-Government services. Because unlike e-government, mobile government users can be literate or illiterate, privileged or unlicensed, and urban or rural people(Shareef,et al., 2014.)The promise of mobile government for greater access to government information is evolving in many developed and developing countries(Chen et al., 2016). Such improvements are primarily due to high subscription rates in developing countries, where mobile devices are part of most people's daily lives(Alwahaibi & Garfan, 2015). This modernization, driven by the accelerated technology industry, has changed the way citizens treat the government. They are no longer satisfied with the traditional way of providing services. Governments must be accountable, transparent and available 24 hours a day. Mobile government services are government services provided through the government mobile app or interactive SMS or government kiosks(Wang & Teo, 2020). Governments can use mobile services to inform citizens about emergencies (domestic security, fires, natural disasters). Today, the use of mobile technology in our lives is increasing rapidly(Almarashdeh & Alsmadi, 2017). Huda et al. (2023) examines the basic components for the person acknowledgment of m-government wellbeing administrations. They coordinates two hypothetical models TAM and ECM. Quantitative strategy was utilized to analyze information with PLS-SEM. The discoveries of this think about bolster all speculations. The study's discoveries appear that Seen Value Seen Simple to Utilize and Fulfillment essentially influence on Purposeful Utilize; Seen Convenience Seen Simple to Utilize and Desire Corroborative altogether influence on Fulfillment Seen Simple to Utilize features a critical impact on Seen Convenience. Desire affirmation altogether influenced Seen Value and seen ease of utilize (Huda 2023).Zhang et al. (2023) conducted a meta-analysis to look for imperative variables in m-government selection from 42 considers from 17 nations. Based on the socio-technical hypothesis this consider connected a meta-regression to clarify the contrasts within the impacts of these variables from the viewpoint of culture and specialized improvement level. The comes about appear that seen convenience seen ease of utilize state of mind social impact seen compatibility and believe all play vital parts in m-government selection. Culture and specialized advancement level play directing parts on the over connections but for the seen ease of use–perceived value way. Our discoveries too uncover that the joint directing impact of cultural and technical advancement level can better explain the effect of natural variables on m-government selection and subsequently give proposals for end of the usage of m-government completely different nations with different societies (Zhang et al. 2023). Sadik et al. (2023) assessed impacts of Innovation Availability and Hedonic Inspirations upon users' behavioral eagerly to acknowledge m-government administrations. A quantitative inquire about was conducted in Pakistan to decide the users'behavior. A add up to of 434 reactions were collected based upon stratified test collected from the common and government capitals of the nation. Basic Condition Modeling (SEM) was utilized to analyze the information. It was concluded that both Innovation Preparation and Hedonic Inspirations essentially influence users' behavioral eagerly to acknowledge m-government administrations. Besides Sexual orientation was distinguished as an arbitrator as it were between Innovation Availability and users' acknowledgment of m-governmental services (Sadik et al. 2023). Nusir (2022) The Innovation Acknowledgment Show (TAM) and the Bound together Hypothesis of Acknowledgment and Utilize of Innovation (UTAUT) were utilized to explore the effect of different variables on M-Government framework acknowledgment (Nusir 2022).Talukder et al. (2022)investigates the enablers and inhibitors of the

