

## **Review Paper: Security in E-government Using Fuzzy Methods**

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### ***Abstract***

*In the recent years, Governments around the world are embracing the digital revolution to enhance services for their citizens. Government services are provided using electronic media anywhere and anytime. One of the most important issues in e-government is the security. E-government security is considered one of the crucial factors for achieving an advanced stage of e-government. As the number of e-government services introduced to the user increases, a higher level of e-government security is required. A several number of Artificial Intelligence (AI) techniques have been proposed for this purpose; fuzzy considered as the dominant approaches in this area. This paper, firstly, presents reviews and discusses the comparison between variant fuzzy-based techniques. This paper has concluded that; Fuzzy set theory is very useful for evaluation of e-government security.*

**Keywords:** *E-government, Security, fuzzy techniques*

### **1. Introduction**

Developments in Information Technology (IT) are changing all aspects of society. One of the main aspects of a society is its public services and government. This technological revolution also has enabled the introduction of new services, better and faster delivery of existing services, cheaper and more effective communications between different parties. Nearly all developed nations now regard developing e-government as a key strategy for ensuring their success in the 21st century, and are rapidly implementing major initiatives in this area. E-government presents challenges and opportunities to transform both the operational process of government, and the nature of governance itself. It has impacts on all government functions and agencies, the private sector, and civil society. In the long term, it has the potential to positively change the way government operates, and how citizens and businesses interact with government. Therefore, there is need to set policy and regulation to implement e-government successfully and to be able to protect the data and information against threats and vulnerabilities.

According to the aim of our research, this paper is structured as follows. First, definitions of e-government are presented in Section 2. In Section 3 the benefit of successful implementation of e-government is stated. In Section 4 the e-government security. In Section 5 Literature review. In Section 6 introductions to Fuzzy numbers. In Section 7 application of fuzzy on e-government security. In Section 8 comparative discussions. In Section 9 conclusions.

## 2. Definition

Information and Communication Technologies (ICT) are transforming the governmental processes for serving citizens (G2C), businesses (G2B) and governments (G2G). There are many definitions for e-government in the literature. ZHANG Bo-ping has defined e-government as: "E-government is a special application area as an information network. It involves large number of confidential data and information, its role is to enable citizens to access government services any time and any place through media "[1]. Another definition by Shahkooch and Abdollahi [2] have defined e-government as; "E-government is use of information technology to provide better and faster online services in addition to information for citizens, businesses and employees by government"[2]. Zhiyuan Fang defined e-government as "E-government is a way for governments to use the most innovative information and communication technologies, particularly web-based Internet applications, to provide citizens and businesses with more convenient access to government information and services, to improve the quality of the services and to provide greater opportunities to participate in democratic institutions and processes"[4]. The transformation of information using electronic media this lead to improving services quality, reducing cost and decrease the corruption. A popular definition published by Salahuddin Alfawaz, Lauren May and Kavooos Mohanak [3], their definition is; "E-government can be defined as government use of information technologies in order to communicate externally in the public sector (with citizens and businesses) and internally (with other government departments)".

From the above definitions, it can be concluded that all researchers are agreed that the e-government is the use of Information and Communication Technology "ICT" to transfer the government services from manual services to electronic services.

## 3. The Benefits of Successful of e-government

The benefit of e-government for citizens are; increasing satisfactions, citizen's convenience and independence, saving their time, effort, and cost. There are many factors impact on the success of e-government in any country, below are the two most important factors [3];

- Characteristic of the country.
- Social culture.

The private and public sectors are affected by external factors such as economic and political authorities. However, developing a successful e-government provides the following benefits [5]:

### 3.1. Deliver Electronic and Integrated Public Services.

More than just offering services online instead of inline, organizations can provide added-value and integrated services. Instead of visiting several different offices, or several different web sites, to obtain a government permit, citizens and businesses can complete all transactions from a single point of access (one-stop portal), available 24 hours a day, 7 days a week.

### **3.2. Bridge the Digital Divide.**

Governments can help to make access to new technologies that are available to the less fortunate in society as well as provide computer literacy education, especially to the young and elderly people.

### **3.3. Achieve Lifelong Learning.**

The concept that education does not end when a person finished school can be realized through the widespread of e-learning. An ensuing society of knowledge workers will continue to access sophisticated and personalized education tools online.

