



An extended model for assessing E-Services of Iranian Universities Websites Using Mixed MCDM method

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Abstract

Since the university is considered one of the most pivotal hubs for developing science and knowledge, it is expected to take e-services development more seriously in comparison with other organizations and agencies. Such a strategy helps universities deliver online services with higher quality based on users' (such as students, professors, staff) requirements. As websites are seen as the preliminary and fundamental infrastructure of e-services, regular assessment of websites is so crucial for leveraging websites' quality. Different studies have been conducted for assessing e-services of university websites but each study has assessed limited dimensions of websites in a specific territory. In this paper, an extended model is proposed for assessing readiness of e-services of Iranian university websites which is able to evaluate wider dimensions of websites by considering various and wider indexes and indicators in comparison with previous studies. Firstly, the most effective indexes and indicators for assessing e-services of university websites are extracted from previous studies such as security, trust, content and information quality, responsiveness quality, website design, participation, support and maintenance, services and usability. As assessing readiness of e-services websites is a Multi Criteria Decision Making (MCDM) problem, Hybrid MCDM methods are proposed to determine the importance of indexes and indicators. The indexes and indicators are assigned weight and ranked by Analytical Hierarchy Process (AHP) and PROMETHEE methods respectively. A pairwise comparison questionnaire was distributed between 80 experts selected based on a purposive sampling technique to collect quantitative data. The model was applied for assessing

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the readiness of 21 top-leading Iranian university websites aimed at recognizing the strengths and weaknesses of e-services. The readiness of university websites is obtained by calculating the readiness values of indexes and indicators. Findings show that Tarbiat Modares University and Amirkabir University received the highest and lowest readiness values respectively. Finally, some useful recommendations are proposed to enhance the websites' quality. The practical implication of the research is providing some useful guidance for website designer and university decision makers for further development of e-services websites in accordance with user's requirements and demands.

Keywords E-service · University · Websites · Assessment model · MCDM · Iran

1 Introduction

The growth of Information and Communication Technology (ICT) in different applications is so ascending. Many organizations make a strong effort into applying ICT for providing online services to citizens which leads to creating a new concept as Electronic services or simply E-services. E-service is conceptualized as an organization's use of ICT for providing faster, more convenient and efficient access to and delivery of information and services to the general population (Abdel-Basset et al. 2018; Verkijika and De Wet 2018a).

Evidence from private and state sectors reveals that many organizations have the willingness to deliver e-services to citizens for decreasing the organization's cost and enhancing business performance. Fostering user's satisfaction and trust is considered another key factor for developing e-services such that the vast majority of organizations have set up a website to offer e-services (Al-dweeri et al. 2019; Ali 2019; Zhou et al. 2019).

The development of e-services is an evolutionary process that is comprised of different steps. The preliminary step is creating a website to share services unilaterally. The next step enables users to experience bilateral communication by offering interactive services. Further e-services development steps cause more citizen's interaction with websites and organizations (Concha et al. 2012; Iannacci et al. 2019; Joshi and Islam 2018).

Website creation is seen as the most fundamental and infrastructural step for developing e-services which allow organizations to deliver values to users, therefore, constant assessment of websites as the main platform for further development of e-services is so significant in providing better quality online services to citizens (Joshi and Islam 2018; Verkijika and De Wet 2018b).

Universities are also no exception in this regard, moreover, they are taken into account as the main hub for propagating science and knowledge in the world, therefore, they are highly expected to deliver high quality e-services to students and researchers (Ismailova and Inal 2018; Singla and Aggarwal 2018).

Due to the high importance of e-services websites to deliver better quality services to people, assessing different dimensions of websites aimed at enhancing e-services quality is so essential (Abdel-Basset et al. 2018; Verkijika and De Wet 2018b). In this paper, a model is proposed for evaluating e-services of university websites which is

able to spot the strengths and weaknesses of e-services websites and suggest some useful recommendations for improving website quality.

Assessing and selecting e-services websites with highest readiness is a complex Multi Criteria Decision Making (MCDM) problem with multiple and often conflicting quantitative and qualitative criteria, therefore, Multi Criteria Decision Making methods are seen as a great solution to solve the problem (Abdel-Basset et al. 2018; Burmaoglu and Kazancoglu 2012). MCDM methods enable decision makers to analyze alternatives from various viewpoints given criteria and sub-criteria simultaneously (Asees Awan and Ali 2019; Hatami-Marbini et al. 2013).

The overall structure of the paper is comprised of seven sections. Firstly, the most significant studies of assessing e-services of university websites are recognized and the most effective indexes and indicators are extracted which are able to assess wide and various dimensions of e-services of universities. Secondly, the importance of indexes and indicators is supposed to be obtained. Due to having different indexes and indicators for assessment, hybrid Multi Criteria Decision Making (MCDM) methods are selected for addressing the problem. Two separate MCDM methods such as Analytical Hierarchy Process (AHP) and PROMETHEE are applied for assigning weight and ranking of indexes and indicators respectively. In the next step, a group of experts is selected based on purposive sampling technique to answer a pairwise comparison questionnaire for collecting data then the model is applied for assessing the readiness of 21 top-leading Iranian universities websites whose readiness value is obtained by calculation of index's and indicator's readiness value. In the next section, the model is compared and analyzed with previous models. The last section is allocated for the research conclusion.

2 Literature reviews

Over the past years, different studies are conducted for assessing e-services of university websites. Each study considers limited dimensions of e-services websites. Manzoor et al. (2019) proposed a model for assessing and enhancing the usability of university websites. The model considered following criteria such as navigation (ease of use of information access), organization of website (information structure and quality), ease of use (usability), design, communication (contact information) and content. The model criteria can be categorized as usability, content and information quality and website design. The model is applied for assessing 86 university websites of Canada, the US and Europe. The criteria weight is the same and equal to one (Manzoor et al. 2019).

Benaida et al. (2018) assessed the usability of university websites in Arabic countries. The study concentrates on ease of use of e-services which are evaluated by following indexes: user's willingness to use the website, lack of website complexity (ease of use of information access), ease of use of website, support and maintenance, service integration, uniformity between webpages, fast learnability, website responsiveness, trust and no need for training before using services. The study assessed three top leading university websites of Saudi Arabia and England. In a nutshell, the study indexes can be summarized as usability, support and maintenance, website design, responsiveness quality and trust. Indexes' weight is the same and equal to one (Benaida et al. 2018).

Faustina and Balaji (2016) conducted a research on assessing Indian university websites. The study considered two main dimensions of responsiveness quality and website design. The study's indexes are load time, page size, number of items, broken links, response time, page rank, traffic and design optimization. The study assessed the e-services of three university websites in Chennai. The most and the least important indexes are load time (its weight is 0.3) and broken links (its weight is 0.02) (Faustina and Balaji 2016).

Devi and Sharma (2016) assessed the e-services of Indian university websites. The study concentrated on the effectiveness of e-services websites (while the previous model focused on responsiveness quality and website design). The study considered the following indexes: functionality (searching tools), usability (ease of use of services), reliability (usability), presentation (visual beauty and technical features of the website) and content and information quality. The study indexes can be summarized as usability, website design and content and information quality. The most and the least important indexes are content and information quality and usability (its weight is 0.3) and presentation and reliability (its weight is 0.1) respectively (Devi and Sharma 2016).

Zhou et al. carried out a study on assessing Chinese university libraries' websites. The study consists of the following indexes: content, website design, practicability (usability), maintenance and expansion (technical features of websites). The research indexes can be categorized as content and information quality, usability, support and maintenance and website design. The most and the least important indexes are as content and information quality (its weight is 0.416) and expansion (its weight is 0.059) (Zhou et al. 2013).

Hasan (2013) assessed the usability of Jordanian university websites. The model is comprised of following indexes such as navigation, website architecture, ease of use and communication (usability), website design (visual beauty) and content and information quality. The indexes' weight is the same and equal to one (Hasan 2013).

Alotaibi (2013) conducted a study on assessing the usability of Saudi Arabian university websites. The study considered following indexes such as visual design and consistency, links and navigation, data entry form, information and precision, privacy and security, search functionality, error tolerance and help and feedback. The indexes can be summarized as website design, usability, content and information quality, security, services and support and maintenance. The indexes' weight is the same and equal to one (Alotaibi 2013).

