Introducing Comprehensive Software Quality Model for Evaluating and Development E-Government Websites in Jordan Using Fuzzy Analytical Hierarchy Process

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Abstract

E-government is a new principle, mainly employed to improve the processes of government to make it appear more efficient, responsive, and transparent. The processes reflect the way that both enterprises and citizens will ultimately interact with their government units as well as the way that government units effectively cooperate and communicate. Besides, the main goal of this contribution is to build a new quality model dedicated to evaluate E-government websites. In this work a comparative analysis has been done on existing software quality models. In this respect, a good number of quality models for evaluating e-government websites have been published. Each model is mainly intended to embody and represent the quality factors' totality and issues which are relevant to a particular idea of websites quality. Besides, such quality models may ultimately be used to improve new websites, develop ways to measure the quality of already existing websites, or in a sense, guide the development of existing websites. Thus, desirable mechanisms ultimately exist to choose the right model of highest intrinsic quality as well as of greater relevance. The researcher, in this research, presents mechanisms which are mainly proposed for the comparative assessment of e-government websites quality models. The introduction of model has been further enhanced and intensified through expanding its general quality, and identifying metrics to ultimately measure their attributes. Finally, the Fuzzy Analytical Hierarchy Process (FAHP) has been applied to the model, just as a decision-making tool, in order to mainly execute an empirical study that aims at verifying the ultimate efficiency of such a model.

Keywords

E-government, Quality Models, FAHP.

Introduction

Overview In the last years, we have seen a revolution in the field of information technology as well as communications technology (ICT). This revolution has caused incremental changes in some aspects of daily life for human all over the world. It also changed and modified the way that governments can interact with their citizens, their employees, and even other stakeholder. E-government is a new interest in the field of E-businesses and it uses ICTs to promote the access to and delivery of government information and services to citizens, businesses, and government employees. ICT has effectively, greatly and mainly improved and enhanced the efficiency as well as the effectiveness of the general services that many governments, around the world, provide to the public, thus improving and supporting economic as well as social development; both locally and globally. (Kumar et al., 2007). Generally, the term e-government, or (e-Gov), first emerged in the late 1990s. Besides, E-government ultimately allows a large number of citizens to access governmental information as well as services. It also allows them to participate in the process of government decision making. Truly, investigating e-government web-based services as well as evaluating and assessing its development have ultimately become one of the contemporary research areas in the field of information systems. Evaluating e-government website is important because it focuses on understanding target users, and testing integrated model of users satisfaction besides information and system quality. To evaluate e-government website this thesis used a quality models, which it define as "group of features, sub-characteristics, and attributes along with the connections between them that ultimately provide the good basis for specifying quality requirements as well as for assessing quality of the component, or even the system". 2 1.1 E-government Definitions: The term E-government, or in a sense, (short for electronic government), refers to the use of all electronic communications devices, namely, computers, and the Internet, to offer public services to all citizens as well as other persons in a country or region. Moreover, the Government is also known as (e-gov), or electronic government. It can also be called as connected government, Internet government, online government, or digital government. (Taylor Nelson Sofres, 2001) conducted a study that mainly focuses on the effect of the Internet service on the government. Moreover, he rightly defined the term E-government as "any government that works electronically, at all levels (Local, federal, and state)". (Backus 2001) also tends to define the term e-government as "a form of Ebusiness, in governance. It refers to those processes and structures which are needed to deliver all electronic services to the general public (both citizens and businesses), establish collaboration with business partners as well as conduct electronic transactions, within any organizational entity. 1.2 E-government in Jordan Just like other developing countries, the Kingdom of Jordan