### **3.4. Rebuild Government-customer Relationship.**

Rather than providing services in a uniform way to all citizens, governments can use new technologies to treat citizens as individuals and provide personalized services. Citizens become more in charge of their relationship with government and re-gain their trust and confidence in the public sector.

### **3.5. Foster Economic Development.**

Governments can help businesses to move online and assists them to use online tools. By being online, businesses can leverage the advantages of being local, such as being close to customers, while they grow and spread out their markets worldwide. It also helps to develop local skills and increase employment prospects.

### **3.6. Create a more Participative Form of Government.**

Ultimately, e-government can lead to direct democracy. For instance, at the local level, municipalities can support online debates, discussion forums and Internet voting to inform the decision making processes.

Also there are several benefits of e-government such as: improved quality of information supply, reduced work process time, fewer administrative burdens, reduce corruption, improve service level, increase customer satisfactions.

## **4. E-government Security**

The concept of an e-government system is to provide access to government services anywhere at any time over open networks. The public sector is increasingly relying on information and communication technology (ICT) to deliver information and services to constituents. But the rise of e-government also lead to unintended security implications and new vulnerability to cyber threat .To face these challenges, government around the world must develop effective cyber security strategies. One of the crucial and growing issues for the near future of e-government is the security of information infrastructure and government information application. Security issues are found to affect public services management [4]. Trust on e-government plays a significant role to increase efficiency and effectiveness on transparent information flow between governments business and citizens. Therefore, security controls is one of key

factors for achieving an advanced phase of e-government for national development.

Security is traditionally concerned with information properties of confidentiality, integrity and availability [6]. These properties support services such as user authentication, authorization, accountability and reliability. The issues of security and privacy in the management of the information systems are guided by these properties. There is need to consider these issues in designing e-government security system [10].

E-government services have different level of sensitivity and they should be accessed through multiple authentication and authorizations methods, the system of e-government security can be applied to any government architecture with minor adjustments. The challenges in e-government services' security include identifying users, authenticating users, storing public and classified information in same websites, checking authorizations, auditing, signing transactions, resolving conflicts, keeping copies of information etc. Hence e-government security systems should be able to meet the following requirements, should provide multiple authentication methods, authorization, credential issuance and revocation, audit, confidentiality, conflict resolution, accountability, availability, platform independent, privacy, information integrity, anonymity, scalability, single sign on and so on.

Many authors argue that an information security management system (ISMS) consists of many aspects such as policies, standards, guidelines, codes of practice, technology, human issues, legal and ethical issues. model of information systems (IS) research is widely known and discussed in the information system management literature. The model distinguishes between three information system environments (user, IS development, and IS operations environments) and three information system processes (use, development, and operations processes)[3]. The environments component defines the resources and constraints that dictate the scope and form of information systems and IS processes. There are many threats that affect on e-government security such as: modification of data, transaction access network, and denial of service attack, theft of information, unauthorized use of resource, spoofing or impersonation to gain unlawful access, viruses, malicious program, discloser, and destruction [8]. As mentioned before, the main aims of software security are the protection of the confidentiality, integrity, and availability of the information assets. In addition to, the resources that the software creates, stores, processes, or transmit, and the executing programs as well. That means, Users in a secure system should have reasonable anticipations that their data is protected against unauthorized access or modification, and data is still available. The Following are details about security attributes [14].

- **Confidentiality:** the information published by e- government is only for authorized users, which cannot be revealed to unauthorized users.
- **Integrity's:** the government information that is stored or maintained transmission cannot be modified.
- **Non-repudiation:** the e-government information cannot be denied
- **Controllability:** The dissemination of the Internet information can be controlled.
- **Efficiency:** is a measure of speed and cost or is getting all you're testing done in the shortest time possible with the least amount of resources,

- **Effectiveness:** it concern with high quality regardless of speed or is doing the job right. Efficiency means "doing the thing right," Effectiveness means "doing the right thing."
- **Vagueness:** the things is not clearly, precisely, or definitely expressed or stated or not precisely determined or known; uncertain.
- **Accuracy :**The state of being accurate; freedom from mistakes, this exemption arising from carefulness; exact conformity to truth, or to a rule or model; precision; exactness; nicety; correctness; as, the value of testimony depends on its accuracy.