Table 1 shows the previous studies title and indexes of each one:

As shown in Table 1, each study considered various dimensions of university websites. The most important and effective indexes for assessing university websites are website design, usability, content and information quality, support and maintenance, responsiveness quality, services, trust and security. Chart 1 shows the frequency of indexes in previous studies:

Since one of the most important missions of e-services development is increasing citizen participation in organizational decisions and processes, therefore, citizen participation should be considered as one of the most important indexes for assessing e-services of university websites (Porumbescu 2016; Twizeyimana and Andersson 2019; Verkijika and De Wet 2018b). The index is not considered in any previous studies of university websites assessment. The index intends to assess the presence of online facilities and services for boosting up citizens' involvement with organizational

Table 1 E-services of university websites assessment studies

No	Study title	Indexes	Study objective (Case study)	Reference
1	Assessing universities websites of US, Europe and Canada	<ul style="list-style-type: none"> -Navigation -Organization of website -Ease of use -Design -Communication -Content 	Assessing the usability of university websites (Canada, US and Europe)	(Manzoor et al. 2019)
2	Assessment of e-services websites of Arabic universities	<ul style="list-style-type: none"> -user's willingness to use the website -lack of website complexity -ease of use of the website -support and maintenance -service integration -uniformity between webpages -fast learnability -website responsiveness -trust -no need for training before using services 	Assessing the usability of e-services of Arabic university websites (Comparison between Saudi Arabia and England's universities)	(Benaïda et al. 2018)
3	Assessment of e-services websites of Indian universities	<ul style="list-style-type: none"> -load time -page size -number of items -broken links -response time -page rank -traffic -Design optimization 	Responsiveness quality and website design assessment (Indian universities)	(Faustina and Balaji 2016)
4	Effectiveness of e-services websites of Indian universities	<ul style="list-style-type: none"> -functionality -usability -reliability -presentation -content an information quality 	Quality and effectiveness of universities (Indian universities)	(Devi and Sharma 2016)

Table 1 (continued)

No	Study title	Indexes	Study objective (Case study)	Reference
5	E-services websites of Chinese libraries	-content -website design -practicability -maintenance -expansion	E-services website of libraries (Indian Universities)	(Zhou et al. 2013)
6	Assessment of e-services websites of Jordan's universities	-content -website design -practicability -maintenance -expansion	Assessing e-services of Jordanian university websites (Three top-leading Jordanian universities)	(Hasan 2013)
7	Assessing the usability of e-services websites of Saudi Arabia universities	-visual design and consistency -links and navigation -data entry forms -information and precision -privacy and security -search functionality -help, feedback and error tolerance	Assessing usability of e-services of Saudi Arabian university websites (8 state and 4 private Saudi Arabia universities)	(Alotaibi 2013)

decisions and processes. Online surveys, online complaints, Frequent Answer and Questions (FAQ) are the most common indicators for measuring the index. There are also other indicators such as online weekly meeting and online polling which help enhance citizen participation with organizational decisions.

Given Chart 1 and the above explanation, the most effective indexes for assessing e-services of university websites are website design, trust, security, support and maintenance, participation, usability, services, responsiveness quality and content and information quality.

3 Proposed Model's indexes for assessing E-services of university websites

Considering section 2, The most important and effective indexes for assessing e-services of university websites are as website design, responsiveness quality, security, trust, content and information quality, participation, support and maintenance, services and usability which are considered as proposed model's indexes. The indexes and relevant indicators are introduced and explained separately:

a. Website design

The index is comprised of two dimensions such as visual beauty and technical features of the website. Visual beauty assesses the uniformity of webpages through considering color, font and design. Technical features of the website consider the website compatibility with different web browsers and systems. Offering personalized services based on users' requirements is also taken into account (Manzoor et al. 2019; Rasyid and Alfina 2017; Tella 2019).

b. Responsiveness quality

The index assesses the speed of website responsiveness to user's requests. The index is assessed by following indicators such as server responsiveness after each click and required time for downloading files and documents. Deploying servers inside the country and applying wide bandwidth for transferring information between servers and user's browsers make a strong contribution to enhancing website responsiveness. With the rapid development and popularity of social media among the general population, website compatibility with social media can leverage website responsiveness to user's requests (Rasyid and Alfina 2017; Twizeyimana and Andersson 2019; Verkijika and De Wet 2018b).

c. Security

Website security is assessed in two dimensions of backend and frontend. The backend mostly evaluates the required facilities for providing a secure platform for transferring information between the user's browser and servers. It is evaluated by the following indicators: the use of secure protocols such as SSL and HTTPS as well as data encryption between server and user's browser in order to avoid data leakage. The

frontend aspect examines required facilities on User Interface (UI) such as security code image, virtual keyboard and sending alarm message when an anonymous user penetrates into the user's account (Henriksson et al. 2007; Rasyid and Alfina 2017; Verkijika and De Wet 2018b).

d. Trust

The index assesses people's trust in organizations and deliver e-services. It is comprised of three main aspects of risk, characteristics of state agencies and social characteristics of citizens. The first aspect concentrates on keeping the personal information of users confidential by avoiding sharing them with organizations and abusers. The second aspect is divided into two parts such as an organization's credibility and user's past experience. The first part assesses an organization's honesty in delivering e-services to citizens as well as considering citizens' interest in offered online services. The second part mostly considers user's feedback about the quality of e-services such as effectiveness and user satisfaction in the past experience. Social characteristics of users assess citizen's inclination and willingness to trust the third party. Additionally, citizen's nodding acquaintance with the internet is also another indicator. The presence of an organization's logo on all web pages and displaying completion messages can increase a user's trust in organization and e-services (Alzahrani et al. 2017, 2018; Benaida et al. 2018).

e. Content and information quality

The Index assesses precision, accuracy and update of information. Additionally, displaying the last date of website updating can inform citizens regarding information updates. Due to different software for viewing information on a website, presenting information with different formats such as HTML and PDF helps enhance information quality (Huang and Benyoucef 2014; Rasyid and Alfina 2017; Verkijika and De Wet 2018a, b).

f. Participation

The index examines existed facilities on a website for increasing citizen's participation with organizations. The most critical facilities are as: online surveys, online criticism and complaints and providing a space on the webpage to share questions and receive answers (FAQ). Holding online meeting for keeping citizens informed about the latest changes in offered e-services is another indicator which leads to broader citizen's participation (Tella 2019; Twizeyimana and Andersson 2019; Verkijika and De Wet 2018a, b).

g. Support and maintenance

Required facilities for guiding users aimed at better use of online services and systems are assessed by support and maintenance. Online support and maintenance and website user manual facilitate the use of delivered online services. Sending emails for informing users about the last status of their requests and displaying error messages while doing

Table 2 Indexes and indicators of the proposed model

No.	Index	Indicators	References
1	Website Design	<ul style="list-style-type: none"> -Web page color -Web page font - Same font in all pages -Simple and same design -Simple pictures compatible with text -Page title -Compatibility with different browsers -Compatibility with different systems (Ex. Mobile phone) -Presenting personalized services -Write-in personal information by users -Time, date and weather display 	<p>(Tella 2019)</p> <p>Rasyid and Alfina 2017) (</p> <p>(Manzoor et al. 2019)</p> <p>(Burmaoglu and Kazancoglu 2012)</p> <p>(Dominic et al. 2010)</p> <p>(Zhu et al. 2007)</p> <p>(Sivaji et al. 2011)</p> <p>(Verkijika and De Wet 2018a)</p> <p>(Henriksson et al. 2007)</p> <p>(Huang and Benyoucef 2014)</p> <p>(Guo et al. 2010)</p> <p>(Zhou et al. 2013)</p> <p>(Hasan 2013)</p> <p>(Alotaibi 2013)</p>
2	Responsiveness quality	<ul style="list-style-type: none"> -Speed of servers' responsiveness after each click -Document downloading time -Wide bandwidth between server and user's browser -Compatibility with social networks -Low-size file -Low-size pictures -Server deployment inside the country 	<p>(Twizeyimana and Andersson 2019)</p> <p>(Rasyid and Alfina 2017)</p> <p>(Verkijika and De Wet 2018b)</p> <p>(Pena-Lopez 2018)</p> <p>(Faustina and Balaji 2016)</p> <p>(Benaïda et al. 2018)</p>
3	Security	<ul style="list-style-type: none"> -Data encryption between server and user's browser -Supporting HTTPS protocol for enhancing security between server and user's browser -Improving transaction security by supporting SSL protocol -Security code image after entering a password -Virtual keyboard for entering a password -Sending alert message after anonymous user's log-in 	<p>(Rasyid and Alfina 2017)</p> <p>(Verkijika and De Wet 2018a)</p> <p>(Verkijika and De Wet 2018b)</p> <p>(Henriksson et al. 2007)</p> <p>(Zhu et al. 2007)</p> <p>(Huang and Benyoucef 2014)</p> <p>(Twizeyimana and Andersson 2019)</p> <p>(Alotaibi 2013)</p>
4	Trust	<ul style="list-style-type: none"> -Disposition to trust -Familiarity with the internet -Avoidance of sharing personal information with other agencies -Avoidance of unauthorized user to access personal information -Avoidance of personal information abuse -High speed of online transaction -Error avoidance in financial transactions -User satisfaction with services in the past experience 	<p>(Rasyid and Alfina 2017)</p> <p>(Verkijika and De Wet 2018a)</p> <p>(Verkijika and De Wet 2018b)</p> <p>(Huang and Benyoucef 2014)</p> <p>(Alzahrani et al. 2018)</p> <p>(Alzahrani et al. 2017)</p>