initiated a national Government that mainly aims to streamline government procedures as well as make information and all government services available to the world of business, as well as to citizens online. Moreover, Jordan E-Government Program was truly launched in the year 2001. 1.2.1 The objectives of e-government in Jordan: E-Government in Jordan is not merely a policy standing in isolation. Rather, it is an integral part of the Kingdom's National Agenda. That is, Jordan's overall strategy as well as its missions for e-transformation has to align with other larger national priorities if it were to ensure socio-economic development as well as enable government entities to offer services from its beneficiaries' perspective and not just automate the current procedures. Besides, the objectives of e-government in Jordan are: Provide services driven by demand for high-quality beneficiaries government in stages. Improve government performance and efficiency. Ensure transparency in the public sector along with accountability. Moreover, reduce indirect costs of access to government services (transportation, time). Increase the ease of interaction with the government. Encourage the ICT sector. Develop skills in the public sector. Improve Ecommerce activities. Improve information security and end-user privacy. 3 Mitigation of risk through a coordinated approach, including technology tools, and policy guidance, and training. 1.3 Research Motivations: The Websites' majority are still nowadays in their early stages of improvement. Besides, there is an obvious and noticeable lack concerning the Websites readiness for rising up to the advanced level that is fundamental for providing all transactional services. Hence, there is a strong need to improve the quality of all government services delivery. There is also a strong need to increase effectiveness as well as efficiency, in the public sector organizations. Moreover, there is a need to raise hopes to reduce operating costs, for both businesses and citizens. This is mainly to provide both citizens and businesses with more convenient access to all online government services. In addition, Jordanian e-government websites are absolutely subject to what can be called as a lack of consistency, in relation to the general standards and features. There is also an absence of other different features that can improve interaction with the user. This is most likely because of a lack of necessary consideration for the citizens' expectations and their needs. Truly speaking, this investigation will greatly and effectively help to identify some important and essential points that could effectively and greatly help to develop the e-government websites in Jordan. Moreover, the availability of computers as well as the Internet service is not the only factors to be evaluated and considered in any e-government. Rather, the gap between the government and its citizens' ideas and perspectives concerning e-government should ultimately be considered. Furthermore, this gulf is viewed as one of the main reasons beyond the failure of certain e-government projects especially in developing countries. 1.4 Research Aim and Objectives The main objective for conducting the present research

is to explore the current situation of the Jordanian e-government websites, with an idea to improve their utilization for a successful e-government scheme in Jordan. This aim was achieved by performing the following objectives: 1. Evaluating the status of the existing e-government websites in Jordan from the end-users perspective; 4.2. Proposing a model of the e-government websites in order to provide a guide on how to achieve a usable e-government websites in Jordan. 1.5 Important questions to the study: 1. Why do we need to evaluate e-government website? 2. How do we evaluate e-government websit? 1.6 Contribution This research has ultimately and effectively provided an important contribution, for the E-government websites in Jordan. Besides, the following points are presented as its major contributions: 1. propose new model to evaluate e-government website in Jordan based on existing quality model to help people to make user friendly website, and to improve existing models, and to add sub-characteristics to the existing models. 2. Integration between fuzzy logic and Analytic Hierarchy Process (AHP) to evaluate a quality model used in e-government website. 1.7 Structure of Thesis: This thesis consists of five chapters: The first chapter is an introduction that explained the meaning of e-government, and the objectives of E-government in Jordan, and it also shows the research motivation, and contribution to this study. The remaining chapters will be presented in this thesis as follows: the second chapter is a review to related work in e-government website, and the quality models which is used to evaluate e-government website, while the last section from related works chapter shows the FAHP method to evaluate a quality models. Third chapter contains a methodology used to evaluate E-government websites. Chapter four focuses on quality Models, and on FAHP to evaluate e-government website. Chapter 5 describes the result of applying FAHP on values extracted from the questionnaire, and summarizes the overall results, draws final conclusions and indicates possible future directions.

Methodology Research

1. Introduction

The aim of this study is to evaluate e-government website by proposing a new quality model. The aim of this study is to evaluate the e-government website.

This chapter answers the question which is raised in chapter 1from this study, "how to evaluate e-government website?"

2. Methodology Steps

The suggested methodology to evaluate e-government website is presented in the following steps:

Step 1: Proposed a new quality model by using existing quality model, that Identifies a small set of agreed-upon, high-level quality attributes, and then, in a top-down fashion decomposes each attribute into a set of subordinate attributes.

Step 2: constructing the new model that implements ideas from international standards, identify attributes for every sub-characteristic, use a set of characteristics to measurement a quality model, and to exanimate if it is correct, contain all characteristics and sub-characteristics which is necessary to evaluate a websites.