The classification of barriers to e-Government, authors in the field have also outlined the challenges and obstacles associated with e-government. A classification system that organizes these obstacles and challenges into four distinct categories: technical, political, cultural, and legal. These four categories of obstacles and challenges are represented in an organizational chart reproduced below (Figure 2: Challenges and Obstacles in e-Government). In summary, the ability to provide security and privacy is not only a barrier to the successful adoption of e-government but is also a challenge and/or obstacle in terms of technical, political, cultural and legal issues. Therefore, security management within the context of e-government is a vital requirement for its successful implementation [12].



**Figure 1: Challenges and Obstacles in e-Government**

The public release of information must be released through the audit. The security challenge in e-government is internal vulnerability and external threat to deal with such problems. Researchers proposed the use of AI techniques to solve security problems. Bayesian Belief Networks also known as Belief Network are the probability analysis and graph theory, a product of the combination in 1985, which was firstly put forward by Judea Pearl. It is a processing model which simulates the uncertainty of the causal relationship in the reasoning process. It used in security e-government to evaluation methods for e-government security risk assessment and the simulation results point that using the Bayesian network assessment has the same effect with the assessment of the experts. The

algorithm is not only scientific and reasonable, but also be applied to the expert system to express the human being's knowledge [15]. The Bayesian Network is presented for uncertainty and complexity in the assessment process because is used for solves the uncertainty problems, the papers is only a preliminary attempt to evaluate e-government security risk assessment and the results point that using the Bayesian network assessment has the same effect with the assessment and also be applied to the expert system to express the human being's knowledge of the experts . Number of researchers have applied Genetic Neural Network algorithm in risk assessment, also Dang Luo et el have tackled the problem that the randomness of the initial weights and thresholds of the BP neural network lead to the low network calculation accuracy and a fall into the local solution of the network easily, and Defines a model of e-government evaluation of the site based on genetic neural network algorithm [16]. in this paper investigate and discuss the evaluation e-government websites and e-government website evaluation is complicated system engineering, with many subjective and objective factors affecting the evaluation. The purpose of e-government website evaluation is to provide a reliable basis for e-government construction decisions. This model has fast speed of convergence and the result of the evaluation model is reasonable and a kind of effective method of e-government website evaluation, and also provides a new way of thinking for evaluation on e-government websites.

And also Mehdi Fasanghari and Habibipour have proposed the use of Fuzzy Numbers [17] , This approach aims to assess the performance of e-government as the traditional models evaluate the performance of e-government is generally very subjective and imprecise. This research introduced a fuzzy TOPSIS technique for assessing the performance e-government. Lingual expressions, for example, are satisfied and fair, is not satisfied, and the natural representation of preference or provision. These characteristics indicate the applicability of fuzzy set theory in capturing the structure of decision-makers' preference.

Uncertainty is the obstacle of evaluation when experts present their opinions in vague information such as verbal language variables. To encounter this problem, fuzzy sets and its applications as fuzzy numbers can be used. And they used the traditional TOPSIS widely in ranking problems, therefore, the researchers proposed fuzzy TOPSIS to handle ranking problems , and they implement triangular fuzzy number for their method since the triangular number is easy to use and another reason for using triangular fuzzy numbers in fuzzy TOPSIS, modeling the decision makers opinion is intuitively easy through fuzzy triangular numbers where the information available is subjective and inaccurate . The main benefit of this method is that it can be used for qualitative and quantitative criteria. The results demonstrate that this model has the ability to be flexible and be applied in assessing the performance of e-government. In the next section we introduce the Fuzzy technique and its application in e-government security.