Table 2 (continued)

No.	Index	Indicators	References
		-Efficiency and effectiveness of services -User's benefit consideration in services by agencies -Organization's honesty in delivering services -Message display after completing procedures -Display of organization's logo in all pages	(Benaïda et al. 2018)
5	Content and Information quality	-Data Precision -Data updating -Data presentation in different formats such as HTML, PDF -Data Accuracy -Service and information delivery based on user's requirements -Latest update date display -Avoidance of using complicated language in presenting information -Presenting important information at the outset of paragraphs -Restricting advertisement content	(Rasyid and Alfina 2017) (Verkijika and De Wet 2018a) (Verkijika and De Wet 2018b) (Henriksson et al. 2007) (Zhu et al. 2007) (Tsai et al. 2009) (Sivaji et al. 2011) (Huang and Benyoucef 2014) (Devi and Sharma 2016) (Zhou et al. 2013) (Alotaibi 2013) (Manzoor et al. 2019)
6	Participation	-Online Survey -Frequent answer and question (FAQ) -Publishing weekly newsletter -Online weekly meeting (ex. Webinar) for increasing people's awareness -Online voting -Online complaint and criticism -Contact information	(Tella 2019) (Twizeyimana and Andersson 2019) (Verkijika and De Wet 2018a) (Verkijika and De Wet 2018b) (Henriksson et al. 2007) (Tsai et al. 2009) (Burmaoglu and Kazancoglu 2012) (Pena-Lopez 2018)
7	Support and Maintenance	-Online supporting services for guiding users while using services -Online maintenance services -Error message display during transactions -Sending email for informing users about latest request status -Sending tracking number after registration -Website user manual	(Verkijika and De Wet 2018a) (Sivaji et al. 2011) (Pena-Lopez 2018) (Benaïda et al. 2018) (Zhou et al. 2013) (Hasan 2013)
8	Services	-Downloadable forms for registering requests -Online payment -Downloadable documents -Online tender participation -Online license -Variety of specialized services	(Verkijika and De Wet 2018a) (Verkijika and De Wet 2018b) (Henriksson et al. 2007) (Tsai et al. 2009) (Burmaoglu and Kazancoglu 2012)

Table 2 (continued)

No.	Index	Indicators	References
9	Usability	<ul style="list-style-type: none"> -Supporting multi languages -Search engine -Simple menu for better navigation -Website map for faster access to information -Ability to return to previous step -Ability to cancel operations -Link management -Links for connecting to other organizations -Accessibility 24 × 7 	<p>(Pena-Lopez 2018) (Benaïda et al. 2018)</p> <p>(Verkijika and De Wet 2018a)</p> <p>(Huang and Benyoucef 2014)</p> <p>(Henriksson et al. 2007)</p> <p>(Tsai et al. 2009)</p> <p>(Devi and Sharma 2016)</p> <p>(Manzoor et al. 2019) (Ismailova and Kimsanova 2017)</p>

transactions with the website are also considered (Sivaji et al. 2011; Verkijika and De Wet 2018a; Pena-Lopez 2018).

h. Services

The index assesses the number of delivered e-services on a website. The most fundamental services are included as downloadable forms and online financial transaction which enable users to pay bills without referring to office. Online tender documents and online tender participation are other pivotal delivered e-services (Benaïda et al. 2018; Verkijika and De Wet 2018a, b).

i. Usability

The Index recognizes the existed facilities for ease of use of websites and e-services. Having a search engine, simple menu and website map helps users reach information and e-services faster and more conveniently. Returnability and ability to cancel ongoing transactions facilitate the use of e-services and websites. Supporting different languages makes the websites and e-services more applicable to users regardless of nationality (Ismailova and Kimsanova 2017; Manzoor et al. 2019).

Table 2 indicates the indexes and indicators of the proposed model:

As shown in Table 2, the most effective indexes and indicators for assessing the e-services of university websites are determined. Given that the indexes and indicators are able to evaluate wider dimensions of e-services websites in comparison with previous studies therefore the final assessment results are more precise and reliable.

4 Research methodology

After extracting the most important indexes and indicators for assessing e-services websites, a model is supposed to reveal for assessing the readiness of e-services

websites. Selecting and ranking e-services websites based on indexes and indicators is a Multi Criteria Decision Making (MCDM) problem, therefore, MCDM methods are proposed for determining the preference and importance of indexes and indicators (Abdel-Basset et al. 2018; Burmaoglu and Kazancoglu 2012).

A number of MCDM methods have been developed to solve multi criteria decision making problems such as AHP, ANP, PROEMTHEE, VIKOR and, etc. (Abdel-Basset et al. 2018; Abdulah et al. 2019). In this research Analytical Hierarchy Process (AHP) method is selected for assigning weight to the indexes. AHP is a reliable method that is able to decompose complicated multi criteria decision making problems into a pairwise comparison between indexes and assign weight and rank them (Singh et al. 2018).

As the number of indicators is plentiful, AHP method is not highly recommended for ranking indicators. Instead, PROEMTHEE method is suggested for ranking indicators. PROEMTHEE is an outranking method that is able to rank indicators regardless of their dependency and frequency (Singh et al. 2018).

In this research AHP and PROEMTHEE methods are applied for assigning weight and ranking indexes and indicators respectively. The methods are explained in details:

4.1 AHP

AHP method was firstly proposed by Thomas Satty in 1970 (Wang et al. 2019). The method is able to convert complicated decision making problems into the simple pairwise comparison between indexes therefore the method has received high attention and popularity by researchers. The method is comprised of five steps (Carfora et al. 2016; Darko et al. 2019; Konstantinos et al. 2019; Zyoued et al. 2016):

a. Decision matrix

Firstly, indexes are compared pairwise using linguistic variables presented in Table 3 then the results are put into a decision matrix:

$$A_{n \times n} = \begin{bmatrix} 1 & \cdots & a_{1n} \\ a_{21} & 1 & \vdots \\ \vdots & a_{ij} & \vdots \\ a_{n1} & \cdots & 1 \end{bmatrix} \quad (1)$$

Table 3 Linguistic variables conversion into Likert number

No.	Linguistic Variables	Likert number
1	Equal importance	1
2	Weak importance	2
3	Strong importance	3
4	Very strong importance	4
5	Extremely important	5

Where the decision matrix A , a_{ij} displays comparison value between index i to index j for all indexes $i, j \in \{1, 2, \dots, n\}$. n shows the number of indexes in the problem.

b. Data Aggregation

Since a pairwise comparison questionnaire is distributed between 80 experts selected based on purposive sampling technique for data collection, data aggregation is required to turn expert’s judgments into a single decision matrix:

$$a_{ij} = \frac{\sum_{l=1}^n a_{ij}^l}{n} \tag{2}$$

Where a_{ij} represents the pairwise comparison value between index i and j in the single decision matrix. n shows the number of experts.