Step 3: Find a way to measure a weights for each characteristics and attributes. This study use a questionnaire.

Step 4: Apply Data Analysis techniques: Our selection would be the Analytic Hierarchy Process (AHP), and integration between AHP and Fuzzy set theory to evaluate a proposed quality model, and it will be used to consolidate data evaluation in order to select the best e-government website among several alternatives.

3.2.1. Questionnaires structure: The questionnaires was organized based on proposed new quality model. It have 27 questions about the characteristics and sub-characteristics and attributes which it used in a proposed model. The user evaluate the characteristics and sub-characteristics, and attributes which it in questionnaire by using a numbers from 1to 9. The numbers from 1-3 that mean the evaluate is low, the numbers from 4-6 the evaluate is medium, while the numbers from 7-9 the evaluate is high.

3.2.1.1. Sample: As stated earlier, since the objective of this study is to evaluate the existing e-government website in Jordan from users perspective. The study sample was based on the views of users (students or developers) The study involved a sample of 30 users. The sample number of participants was not large. Because this has ultimately been more reliable, since the questionnaire has really been conducted in person as well as verbally administered.

3.2.1.2 Procedure As it has been stated earlier, the present study adopted the questionnaire technique. As for Hsieh & Huang (2008) questionnaire is regarded as an efficient, easy, effective and inexpensive ways to collect data in such scientific investigations. Moreover, studying the related previous literature as well as the related projects has ultimately led to design a questionnaire which has been piloted. Then it was modified into its final form. During the design of the questionnaire, a number of questions focused on the main issues, with much emphasis on using unbiased, short and simple language. Moreover, the questionnaire was ultimately and originally designed in English. In this connection, the

questionnaire was later translated into Arabic. This is done in order to give a copy of the questionnaire to the participants; particularly those who face problems in English, preferring to answer in Arabic in order to achieve the full understanding of the questions. 20 questionnaire can either be self-administered, where the respondent answers all the questions alone, or researcher administered, where the researcher can ask the participant to reply to questions. Here, the questionnaire was absolutely administered personally, by the researcher, to greatly ensure the respondents' full understanding for all the questionnaire's questions. Moreover, all the respondents were really visited by the researcher. The following table (Table 3.1) reflects the Jordanian e-government websites; those which were included in the present study.

Table 3.1 Jordan E-government website

Jordan E-government website :
www.mutah.edu.jo
www.ttu.edu.jo
www.bau.edu.jo

Summary

The literature review provided a general and useful information about the status of e-government websites in Jordan. The literature review found that the most e-government website in the early stage of development, and there is a gap between e-government website and their users. This chapter discusses the methodology used to evaluate e-government website. The methodology has several steps shown above, and how to build a new model, and how to evaluate it and shows the method use to calculate the value use in FAHP.

Result

1 Result based on Fuzzy Analytical Hierarchy Process in Mutah University

This section is presented a result from applied FAHP on Mutah University website. Figure 5.1 shows the membership function to TFN that use in this thesis. The law value is 0.06, medium is 0.12, high is 0.18.
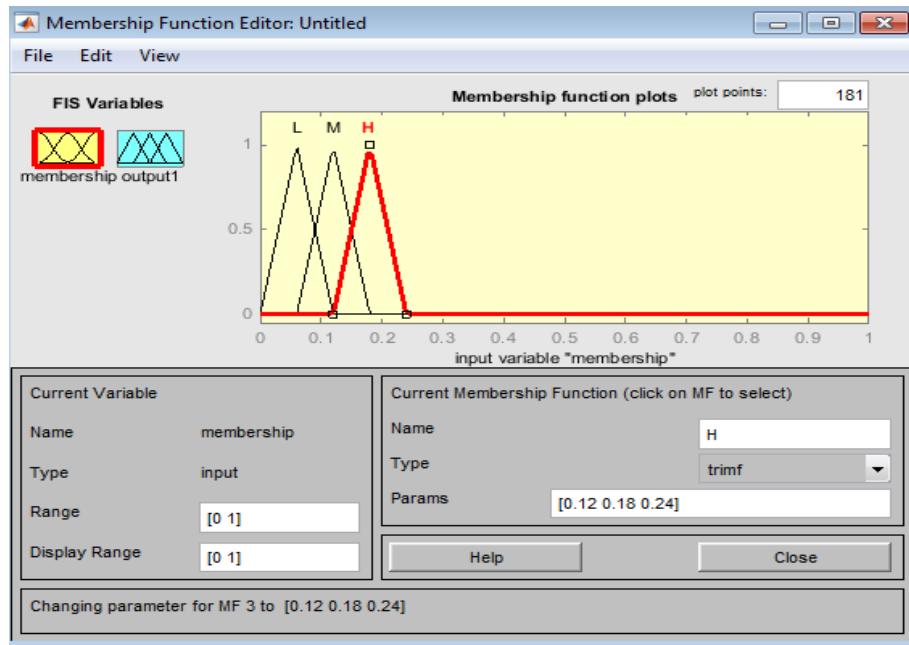
Figure 5.1 Membership function