elderly's m-government benefit appropriation behavior. Four develops from the bound together hypothesis of acknowledgment and utilize of innovation (UTAUT) specifically execution hope exertion anticipation encouraging conditions social impact; and self-actualization are treated as enablers whereas client resistance to alter innovation uneasiness and declining physiological conditions are respected as inhibitors. Comes about appear that appropriation of m-government by the elderly is essentially impacted by all tried enablers and inhibitors but for social impact (Talukder et al. 2022).Inan et al. (2022) investigate points to explore versatile self-efficacy and individual innovativeness as inherent inspirations driving to the purposeful to receive the portable government. Self-Determination Hypothesis (SDT) comprising seen competence relatedness and independence is the foremost agent hypothetical focal point to depict this issue. A add up to of303 substantial respondents were collected to dissect encourage utilizing Fractional Slightest Square-Structural Condition Displaying (PLS-SEM). The discoveries uncover that both predecessors essentially influence the deliberate to receive m-gov. In spite of the fact that portable self-efficacy has no noteworthy impact on seen relatedness through and through the show accounted for 49% of the fluctuation in appropriation deliberate with seen ease of utilize contributing more to deliberate than the other builds (Inan et al. 2022). Mtingwi et al. (2018) examined the adoption framework of mobile government (M-government) for less developed countries. They used qualitative research using the philosophy of pragmatism, and descriptive and explanatory approaches to promote the presentation and understanding of research findings.Their results showed that the governments of less developed countries should use any current mobile technology to process information and provide services to the beneficiaries who own mobile devices.(Mtingwi et al., 2019). Saxena, (2017) investigated the strengthening of ICT infrastructure in public services on the adoption of mobile government. The findings showed that maintaining the privacy and confidentiality of personal information is critical to maintaining any e-government service. Acceptance of mobile government services by users is also a function of self-efficacy and awareness of users about government services. Isagah and Wimmer (2018) presented a framework for designing mobile government services in developing countries. The findings of this study identified a set of components that support the design of mobile government services in developing countries. This framework can be used in government agencies when designing mobile public services.(Isagah & Wimmer, 2017)(Isagah & Wimmer, 2018). Ahmad and Khalid (2017) investigated factors that predict end-users' intention to adopt mobile government services in a developing country. In this study, advanced statistical techniques were used to test the Technology Acceptance Model (TAM) by combining the determinants of trust, cost, social influence, variety of services, perceived usefulness in information technology, and demographic profiles. The findings showed that trust and social influence are positively related to end-users' intention to adopt mutual government services in the UAE(Ahmad & Khalid, 2017) Alotaibi et al. (2016) investigated potential factors affecting the acceptance of many government services in Saudi Arabia. To examine the relationships between external factors and behavioral intention to use (BIU) in the TAM model, they conducted a qualitative study using semi-structured interviews. The results of this qualitative study also showed that enjoyment does not affect the acceptance of central government services in Saudi Arabia.(Alotaibi et al., 2016) Abaza and Saif (2015) in a study titled Adoption of Mobile Government Services in Developing Countries showed that despite the importance of mobile government, few developing countries have successfully used it. The results of this study have shown that perceived usefulness, compatibility, awareness, social influence, and face interactions significantly contribute to the prediction of intention to use mobile government (Abaza & Saif, 2015). Table 1 shows many studies on mobile government.

Table 1
Some studies m-government

author	method	subject
Huda et al. (2023)	Survey method	Mobile Government Services, Developing Countries
Zhang et al. (2023)	meta-analysis	citizens' adoption, m-government
Sadik et al. (2023)	Survey method	COVID-19 pandemic, m-government, technology readiness
Nusir (2022)		Mobile-Government, citizens' cultures and attitudes
Talukder et al. (2022)	Survey method	m-government services, younger citizens, elderly
Inan et al. (2022)	Partial Least Square-Structural Equation Modelling	mobile self-efficacy, mobile government adoption, personal innovativeness
Mtingwi et al. (2018)	Square-Structural Equation Modelling	Least Developed Countries (LDCs), mobile self-efficacy, Mobile government
Isagah and Wimmer (2018)	Survey method	m-government design, developing countries
Ahmad and Khalid (2017)	Structural equation modeling	Technology acceptance model (TAM), M-Government services
Alotaibi et al. (2016)	thematic analysis	M-government, TAM model
Abaza and Saif (2015)	survey method	Mobile government , youth
Peresnt study	FCM	mobile government ,Fuzzy Cognitive Map

3. Research process

The current research is based on the purpose of the applied development type and in terms of data collection, it is descriptive-survey type. The statistical population of

the current research is experts in the field of information and communication technology and university professors, and their number is 10 people, and the selected sample was made non-probably and with the snowball method, and a semi-structured interview was used to collect data. In this research, indicators were extracted based on previous studies on mobile government success, and the fuzzy cognitive map creation method and USINET software were used.