c. Normalization

The normalized decision matrix is obtained by the division of each element value over the addition of relevant column value:

$$a_{n1} = \frac{a_{n1}}{\sum_{l=1}^n a_{l1}} \tag{3}$$

d. Calculation of Indexes weight

Weight of each index is obtained by:

$$W = [w_1, w_2, \dots, w_n]^T \tag{4}$$

$$A_{n \times n} = \begin{bmatrix} a_{11} & \dots & a_{1n} \\ a_{21} & a_{22} & \vdots \\ \vdots & a_{ij} & \vdots \\ a_{n1} & \dots & a_{nn} \end{bmatrix} \left\{ \begin{array}{l} Z_1 = a_{11} + a_{12} + \dots + a_{1n} \\ Z_2 = a_{21} + a_{22} + \dots + a_{2n} \\ \vdots \\ Z_n = a_{n1} + a_{n2} + \dots + a_{nn} \end{array} \right. \tag{5}$$

$$Z_t = Z_1 + Z_2 + \dots + Z_n \tag{6}$$

$$W_1 = \frac{Z_1}{Z_t}, W_2 = \frac{Z_2}{Z_t}, \dots, W_n = \frac{Z_n}{Z_t} \tag{7}$$

Where Z_1 displays the addition of all elements in each row. Z_t shows the addition of all elements in the normalized decision matrix. The final weight of each index is obtained by dividing the addition of each row by the addition of all elements in the normalized decision matrix.

e. Consistency ratio

The consistency ratio of the decision matrix is obtained by:

$$CR = \frac{CI}{RI} \quad (8)$$

Given the above equation, CI is obtained by eq. 5 and RI is obtained by Table 4:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (9)$$

n shows the number of indexes. Maximum of eigenvector λ_{max} is obtained by:

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^n \frac{(AW)_i}{w_i} \quad (10)$$

The value of CR should be less than 0.1 to reach a consistent decision matrix.

4.2 PROEMTHEE

PROMETHEE is firstly proposed by Brans in 1986. PROEMTHEE is considered an outranking method. Ease of use and high precision in ranking alternatives cause many researchers to apply PROEMTHEE method in research activities. The method has different versions but PROMETHE II is applied for providing complete indicator's ranking. The method is comprised of 6 steps (Abdulah et al. 2019; Wu et al. 2019):

a. Decision Matrix

Firstly, each indicator is compared pairwise with other indicators using linguistic variables presented in Table 4 then the results are put into the decision matrix.

Table 4 Value of (RI)

Number of Indexes	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.40	1.49

b. Data aggregation

A pairwise comparison questionnaire is distributed between 80 experts selected based on a purposive sampling technique. Collected data is aggregated and put into a single decision matrix by:

$$a_{ij} = \frac{\sum_{l=1}^n a_{ij}^l}{n} \tag{11}$$

c. Calculation of indexes deviation

The Difference between two indicators evaluation value is calculated by:

$$d(a, b) = g_j(a) - g_j(b) \tag{12}$$

$g_j(a)$ and $g_j(b)$ represent pairwise comparison value of a and b indicators respectively. $d(a, b)$ denotes difference value between the evaluation of a and b indicators.

d. Calculation of indicators preferences respecting each index

Indicators preference respecting to each index is obtained by:

$$P_j(a, b) = F_j[d_j(a, b)] \tag{13}$$

P_j denotes preference of indicator a to indicator b respecting index j which is obtained by calculation of preference function F . The most popular preference function are as: usual, U-shape, V-shape, level, linear and Gaussian. Due to the common use of V-shape preference function in previous research, it is applied for spotting precise preference of indicators.

$$P(d) = \begin{cases} \cdot & d \leq q \\ \frac{d-q}{p-q} & q < d \leq p \\ \backslash & d > p \end{cases}$$

d shows the difference value of two indicators respecting to each index. Additionally, q and p show indifference and preference threshold. The lower value of the preference function shows the indifference of decision makers. On the contrary, a higher value indicates a stronger preference.

e. Calculation of index preference respecting to all indexes

In this step, indicator preference is calculated respecting to all indexes by:

$$\pi(a, b) = \sum_{j=1}^k P_j(a, b) \times w_j \tag{15}$$

w displays index weight. $P_j(a, b)$ represents preference indicator a to b respecting to index j . $\pi(a, b)$ shows the preference degree of indicator a to indicator b respecting all indexes.

f. Calculation of preference order

In this step, indicators ranking can be conducted partially or completely but in this research complete ranking is required to compare all indicators simultaneously while in partial ranking the preference of all indicators is not comparable. The complete preference order of indicators is obtained by:

$$\emptyset^+ = \frac{1}{n-1} \sum_{x \in A} \pi(a, x) \tag{16}$$

$$\emptyset^- = \frac{1}{n-1} \sum_{x \in A} \pi(x, a) \tag{17}$$

$$\emptyset = \emptyset^+ - \emptyset^- \tag{18}$$

\emptyset^+ is the positive outranking flow or known as leaving flow denoting how indicator a dominates all other indicators. \emptyset^- is the negative outranking flow or entering flow indicating how indicator a is dominated by all other indicators. n shows the number of indicators.

\emptyset is net flow which is obtained by difference of positive and negative flow values. The net flow allows all indicators to be comparable. The higher value of net flow denotes a higher preference of indicator.

5 Proposed model for assessing e-services websites of Iranian universities

The main objective of the research is proposing an extended model for assessing the readiness of e-services of university websites. The model is able to recognize strengths and weaknesses of e-services websites as well as offering some useful

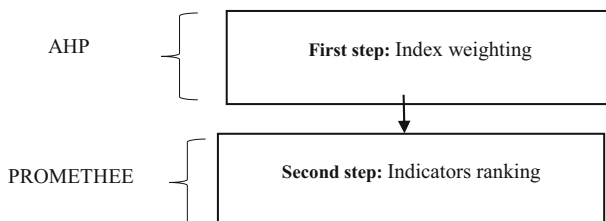


Fig. 1 Research methodology steps

Table 5 Demographic information of respondents

Sex	Female	24 persons	%30
	Male	56 persons	%70
Education	Bachelor	26 persons	%32
	Master	42 persons	%52
	PhD	12 persons	%15
Age	Less than 30 years	27 persons	%34
	Between 30 and 40 years	33 persons	%41
	Between 40 and 50 years	14 persons	%17
	More than 50 years	6 persons	%8
Work experience	Less than 5 years	23 persons	%29
	Between 5 and 10 years	39 persons	%49
	More than 10 years	18 persons	%22
Career	Member of the scientific committee	18 persons	%22
	Expert	46 persons	%57
	Manager	20 persons	%16

recommendations for enhancing website quality. The model's research methodology consists of two main steps, the first step is responsible for assigning weight to indexes using Analytical Hierarchy Process (AHP) and the second step is devoted to ranking indicators by PROEMTHEE method. Figure 1 shows the research methodology steps:

A pairwise comparison questionnaire was distributed between 80 experts in the sphere of Information Technology and e-services to assess indexes and indicators pairwise. The respondents are selected based on a purposive sampling technique. In the purposive sampling technique, respondents are determined by researchers. The researcher requires to have prior knowledge about the purpose of the study so that they can properly choose eligible respondents (Karabatak and Polat 2019). Table 5 shows demographic information of respondents:

Table 6 shows the final results of the proposed model where all indexes and indicators are assigned weigh and ranked by AHP and PROMETHEE methods respectively:

As shown in Table 6, the most important indexes are as: security (its weight is equal to 0.1570), trust (its weight is equal to 0.1410), responsiveness quality (its weight is equal to 0.1250), content and information quality (its weight is equal to 0.1240), website design (its weight is equal to 0.1017), support and maintenance (its weight is equal to 0.0930), usability (its weight is equal to 0.0901), services (its weight is equal to 0.0880) and participation (its weight is equal to 0.0835).