The global weights which it show in table 5.1, 5.2 and 5.3 it use in fuzzy membership function to extraction a TFN for each global weights. Table 5.4 shows the TFN for each global weight in Mutah University.

Table 5.4 TFN in Mutah university

Characteristic	sub-characteristic	Attribute	Global weight	TFN
Functionality	Suitability	coverage ratio	.2158	(0,0,0.40)
		functional specification	.0476	(0.79,0,0)
	Operability	appropriateness	.1354	(0,0.83,0.16)
	Security	privacy	.0572	(0.95,0,0)
		authentication	.0105	(0.17,0,0)
	Compatibility	interoperability	.0634	(0.94,0.05.0)
Reliability	Fault-tolerance	Number of errors	.1328	(0,0.80,0.1)
	Recoverability	Time and effort	.0597	(0.99,0,0)
	Availability	Readiness	.0149	(0.24,0,0)
		Identification	.0066	(0.1,0,0)
		License	.0213	(0.35,0,0)
Portability	Adaptability	Flexibility	.1228	(0.0,0,0.95,0.23)
	Installability	Time	.0216	(0.36,0.0)
		Ability to back out of Installation	.0042	(0.07,0,0)
Usability	Learnability	Time to use	.020	(0.33,0,0)
	Satisfaction	Usefulness	.0132	(0.22,0,0)
	Accessibility	User interface	.0073	(0.12,0,0)
		Links	.0014	(0.023,0,0)
	Understandability	Documentation	.0052	(0.086,0,0)
		Supportability	.0010	(0.016,0,0)
	Effectiveness	Accuracy	.0031	(0.05,0,0)
	Efficiency	Time behavior	.0020	(0.033,0,0)
		Performance	.0049	(0.08,0,0)
Maintainability	Analyzability	Activity record	.0230	(0.28,0,0)
	Reusability	Code reuse	.0114	(0.19,0,0)
	Changeability	Change impact	.0044	(0.07,0,0)

Result based on Fuzzy Analytical Hierarchy Process in Tafilia Technical University

This section is presented a result from applied FAHP on Tafili Technical university website. Figure 5.1 shows the membership function to TFN that use in this thesis. The law value is 0.06, medium is 0.12, high is 0.18.
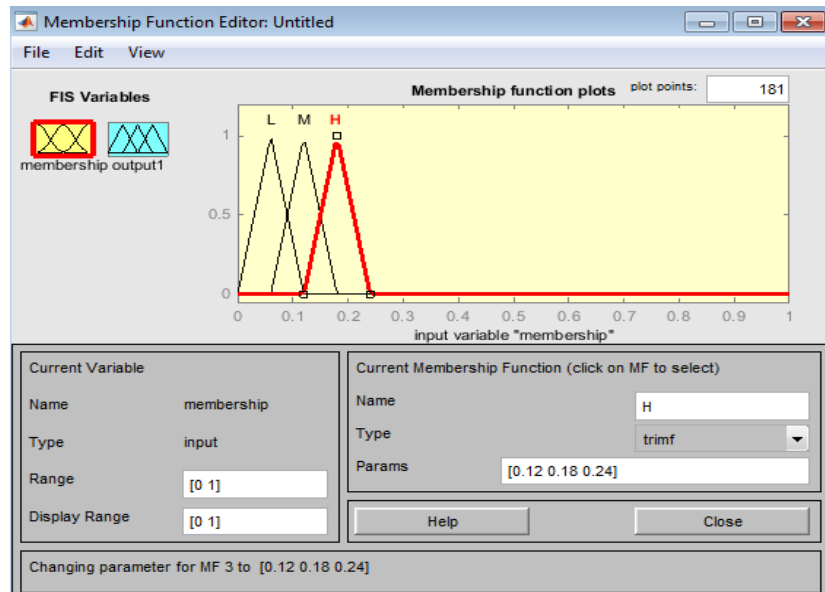