## 5. Literature Review

E-government can be defined as government use of information technologies in order to communicate externally in the public sector (with citizens "G2C" and businesses"G2B") and internally (with other government"G2G" and employee "G2E" departments) [11] . E-Government is usually presented as using IT to: (1) provide easy access to government information and services to citizens and business; (2) increase the quality of services, by increased speed, completeness and process efficiency; and (3) provide citizens with the opportunity to participate in different kinds of democratic processes [9]. The implementation of e-Government involves not only a profound transformation in the way government interacts with the governed but also the reinvention of its internal processes and

organization. E-Government concerns both internal and external use of IT, for internal administration as well as for external services E-government is focused on citizens, business community, government employees and other governments. Informational process is defined as one-way gathering of information. Communication, on the other hand, represents a two-way information exchange. Transaction is a transfer of objects or rights between two entities in communication process. Basic interaction models within e-Government are [7]:

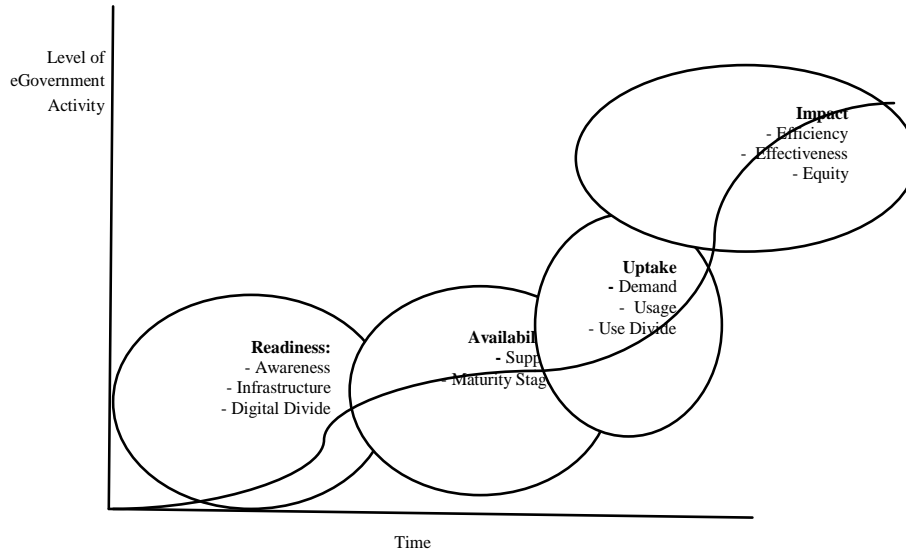
- Government-to-Citizen or Government-to-Customer (G2C).
- Government-to-Business (G2B).
- Government-to-Government (G2G), and
- Government-to-Employees (G2E).

Inside each of these models, the following activities are executed [7]:

- Sending information via Internet,
- Two-way communication between agency and citizens, companies or other government agencies,
- Transactions processing, and
- Management system activities.

The communication technologies, especially the Internet, have caused a big change, maybe even a revolution in day-to-day life and work. Today, a great number of transactions can be done online [5]. Some of them are used for paying taxes, changing your address of residence, or automatic registration. In order to conduct such transactions, it is necessary to connect the government with citizens, businesses, or some other social entities through the Internet. E-government, electronic government or online government presents a concept whose purpose is to allow access to governmental institutions through the Internet [7]. A different author gives measures for the level of e-government development. Articles on e-government in some leading countries have been published. A relationship model of e-government integration has been proposed arguing that the development of effective relationships between central government, individual government agencies and users of e-government services are critical to successful e-government integration. Those barriers show that both technical and non-technical issues should be considered when implementing e-government integration. One of technical measures of e-government is quality thus the example of technical quality: website loading time, availability 24/7, accessibility 24/7, security and privacy, navigation. Example of information quality: comprehensive, up to date, accuracy (accurate), clear to understand, relevant. One of the main objectives of e-government is to increase: citizen's convenience, task efficiency (save time and effort) [10].

There are some reasons for using internet for public sector some of them are to enhance efficiency, optimize service quality, maintaining successful outcomes, encouraging economic policy goals, bringing further improvement in agenda, and building trust relationship, etc.



**Fig 2: The Level of e-government Activity.**

## 6. Introductions to Fuzzy Numbers

### 6.1 Linguistics and Fuzzy Sets Theory

There are some situations in which information may be hard or even impossible to quantify due to its nature, and thus, it can only be expressed in linguistic terms (e.g., when evaluating the comfort or design of a car, terms like “good”, “fair”, “poor” can be used). In other cases, precise quantitative information cannot be provided because it is either unavailable or the cost for its computation is too high and an approximate value can be tolerated. Such qualitative information can be mathematically modeled through the use of Fuzzy Sets Theory. The latter handles fuzziness and represents qualitative aspects as linguistic variables, i.e. variables whose values are not numbers but words or sentences according to a natural or artificial language. More specifically, qualitative information expressed through linguistic terms (e.g. “low”, “medium”, “high”) can be converted to fuzzy numbers using a suitable conversion scale. Processing of the relevant information takes place using these fuzzy numbers, which are finally converted to crisp numbers through the process of defuzzification. Obviously, the same linguistic terms in different conversion scales can have different crisp values.