6 Assessing the readiness of e-services of top-leading Iranian university websites

The proposed model is applied for assessing the readiness of e-services of 21 outstanding Iranian university websites such as Tehran university, Tehran university of medical

Table 6 Indexes weight and indicators ranking of the proposed model

No.	Index (Weight)	Indicator	Ranking	Net flow
1	Security (0.1570)	-Data encryption between server and user's browser	4	0.0623
		-Supporting HTTPS protocol for enhancing security between server and user's browser	3	0.1091
		-Improving transaction security by supporting SSL protocol	2	0.1532
		-Security code image after entering a password	5	-0.1974
		-Virtual keyboard for entering a password	6	-0.2805
		-Sending alert message after anonymous user's log-in	1	0.1532
		2	Trust (0.1401)	Disposition to trust
Familiarity with the internet	5			2.6364
Avoidance of sharing personal information with other agencies	8			0.3766
Avoidance of unauthorized user to personal information	7			1.1299
Avoidance of personal information abuse	6			1.8831
High speed of online transaction	9			-0.3766
Error avoidance in financial transaction	10			-1.1299
User satisfaction with services in the past experience	3			4.1429
Efficiency and effectiveness of services	4			3.3896
User's benefit consideration in services by agencies	1			5.6494
Organization's honesty in delivering services	2			4.8961
Message display after completing procedures	12			-5.5974
Display of organization's logo in all pages	13			-4.8961
3	Responsiveness quality (0.1250)	Speed of servers' responsiveness after each click	1	0.5325
		Document downloading time	3	0.1740
		Wide bandwidth between server and user's browser	2	0.4156
		Compatibility with social networks	6	-0.2000
		Low size file	4	-0.0467
		Low size pictures	5	0.1304
		Server deployment inside the country	7	-0.6909
4	Content and information quality (0.1240)	Data precision	1	0.6390
		Data updating	2	0.6390
		Data presentation in different formats such as HTML, PDF	6	-0.2571
		Data Accuracy	3	0.4494
		Service and information delivery based on user's requirements	5	0.1066
		Displaying latest update of date	7	-0.4572
		Avoidance of using complicated language in presenting information	4	0.1142
		Presenting important information at the outset of paragraphs	9	-0.5741
		Restricting advertisement content	8	-0.5221
5	Website design (0.1017)	Web page color	8	-0.2604
		Web page font	6	0.0779
		Same font in all pages	10	-1.0728

Table 6 (continued)

No.	Index (Weight)	Indicator	Ranking	Net flow
		Simple and same design	7	-0.0780
		Simple pictures and compatible with text	5	0.2909
		Page title	3	0.6104
		Compatibility with different browsers	2	1.6156
		Compatibility with different systems (Ex. Mobile phone)	1	1.9714
		Presenting personalized services	4	0.2935
		Write-in personal information by users	9	-0.2988
		Time, date and weather display	11	-3.1999
6	Support and maintenance (0.0930)	Online supporting services for guiding users while using services	1	0.3688
		Online maintenance services	2	0.1429
		Error message display during transactions	6	-0.2961
		Sending email for informing users about latest request status	5	-0.2597
		Sending tracking number after registration	3	0.1403
		Website user manual	4	-0.1011
7	Usability (0.0901)	Supporting multi language	7	-0.2987
		Search engine	3	0.4909
		Simple menu for better navigation	2	0.6364
		Website map for faster access to information	4	0.0259
		Ability to return to previous step	5	-0.1947
		Ability to cancel operations	6	-0.2337
		Link management	8	-1.1116
		Links for connecting to other organization's websites	9	-1.6416
		Accessibility 24 × 7	1	1.4753
8	Services (0.0880)	Downloadable forms for registering requests	3	0.2519
		Online payment	1	0.5636
		Downloadable documents	5	0.1533-
		Online tender participation	4	0.0962
		Online license	2	0.5636
		Variety of specialized services	6	-0.2052
9	Participation (0.0835)	Online Survey	3	0.5143
		Frequent answer and question (FAQ)	2	0.7506
		Publishing weekly newsletter	7	-1.0727
		Online weekly meeting (ex. Webinar) for increasing people's awareness	6	-1.0727
		Online voting	5	0.3013
		Online complaint and criticism	1	1.0883
		Contact information	4	0.4078

science, Sharif university of technology, Amirkabir university of technology, Tarbiat Modares university, Shahid Beheshti University of medical sciences and health services, Isfahan university of technology, Iran University of science and technology, Ferdowsi Mashhad University, Shahid Beheshti University, Shiraz University, Tabriz

University, Shiraz University of medical sciences, K.N Toosi University of technology, Alzahra University, Kharazmi University, Allameh Tabatabai University, Iran University of medical sciences, Ahvaz University of medical sciences, Tabriz University of medical sciences and Mashhad University of medical science. In order to quantify the study, the readiness value of indicators is obtained by selecting a number between zero to 100. The higher value denotes the higher readiness of indicator. Table 7 shows the general information of the universities (UniRank 2019):

1.1. Security

Security is considered the most important index. The index is comprised of two main dimensions such as security at infrastructure and user interface. The first dimension is looking for providing a secure platform for transferring data between servers and the user's browser by applying secure protocols (such as HTTPS and SSL) and data encryption. The second dimension evaluates required facilities at User Interface (UI) such as security code image, a virtual keyboard for entering a password and sending alarm message when an unknown user logs into other user's accounts. Figure 2 shows the readiness value of indicators:

Table 7 General information of universities

No	University	City	Founded year	Number of students	University type	Global ranking
	Tehran University	Tehran	1313	52,000	State	419
2	Tehran University of medical science	Tehran	1313	14,500	State	560
3	Sharif University of technology	Tehran	1344	12,000	Sate	641
4	Amir Kabir University of technology	Tehran	1307	14,000	State	815
5	Tarbiat Modares University	Tehran	1361	9,850	Sate	875
6	Shahid Beheshti University of medical sciences and health services	Tehran	1365	13,000	Sate	932
7	Isfahan University of technology	Isfahan	1356	9,000	State	955
8	Iran University of science and technology	Tehran	1308	7,000	State	974
9	Ferdowsi Mashhad University	Mashad	1328	22,000	State	1014
10	Shahid Beheshti University	Tehran	1338	19,000	State	1124
11	Shiraz University	Shiriaz	1325	20,000	State	1248
12	Tabriz University of medical sciences	Tabriz	1325	8,500	State	1279
13	Mashhad University of medical science	Mashad	1365	9,200	State	1281
14	Tabriz University	Tabriz	1325	24,000	State	1373
15	Shiraz University of medical sciences	Shiraz	1325	10,000	State	1385
16	K.N Toosi University of technology	Tehran	1307	8,000	State	1431
17	Iran University of medical sciences	Tehran	1352	9,000	State	1729
18	Ahvaz University of medical sciences	Ahvaz	1336	8,000	State	2346
19	Alzahra	Tehran	1343	10,000	State	2349
20	Kharazmi	Tehran	1297	12,500	State	2397
21	Allameh Tabatabai	Tehran	1363	18,000	State	2763

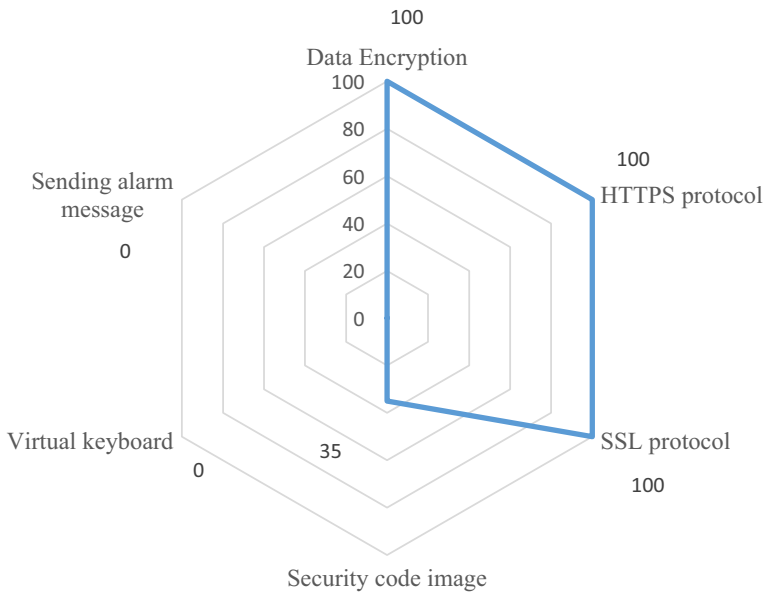


Fig. 2 Readiness of security indicators

The most important indicators are SSL and HTTPS which pave the way for more secure data transferring between the user's browser and servers. They are all well-considered on the websites and data are transferred securely but user interface indicators such as a virtual keyboard and security code image are not well-observed such that less than 40% of indicators exist on the websites. The final readiness value of the security index is equal to 55%.