Figure 5.1 Membership function

The global weights which it show in table 5.1, 5.2 and 5.3 that it use in fuzzy membership function to extraction a TFN for each global weights. Table 5.6 shows the TFN for each global weight in Tafilia Technical university website.

Table 5.5 TFN in Tafilia technical university

Characteristic	sub-characteristic	Attribute	Global weight	TFN
Functionality	Suitability	coverage ratio	.0894	(0.51,0.48,0)
		functional specification	.014	(0.23,0,0)
	Operability	appropriateness	.0127	(0.0,0.88,0.05)
	Security	privacy	.058	(0.96,0,0)
		authentication	.008736	(0.145,0,0)
	Compatibility	interoperability	.029	(0.48,0,0)
Reliability	Fault-tolerance	Number of errors	.07	(0.73,0.28,0)
	Recoverability	Time and effort	.028	(0.46,0,0)
	Availability	Readiness	.00252	(0.041,0,0)
		Identification	.00712	(0.116,0,0)
		License	.001404	(0.023,0,0)
Portability	Adaptability	Flexibility	.085	(0.58,0.41,0)
	Installability	Time	.0114	(0.019,0,0)
		Ability to back out of Installation	.00152	(.025,0,0)
Usability	Learn ability	Time to use	0.18	(0,0,0.95)
	Satisfaction	Usefulness	.08	(0.66,0.16,0)
	Accessibility	User interface	.06	(0.95,0.025,0)
		Links	0.00952	(0.158,0,0)
	Understandability	Documentation	0.036	(0.6,0,0)
		Supportability	.0048	(0.08,0.0)
	Effectiveness	Accuracy	.027	(0.45,0,0)
	Efficiency	Time behavior	.015	(0.25,0,0)
		Performance	.00229	(0.036,0,0)
Maintainability	Analyzability	Activity record	0.0364	(0.6,0,0)
	Reusability	Code reuse	0.012	(0.2,0,0)
	Changeability	Change impact	0.0056	0.093,0,0)

Result based on Fuzzy Analytical Hierarchy Process in *AL-Balqa' Applied University* Technical University

This section is presented a result from applied FAHP on AL-*Balqa' Applied University* website. Figure 5.1 shows the membership function to TFN that use in this thesis. The law value is 0.06, medium is 0.12, high is 0.18.
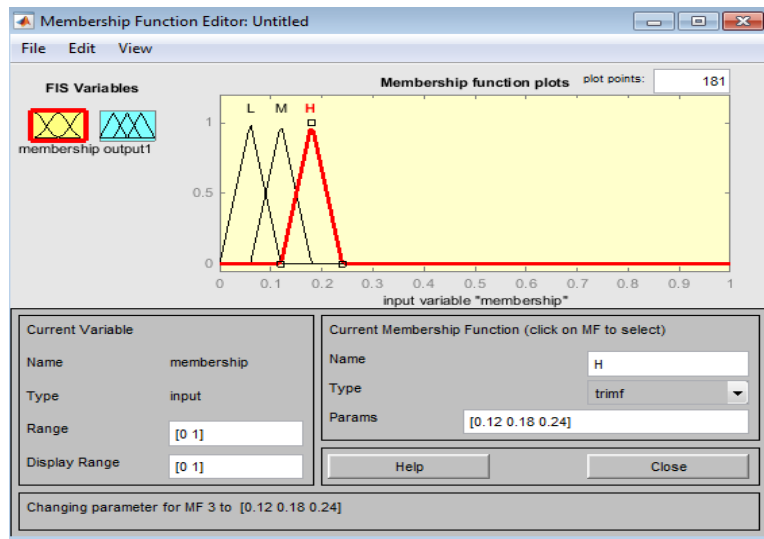

Figure 5.1 Membership function

The global weights which it show in table 5.1, 5.2, and 5.3 it use in fuzzy membership function to extraction a TFN for each global weights. Table 5.8 shows the TFN for each global weight in AL-*Balqa' Applied University* website.