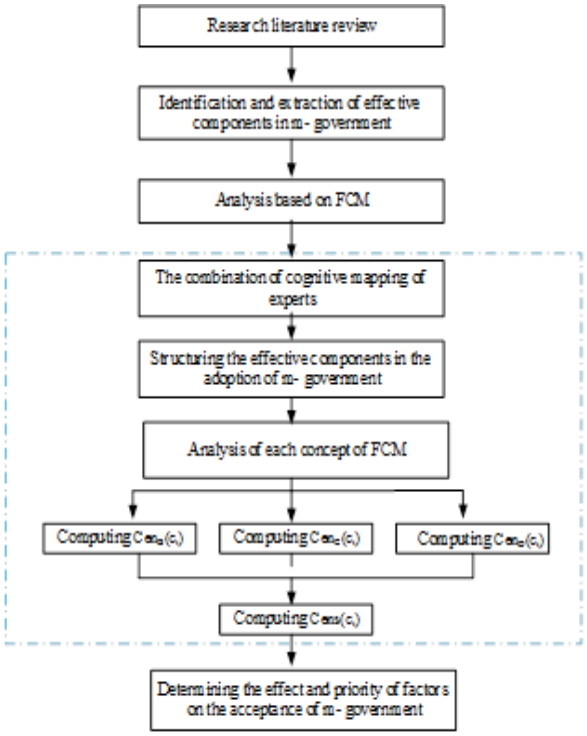

Fig .1. The framework of research

4. Fuzzy Cognitive Mapping

The concept of cognitive mapping was first introduced and used by Axelrod, a political scientist, in 1976 (Rodriguez-Respio, Stechi and Salmeron, 2007). Cognitive mapping is a method that is used in many research fields including medicine, environment, engineering sciences, economics and management. This method, which is included in the soft methods of operations research, is a powerful tool in system simulations. In addition to being a useful method for problem solving, cognitive mapping helps decision-makers analyze hidden causal relationships and facilitates reaching the desired solution. The cognitive map is a combination of nodes that represent the most important factors of the decision-making environment, in addition to this cognitive mapping, it provides the possibility of identifying different causal relationships between the nodes. From this point of view, cognitive maps can be considered as a type of model that have specific rules for their expansion and their main feature is defining a hierarchical structure for decision-making issues. Fuzzy Cognitive Mapping (FCM) is a method for modeling complex systems using existing knowledge and expert experience. FCM is a method for representing knowledge of systems characterized by uncertainty and complex processes (Pappageorgiou Salmeron, 2014). An FCM can be considered a cognitive diagram that describes the behavior of a physical system in terms of nodes and edges connected to them.(Felix et al., 2019)

These maps were developed by Casco as a result of the expansion of cognitive maps and belong to the class of fuzzy neural systems that can incorporate human knowledge and use it in line with learning procedures. Fuzzy cognitive maps are designed by experts during an interactive knowledge acquisition procedure. The FCM model includes a number of concepts that show how the elements related to a phenomenon affect each other by defining the causal relationship between those concepts. Fuzzy cognitive mapping, like other cognitive maps, originated from George Kelly's theory. Fuzzy cognitive mapping is a directed and balanced graph that represents the relationship between nodes. Nodes express the concepts or variables describing the system's behavior and balanced directed edges also indicate the causal relationship between the nodes.

4.1. Extracting individual and social cognitive maps

After identifying and extracting the effective variables or components in the problem, first the individual cognitive maps of the experts are obtained. The cognitive aspects of each of the experts can be extracted in different ways, including interviews or distribution of questionnaires. In this article, according to the initial identification of the variables through the study of research literature, through the distribution of questionnaires among experts and obtaining their opinions about The type and degree of relationship between the components were extracted. In this regard, and to determine the degree of causal relationship between the components, five fuzzy spectrums (M_1 to M_5) have been used according to the table below. Fuzzy linguistic values were converted into quantitative and definite values using the method provided by Gita and Sekar..(Geetha &Sekar ,2017)

Table 2
Determining the degree of causal relationship between variables

Fuzzy linguistic expressions	**Descriptive meaning**	**Definitive Quantities**
M_1	Component i has no effect on j	0.115
M_2	Component i has little effect on j	0.295
M_3	Component i has a moderate effect on j	0.495
M_4	Component i has a great influence on j	0.695
M_5	Component i has a great impact on j	0.895