6.1 Trust

The second most important index is trust which is responsible for assessing user's trust in organization and e-services. The index is comprised of three main dimensions such as risk, social characteristics of citizens and state agencies' characteristics. The state agency characteristics are divided into two parts such as an organization's credibility which is assessed by the following indicators: considering citizen's interest and organization's honesty in delivering e-services to citizens. The second part is users' past experience which is evaluated by the user's satisfaction with and effectiveness of e-services. Risk dimension assesses transaction speed, financial transaction errors and user's privacy (avoidance of sharing user's personal information with third parties). Social characteristic of citizen's dimension is comprised of following indicators such as user's knowledge about the internet and their willingness to trust the third party. Figure 3 shows the readiness value of indicators:

Considering citizen's interest is the most important indicator such that less than 30% of students and users take the view that universities consider their interest in delivered e-services while the vast majority of students believe that universities are honest in e-services. Findings show that less than 30% of students are satisfied with e-services in the past experience. The effectiveness and efficiency of e-services play a crucial role in enhancing citizen's trust. The assessment indicates that only 50% of citizens believe

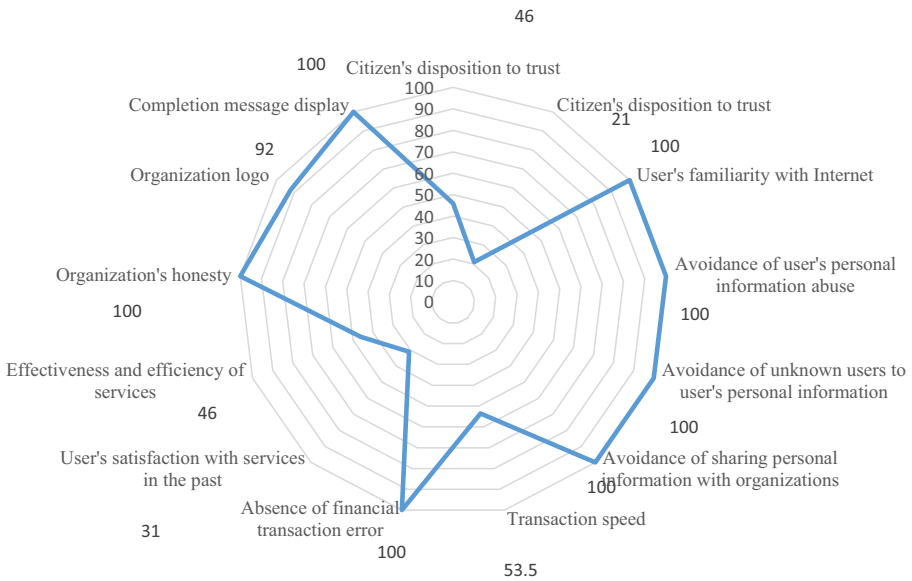


Fig. 3 Readiness of trust indicators

that e-services of university websites are efficient and effective. As the vast majority of university websites users are students, they have knowledge about how to access the internet, therefore. Its readiness value is 100%. A huge volume of user's personal information is kept on the websites. It is highly expected from universities to keep them confidential and avoid sharing them with other organizations and unknown people whose readiness value is obtained 100% indicating that user's personal information is not at risk of disseminating with abusers and other organizations.

The absence of financial transaction errors on the website also makes a contribution to increasing user's trust which is well-considered and users can do financial transactions with the least errors. User's willingness to trust the other party is mostly relevant to social and cultural characteristics. The indicator is not in suitable status such that just half of the users are inclined to trust the third party. Having a logo on web pages and displaying completion message is also well-considered on all of the websites. The final readiness value of the trust index is equal to 74%.

6.2 Responsiveness quality

Responsiveness quality assesses website responsiveness to user's requests on the website. The index is comprised of two parts such as infrastructure and user interface (UI). Website infrastructure assesses the speed of website response after each click. Applying wide bandwidth plays an important role in raising data transfer speed between the user's browser and servers, moreover, it allows more users to access websites concurrently. Using low-size files and pictures can enhance website response to user's requests. Due to the rapid development of social networks among the general population, website compatibility with social networks can increase the website's response to meet more user's requests. Figure 4 shows the readiness value of indicators:

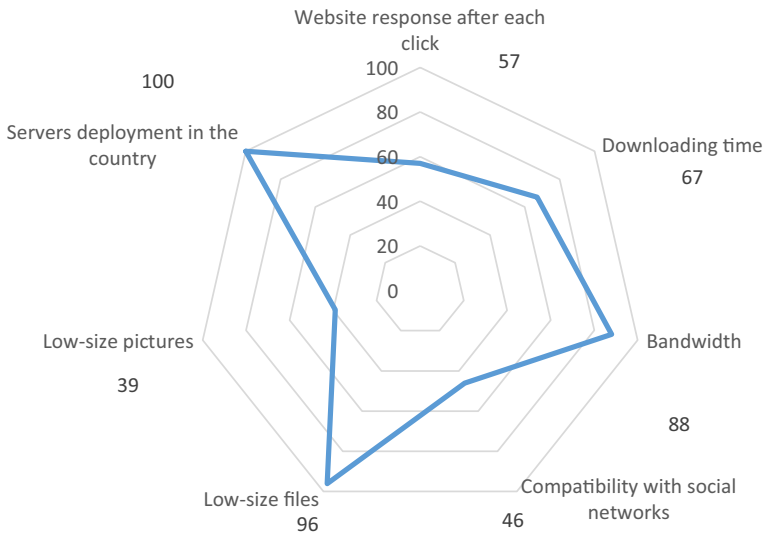


Fig. 4 Readiness of responsiveness quality indicators

The most important indicators are website response after each click and required time for downloading documents that are not well-assessed and only half of the websites enjoy satisfactory response time. Low-size files and pictures are observed in more than 90% of websites. Social network compatibility is so pivotal to meeting online user's requests. Findings show that only half of the websites are equipped with social networks. The final readiness value of the responsiveness quality index is equal to 72%.

6.3 Content and information quality

The index assesses the information quality based on precision, accuracy and update of information. Presenting information with different formats allows users to have easy access to information. Presenting Information in a simple language without any complexity and ambiguities is another important indicator for leveraging information quality. Figure 5 shows the readiness value of indicators:

The most important indicator is information precision which is considered in 75% of websites. Information accuracy and updating are other important indicators that are considered in more than 50% of websites. Presenting information based on user's requirements is so crucial whose readiness value obtained around 40%. Since users use different software for viewing information, presenting information by different formats such as PDF and HTML facilitates information access which is considered in less than 20% of websites. Displaying the last date of website update is observed in less than 40% of the websites. The final readiness value of content and information quality index is equal to 67%.

6.4 Website design

The index is comprised of two main dimensions such as visual beauty and technical features of website. The visual beauty is responsible for assessing the uniformity of web

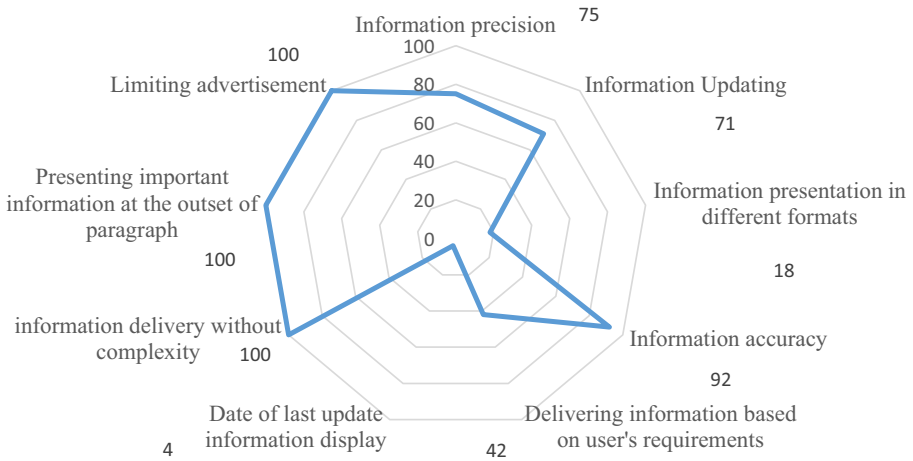


Fig. 5 Readiness of content and information quality indicators

pages such as color, font and the same design. The indicators make the websites more appealing and attractive to users. The technical features of the website are assessed by website compatibility with different systems and browsers. Figure 6 shows the readiness value of indicators:

The vast majority of websites consider the most important indicators such as website compatibility with browsers and systems. Since the websites allow students to take credit for each semester, therefore, presenting personalized e-services is provided such that more than 80% of websites are equipped with. Page title, simple pictures, font and personalized information registration is considered in more than 80% of the websites. Using the same font and simple design is just observed in more than 50% of the websites which intends to decrease websites' attractiveness and integrity. The final readiness value of the website design index is equal to 79%.