Table 5.6 TFN in Balqa' Applied University

Characteristic	sub-characteristic	Attribute	Global weight	TFN
Functionality	Suitability	coverage ratio	.1739	(0,.101,.89)
		functional specification	.0347	(.57,0,0)
	Operability	appropriateness	.0509	(.84,0,0)
	Security	privacy	.0775	(.70,.14,0)
		authentication	.0156	(.26,0,0)
	Compatibility	interoperability	.0362	(.60,0,0)
Reliability	Fault-tolerance	Number of errors	.1456	(0,.57,.42)
	Recoverability	Time and effort	.0579	(.96,0,0)
	Availability	Readiness	.0134	(.22,0,0)
		Identification	.0094	(.15,0,0)
		License	.0032	(0.05,0,0)
Portability	Adaptability	Flexibility	.1328	(0,.78,.213)
	Installability	Time	.0177	(.29,0,0)
		Ability to back out of Installation	.0034	(.05,0,0)
Usability	Learnability	Time to use	.0515	(.85,0,0)
	Satisfaction	Usefulness	.0333	(0.55,0,0)
	Accessibility	User interface	.0196	(.32,0,0)
		Links	.0027	(.045,0,0)
	Understandability	Documentation	.0145	(.24,0,0)
		Supportability	.0029	(.048,0,0)
	Effectiveness	Accuracy	.0361	(.60,0,0)
	Efficiency	Time behavior	.0968	(.386,.613,0)
		Performance	.0023	(.038,0,0)
Maintainability	Analyzability	Activity record	0.0414	(.69,0,0)
	Reusability	Code reuse	0.0194	(.32,0,0)
	Changeability	Change impact	0.0082	(.13,0,0)

The Final Result & Analysis

According (Amy H.I. Lee, 2009) the TFN ratio for each characteristics in a proposed model which it applied on Mutah University website, AL-Tafilia technical university website, and *AL-Balqa' Applied* university website is show in tables 5.7, 5.8, 5.9.

Table 5.7 TFN ratio for each characteristics in a proposed model which it applied on Mutah university website.

Table 5.7 TFN to Mutah university website

Functionality	Reliability	Portability	Usability	Maintainability
(2.82,1.88,0.56)	(1.68,0.8,0.1)	(0.43,.095,0.07)	(0.95,0,0)	(.54,0,0)

Table 5.8 the TFN ratio for each characteristics in a proposed model which it applied on Tafilia technical university website.

Table 5.8 TFN to Tafilia technical website

Functionality	Reliability	Portability	Usability	Maintainability
(2.56,1.48,0)	(1.37,0.28,0)	(0.672,0.28,0)	(3.18,.41,0.95)	(0.89,0,0)

Table 5.9 TFN ratio for each characteristics in a proposed model which it applied on *AL-Balqa' Applied* university website.

Table 5.9 TFN to *AL-Balqa' Applied* university website

Functionality	Reliability	Portability	Usability	Maintainability
(2.95,.24,.89)	(1.38,0.57,0.42)	(0.34,0.78,0.21)	(3.07,0.613,0)	(1.14,0,0)

Mutah university website have a highest ratio in functionality compare with AL-Tafilia Technical university,and AL-Balqa' applied university, while the maintainability is a lowest ratio in it. The functionality ratio in Mutah university website =2.82+.88+.56=4.26, Reliability =2.58, portability =1.61, uability =.958 maintainability =.54.

The usability in Tafilia technical university website is a highes ratio from usability in Mutah university website, and AL-Balqa' applied university. The usability ratio in AL Tafilia university is 4.54, Functionality =4.13, Reliability =1.65, Portability =.952, Maintainability =.89.