We define the membership functions of fuzzy variables as follows:

$$\mu_{M_1}(x) = \begin{cases} 1 & x = 0 \\ \dfrac{0.3 - x}{0.3} & 0 \le x \le 0.3 \end{cases} \quad (1)$$

$$\mu_{M_2}(x) = \begin{cases} \dfrac{x - 0}{0.3} & 0 \le x \le 0.3 \\ \dfrac{0.5 - x}{0.2} & 0.3 \le x \le 0.5 \end{cases} \quad (2)$$

$$\mu_{M_3}(x) = \begin{cases} \dfrac{x - 0.3}{0.2} & 0.3 \le x \le 0.5 \\ \dfrac{0.7 - x}{0.2} & 0.5 \le x \le 0.7 \end{cases} \quad (3)$$

$$\mu_{M_4}(x) = \begin{cases} \dfrac{x - 0.5}{0.2} & 0.5 \le x \le 0.7 \\ \dfrac{1 - x}{0.3} & 0.7 \le x \le 1 \end{cases} \quad (4)$$

$$\mu_{M_5}(x) = \begin{cases} \dfrac{x - 0.7}{0.3} & 0.7 \le x \le 1 \\ 1 & x = 1 \end{cases} \quad (5)$$

After extracting individual maps, the next step is to consolidate them and extract the consensus map of experts. For this purpose, the data related to fuzzy cognitive mapping is displayed as an N×N matrix. By using the aggregate mapping method, consensus mapping is obtained by calculating the average matrix of individual mappings. If a_a_{ij}^k is the mapping domain of the k-th expert regarding the relationship between component i and component j and is used in the opinion of M experts, the consensus mapping domains are obtained using the following relationship:

$$e_{ij} = \frac{\sum_{k=1}^{k=M} a_{ij}^k}{M} \quad (6)$$

One of the other topics in fuzzy cognitive mapping is related to analyzing nodes and concepts and calculating the effectiveness of each concept in the problem structure. For this purpose, we use the concept of credit weight of nodes and degree of centrality and central conformity index to analyze nodes and identify the most effective node.

Central conformity index ($Cen_{cons}(c_i)$) from the sum of three indicators of degree of centrality ($cen_D(c_i)$), closeness degree ($cen_C(c_i)$) and intermediate degree ($cen_B(c_i)$) is obtained and we have:

$$Cen_{cons}(c_i) = Cen_D(c_i) + Cen_C(c_i) + Cen_B(c_i) \quad (7)$$

$$cen_D(c_i) = id(c_i) + od(c_i) \quad (8)$$

$$id(c_i) = \sum_{j=1}^{N} |e_{ji}| \quad (9)$$

$$od(c_i) = \sum_{j=1}^{N} |e_{ij}| \quad (10)$$

where id(c_i) is the input degree of node c_i and $od(c_i)$ is the output degree of node c_i and we also have:

$$Cen_B(c_i) = \sum_{i \ne s \ne t} \frac{\sigma_{st}(c_i)}{\sigma_{st}} \quad (11)$$

where σ_{st} represents the number of the shortest path between s and t and s and $\sigma_{st}(c_i)$ represents the number of the shortest path between two nodes s and t that passes through $\sigma_{st}(c_i)$ and so we have:

$$Cen_C(c_i) = \frac{1}{\sum d(c_i, t)} \quad (12)$$

where $d(c_i, t)$ is the shortest path between two nodes t and c_i in the fuzzy mapping structure.

According to the power matrix, a column chart has been drawn for the factors.