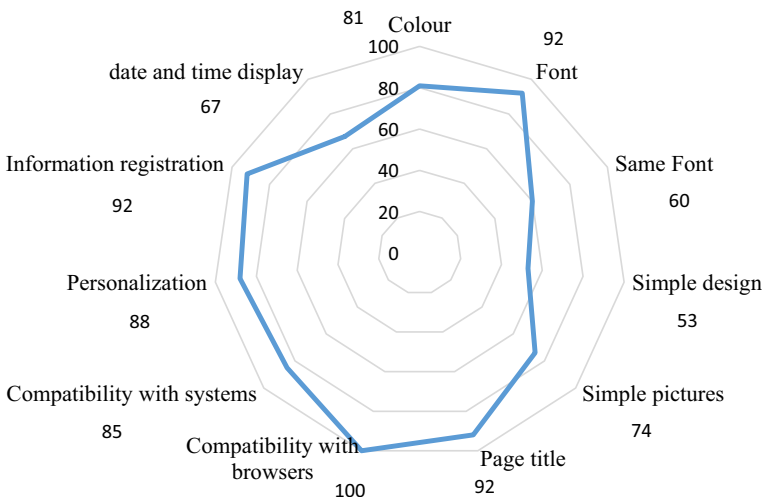


Fig. 6 Readiness status of website design indicators

6.5 Support and maintenance

The index assesses existed facilities such as online support and maintenance and website user manual for guiding people aimed at better use of e-services. Other indicators intend to keep users informed regarding the status of online requests such as sending tracking numbers and sending informative emails to users about the last status of requests. Figure 7 shows the readiness value of indicators:

The most important indicator is online support which helps users experience a better use of the website. The indicator is considered in less than 50% of websites. Online maintenance is also another indicator that is observed in less than 20% of websites. Sending emails for informing users regarding their requests is poorly considered and only 4% of websites are equipped with. The final readiness value of support and maintenance index is equal to 30%.

6.6 Usability

The index assesses required facilities for ease of use of websites and e-services which take place through a search engine, simple menus and a website map. Ability to cancel process and return to previous step during transaction facilitates the use of websites and e-services. Figure 8 shows the readiness value of indicators:

The vast majority of websites (more than 80%) consider the most important indicators such as accessibility, simple menus and search engines. Website map plays a crucial role in directing users to reach information and e-services conveniently which is observed in 50% of the websites. Link management assesses the activation of links for connecting to other web pages and websites. Findings indicate that 20% of links are broken therefore the readiness value of the indicator is 80%. The final readiness value of the usability index is equal to 72%.

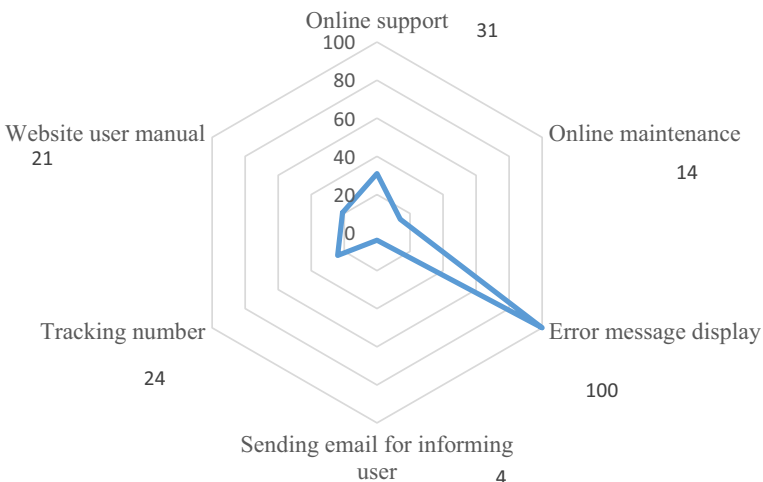


Fig. 7 Readiness of support and maintenance indicators

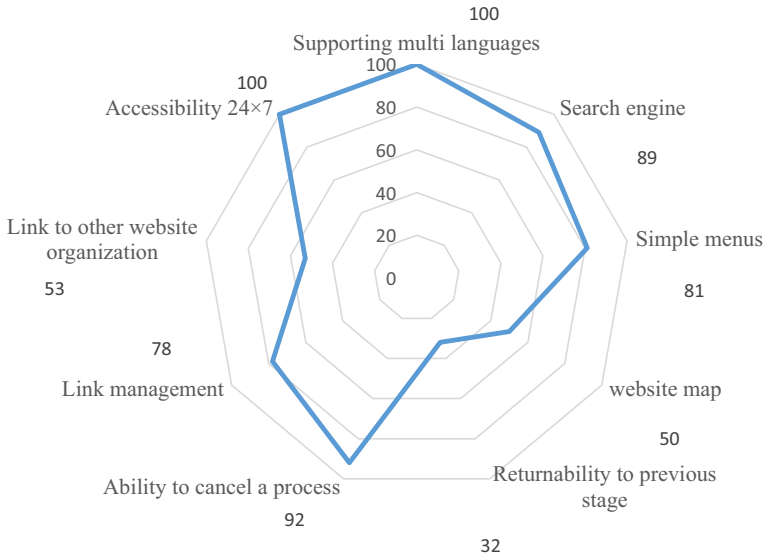


Fig. 8 Readiness of usability indicators

6.7 Services

The index assesses the variety and number of delivered services. The most important services are downloadable forms, downloadable tender documents and online financial transactions. The Number of specialized e-services for students and researchers is another indicator. Figure 9 shows the readiness value of services indicators:

Downloadable forms is one of the most important indicators whose readiness value is 92%. Downloadable tender documents and online tender participation enable users to participate in tender easily which are assessed below the par and their readiness values

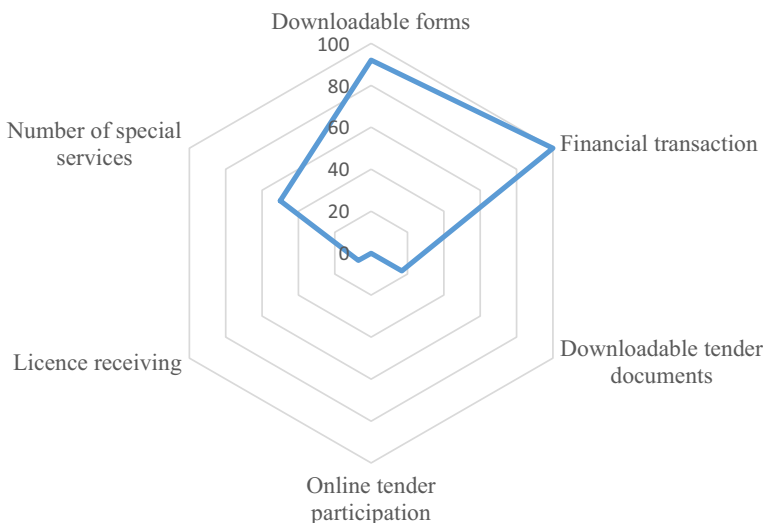


Fig. 9 Readiness of services indicators

are less than 20%. Financial truncation is so helpful for users to experience online payment which is existed in all the websites. The final readiness value of the services index is equal to 51%.