The last website in this study AL-Balqa' applied university the functionality in this website is the highest ratio = 4.08 while the maintainability is the lowest ratio = 1.14. The Reliability ratio = 2.37,and Portability =1.33, Usability = 3.68.

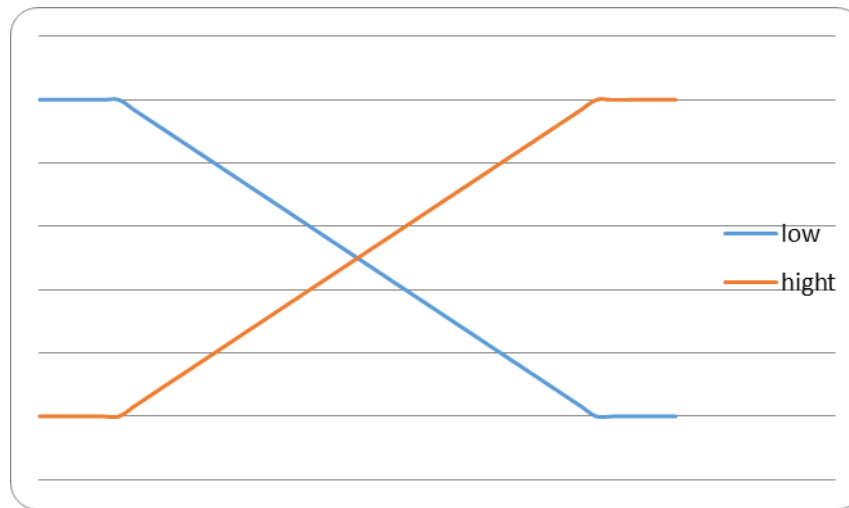To select the best website we used th IF-THEN rules, then use the membership function which shows in figure 5.2.

Figure 5.2 Membership function to fuzzy output

The IF-THEN rules which used in this study are:

IF (F(H)^R(H)^P(H)^U(H)^M(H))--➔High.
IF (F(L)v R(L) v P(L) v U(L) v M(L))--➔Low.

The F means Functionality, R Reliability, P Portability, U Usability, M Maintainability.
The H means High, while the L means Low.
To Mutah university website:
(2.82^1.68^.95^.958^.54)-➔2.82

From figure 5.2, by using the equation 1 the value of 2.82 =.23 in low
2.82=.76 in high.
take the maximum (.23^.76) =.76
The value of Mutah university =.76

To AL-Tafilia Technical university website:
(2.56^1.37^.67^3.18^.89)-➔3.18
From figure 5.2, by using the equation 1 the value of 3.18=.13 in low
3.18=.86 in high.
take the maximum (.13^.86)=.86
The value of Tafilia technical university =.86
To AL-Balqa' applied university website:
(2.95^1.38^.78^3.07^1.14)-➔3.07

From figure 5.2, by using the equation 1 the value of 3.07=.16 in low
3.07=.83 in high.
take the maximum (.16^.83)=.83
The value of AL-Balqa' applied university =.83

The maximum value from (0.76^0.83^0.86) =0.86 is to Tafilia technical university
website, so the Tafilia technical university website is the best one.

Conclusion

In short, this study has ultimately been carried out in order to find out, explore and
investigate the current situation of the Jordanian E-government websites. This is mainly
done in order to improve their usability for better application and to develop it so as to
achieve users satisfaction, and to complete the services which users needed it in a less
time.

The investigate done by proposing a new quality model which include characteristics, and
sub-characteristics that important to evaluate any website. Evaluating new quality model
by using fuzzy analytical hierarchy process, and applied this quality model on three
universities websites Mutah university, AL-Tafilia technical university, and AL-Balqa'
applied university.

On the basis of the findings, from the different tasks which have been conducted within
the general framework of the present research, the following concluding points have been
drawn:

The highest ratio in Mutah university website and AL-Balqa' applied university website is
functionality, while the usability is the highest ratio in AL-Tafilia university. The lowest
ratio in the three websites is maintainability.

The final result from applied IF-THEN rules the Tafilia technical university website is the
best website.

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