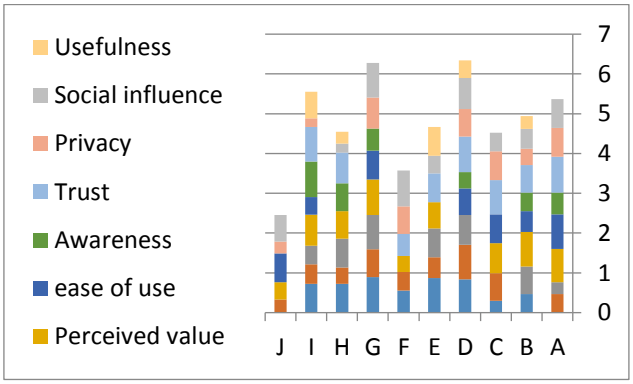

Fig. 2. Column chart of factors

Next, to obtain the structure of the causal relationships, combined individual mappings and collective mappings were created. Collective cognitive mapping with the shape (2) was obtained using netdraw software and through the average opinions of experts.

To determine the effectiveness of each component in the causal structure of mobile government empowerment, the credit weight of each component was calculated. For this purpose, by using ucinet software, the 1-2-3-4 relationships of the degrees of closeness, betweenness and centrality of each component were calculated. The results of data analysis are presented in table (2).

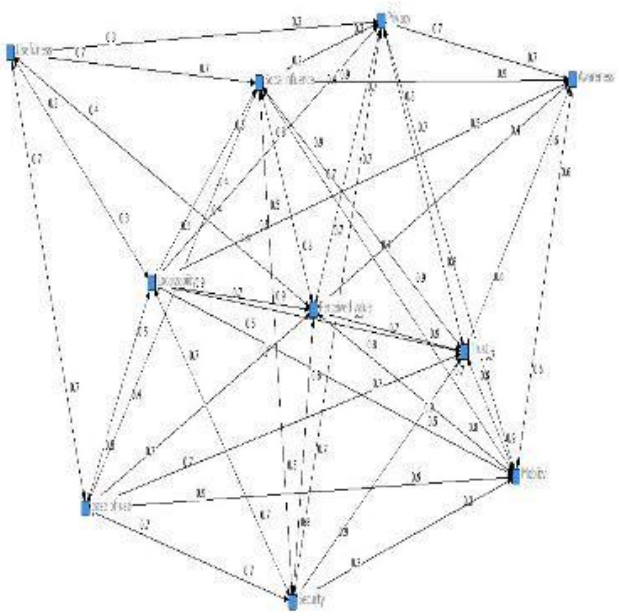

Fig. 3. Collective cognitive mapping of experts

Table 2
Ranking of fuzzy cognitive map variables based on centrality index

No	Indicator	Closeness	Betweenness	Degree centrality	Consensus centrality measur
1	Mobility	10	0.51	12.68	23.19
2	Localizability	9	1.36	12.54	22.9
3	Security	11	0.14	11.8	22.94
4	Perceived value	9	1.36	10.72	21.08
5	ease of use	11	0.60	9.88	21.48
6	Awareness	12	0.00	9.32	21.32
7	Trust	10	0.51	9.08	19.59
8	Privacy	10	1.01	9.04	20.05
9	Social influence	9	1.36	7.12	17.48
10	Usefulness	13	0.14	4.9	18.04

5. Conclusion

The increasing importance of communication and information has required using the latest achievements in technologies related to this field, including mobile data services. In this research, the needs of mobile government users in the country were identified. Mobility, Localizability, security, perceived value, ease of use, Awareness, Trust, Privacy, Social influence and Usefulness are the most important dimensions in successfully providing government services to the country's users. Due to the fact that government services are provided to citizens at different levels, it is necessary to pay close attention to the interaction capability of the levels. If the users consider mobile government services as useful and easy services, they will have a positive attitude towards using them. Fuzzy cognitive mapping, as one of the methods developed in the framework of soft operations research, can structure the complex and ambiguous nature of issues in the form of causal relationships. Fuzzy cognitive mapping also provides the capability of quantitative problem analysis for decision makers and policymakers Fuzzy cognitive mapping is considered as a useful methodology in various scientific fields, including modeling and decision making. However, the decision-making capabilities of fuzzy cognitive mapping have been used less. In this research, relying on the capabilities of cognitive phase mapping technique in problem modeling and decision-making, the effective components in the adoption of mobile government have been analyzed. Based on the results of the data analysis, based on the causal structure of the empowerment of the mobile government, the components of Mobility, Security.

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