### 6.2 Fuzzy Numbers

The fuzzy sets theory, introduced by Zadeh (1965) as a means of dealing with vagueness, imprecision and uncertainty in problems, has been used as a modeling tool for complex systems that can be controlled by humans but are hard to define precisely. A fuzzy set is one that assigns grades of membership between 0 and 1 to objects using a particular membership function  $\mu_A(x)$ . The membership function of a triangular fuzzy number is defined by three real numbers, expressed as  $(l, m, u)$ , where  $l$  is the lower limit value,  $m$  is the most promising value and  $u$  is the upper limit value [13].



### 6.3 Defuzzification Methods

Defuzzification is the process of producing a quantifiable result in fuzzy logic; in other words the extraction of a crisp value that represents effectively a given fuzzy number .

## 7 .Application of Fuzzy on E-government Security

Using fuzzy in evaluation process is critical due to the security and lack of knowledge; researches have proposed the combination of fuzzy with other methods.

Jun Fei and Lihua Yu have proposed the use of fuzzy with AHP [18], this approach aims to evaluation of public satisfaction is essential to the construction of e-government. Evaluation models for public satisfaction and fulfillment are usually subjective and imprecise, and they used Fuzzy Analytic Hierarchy Process based on trapezoidal fuzzy numbers (FrFN) as the evaluation method to evaluating public satisfaction of e-government. in this paper fuzzy used because of the uncertainty and imprecision on subjective judgments of the decision-maker, and AHP seems to be insufficient and imprecise to capture the right judgments of decision maker combined together Fuzzy AHP, also used Fuzzy with AHP in this papers to develop a fuzzy multiple-attribute decision-making (FMADM) model for public satisfaction evaluation of e-government. The main benefits of this research are to be used for qualitative and quantitative benchmarks. From their results we can notice the model has the ability to be adaptable and implementable in the evaluation of e-government satisfaction. The fuzzy AHP technique can be expanded to a variety of evaluations such as human subjectivity.

And also Guangfu Wei ET el have proposed the use of Fuzzy AHP and Artificial Neural Network model [19] ,this paper firstly established a hierarchy structure index system for E-government information systems.

Security risk assessment based on the operationally critical threat, assets and vulnerability evaluation and also proposes a new security risk assessment method based on FAHP and ANN and this method is less time cost than only using ANN method without decreasing the accuracy of the result, and he used this index to assess e-government information system for evaluating an efficient and effective . We combine F-AHP with ANN to assess e-government security risk and this method can improve the efficiency and accuracy of the assessment process. In addition, we will improve the index system and assessment method gradually to make the assessment more accurate and efficient in the future research work.

.And also Irfan Syamsuddin and Junseok Hwang have proposed the use of A New Fuzzy MCDM Framework [6] Because of constant threats and vital to the security of information and one government , policy makers require to assess the information on the security strategy to bring reliable and e-government services. This research produced information security evaluation framework depend on novel fuzzy multi criteria decision making (MCDM) to assist policy makers to perform comprehensive evaluation of e-government security strategy. This research tries to introduce a holistic method from managerial decision making viewpoint by merging all relevant features of security to generate a framework used to assess e-government security plan. Fuzzy set theory is used to supplement the framework to handle fuzziness in the form of inconsistencies and vagueness coming from subjective judgments by decision makers.

.And also Markaki, Charilas and Askounis have proposed the use of Fuzzy Analytic Hierarchy Process [20] this approach develops an evaluation framework that overcomes the

problem of ambiguity by using triangular fuzzy numbers and also adopts Fuzzy Analytic Hierarchy Process. A fuzzy multiple attribute decision making approach, is used to evaluate the quality features of e-government websites. FAHP is implemented to offer a fuzzy weight for each features used in the selection procedure. Finally this approach may provide e-government administrators with a important reference for assessing the quality of e-Government implementation.

## 8. Comparative and Discussion

### 8.1. Comparative

In this section we demonstrate the results of comparison between five different approaches use Fuzzy techniques to evaluate e-government security. The criteria used in this evaluation are; effectiveness, efficiency, vagueness, accuracy, and inconsistency. In our comparative effectiveness refers to concern with high quality regardless of speed or is doing the job right. Efficiency means is a measure of speed and cost or is getting all you're testing done in the shortest time possible with the least amount of resources,, vagueness indicates the things is not clearly, precisely, or definitely expressed or stated or not precisely determined or known; uncertain. Accuracy represents The state of being accurate; freedom from mistakes, this exemption arising from carefulness; exact conformity to truth, or to a rule or model; precision; exactness; nicety; correctness; as, the value of testimony depends on its accuracy, and finally inconsistency is the fact or state of being inconsistent or an inconsistent element or an instance of being inconsistent. As illustrated in Table 1, if the feature is supported by the technique then it denoted by “Yes”, else it donated by “No”.

**Table 1: Table Illustrate the Comparison between the Techniques**

Criteria	effectiveness	efficiency	vagueness	Accuracy	inconsistency
Fuzzy AHP(2009-2010)	No	No	Yes	yes	No
Fuzzy AHP and Artificial Neural Network(2010)	Yes	Yes	Yes	No	Yes
Fuzzy numbers and statistics(2010)	No	Yes	Yes	No	Yes
A new fuzzy MCDM(2010)	No	No	Yes	No	Yes
Fuzzy Group Analytic Network Process(2011)	No	No	No	Yes	No

In Fuzzy AHP (2009-2010), there is lack of efficiency, effectiveness and inconsistency. The technique has a good accuracy rate and vagueness Fuzzy AHP and Artificial Neural Network (2010), there is lack of accuracy. The technique has a good efficiency, effectiveness, vagueness and inconsistency rate Fuzzy numbers and statistics (2010), there is lack of effectiveness, accuracy and inconsistency. The technique has a good efficiency and vagueness. A new fuzzy MCDM (2010). There is lack of efficiency, effectiveness and accuracy. The technique has a good vagueness and inconsistency. Fuzzy Group Analytic Network Process (2011), there is lack of efficiency, effectiveness, vagueness and inconsistency .The technique has a good accuracy rate [21].

Next section presents the result and discussion of the comparative between the five approaches.

## 8.2. Analysis and Discussion

In this paper we discuss the use of fuzzy techniques in approaches to evaluate of e-government security. It is clearly observed that, most approach combined Fuzzy with other technique. As mentioned before Fuzzy assists to overcome the problem of uncertainty that obstacle the evaluation when experts describe their views in unclear information such as vocal language. Fuzzy AHP demonstrated vagueness, accuracy and inconsistency. However, the method fails in evaluating the effectiveness and efficiency of e-government. While, the technique uses Fuzzy AHP and Artificial Neural Network, verifies vagueness, inconsistency, effectiveness and efficiency, but it needs more concern in the evaluation of the accuracy. The Fuzzy numbers and statistics method verifies vagueness, inconsistency and efficiency but also fail to evaluate accuracy, effectiveness and inconsistency. The new fuzzy MCDM takes care of vagueness and inconsistency, although it requires more concern to evaluate effectiveness, efficiency and accuracy. The Fuzzy Group Analytic Network Process verifies accuracy but needs to deeply concern about the performance.

## 9. Conclusion

Fuzzy logic has been widely used in real world especially in automation and process control, fuzzy logic is best solution and much appropriate for work with indefinite information. In context of evaluation the security of e-government and according to the criteria used, it was obviously observed that, policy makers require assessing the information on the security strategy to produce reliable and e-government services. In this paper we have investigated and reviewed the application of Fuzzy algorithms in the field of e-government security. A comparison between five approaches based on Fuzzy has been described, a result, and discussion has been presented. We conclude that there is need for new evaluation methods to obtain the good performance particularly in the evaluation of effectiveness and efficiency. Although the current approaches that use Fuzzy offers the opportunity to better evaluate security of the e-government, but still there is an effort required to come up with technique that satisfy the above discussed features. Our future work is focus on developing hybrid approach to ensure the effectiveness and efficiency of evaluation.

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