6.8 Participation

Since one of the main objectives of e-services development is increasing user’s participation in organizational decisions and processes. The index evaluates the presence of facilities for increasing user’s transactions with the organization and website. The indicators assess facilities for enabling users to leave comments and suggestions such as online survey, frequent questions and answers (FAQ), online complaints and online criticism. Other relevant indicators are online weekly newsletters and online meetings for informing users about the latest delivered e-services. Other indicators assess the required information to contact an organization such as email and number. Figure 10 shows the readiness value of indicators:

The most three important indicators are online complaints and criticism, frequent answers and questions and online surveys. The finding show that they are considered in less than half of the websites. Online voting and online meeting aimed at collecting users’ comments in the organization’s decisions and informing users can leverage user’s participation whose readiness value is zero such that they do not exist in any websites. The final readiness value of the participation index is equal to 41%.

The index readiness value is obtained by calculating the average readiness value of relevant indicators. Table 8 and Figure 11 shows the readiness value of indexes in e-services of university websites:

Table 9 shows the readiness value of indexes on university websites. The readiness value of each website can be obtained by the addition of multiplication of indexes’

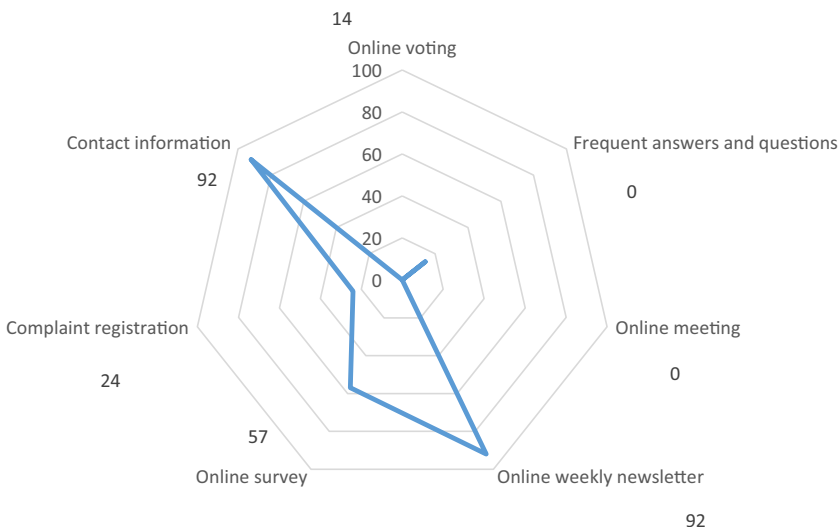


Fig. 10 Readiness of participation indicators

Table 8 Readiness value of indexes

No.	Index University	Website design	Responsiveness quality	Security	Content and information quality	Participation	Trust	Support and maintenance	Services	Usability
1	Tehran University	%90	%57	%50	%55	%28	%61	%16	%42	%66
2	Tehran University of medical science	%81	%42	%50	%66	%28	%69	%33	%71	%88
3	Sharif University of technology	%81	%57	%50	%66	%28	%61	%16	%42	%55
4	Amir Kabir University of technology	%54	%57	%50	%55	%42	%61	%33	%42	%55
5	Tarbiat Modares University	%90	%85	%66	%88	%57	%84	%33	%57	%55
6	Shahid Beheshti University of medical sciences and health services	%90	%71	%50	%55	%28	%92	%33	%57	%77
7	Isfahan University of technology	%81	%71	%50	%44	%42	%77	%33	%57	%88
8	Iran University of science and technology	%81	%85	%50	%66	%28	%69	%16	%42	%55
9	Ferdowsi Mashhad University	%72	%57	%50	%66	%42	%84	%16	%42	%77
10	Shahid Beheshti University	%100	%71	%66	%66	%28	%69	%16	%57	%77
11	Shiraz University	%27	%85	%50	%88	%42	%84	%16	%57	%77
12	Tabriz University of medical sciences	%100	%42	%50	%100	%57	%77	%33	%42	%77
13	Mashhad University of medical science	%90	%85	%50	%66	%42	%84	%66	%42	%88
14	Tabriz University	%81	%85	%66	%55	%42	%69	%33	%57	%66
15	Shiraz University of medical sciences	%72	%85	%50	%77	%28	%100	%16	%57	%66
16	K.N Toosi University of technology	%90	%85	%66	%66	%25	%69	%50	%57	%66
17	Alzahra	%72	%71	%66	%55	%62	%76	%33	%57	%88
18	Kharazmi	%100	%71	%66	%66	%37	%69	%33	%57	%88
19	Allameh Tabatabaee	%63	%100	%37	%77	%62	%69	%16	%57	%77
20	Iran medical science University	%54	%57	%66	%66	%50	%61	%66	%42	%77
21	Ahvaz medical science University	%90	%100	%66	%66	%75	%76	%33	%42	%66

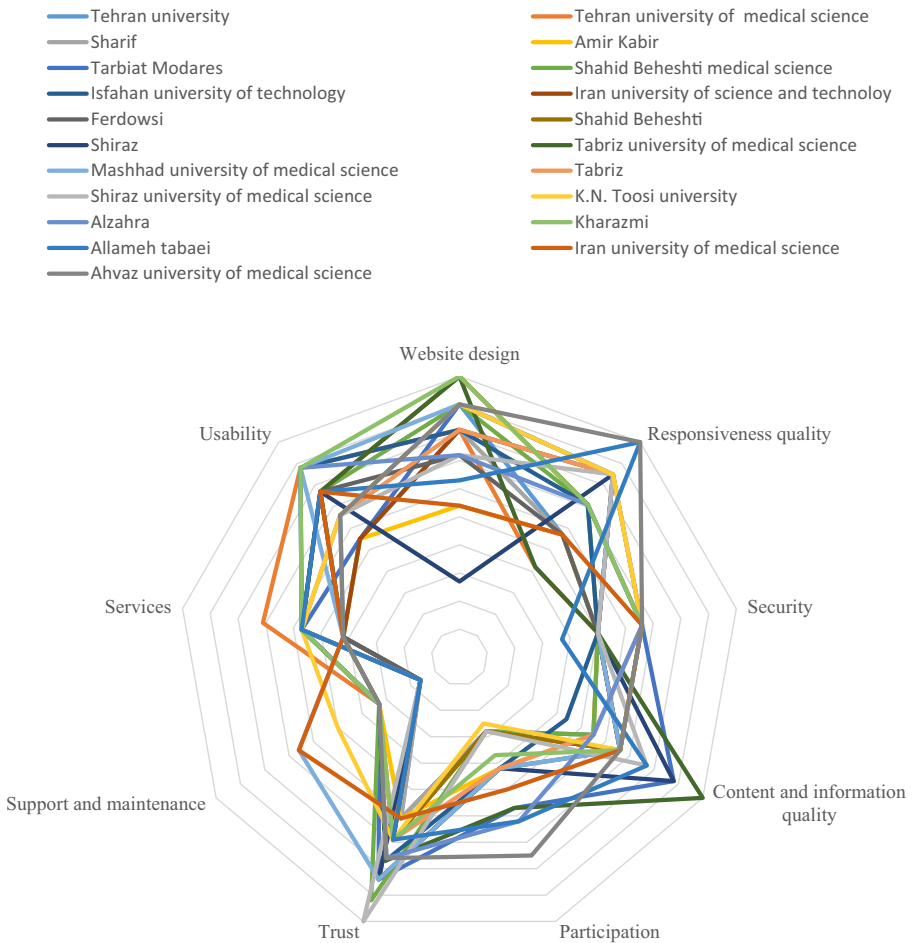


Fig. 11 Readiness status of indexes

weight into average indicators’ readiness value which is shown in Table 8. The readiness value of university websites is a number between zero and one. The higher value denotes the higher readiness of websites.

As shown in Table 9, the readiness value of 21 outstanding university websites is obtained and ranked. Higher value indicates the higher readiness. The final result shows that Tarbiat Modares University and Amirkabir University received the highest and lowest readiness respectively.

7 Discussion

The purpose of this paper is proposing an extended model for assessing the e-services of university websites. The model is able to assess the readiness value of e-services websites as well as recognizing weaknesses and strengthens. The model is comprised of nine indexes such as security, trust, content and information quality, responsiveness quality, website

Table 9 Readiness value of top-leading Iranian university websites

Ranking	University	Readiness value (from one)
1	Tarbiat modares	0.7718
2	Ahvaz university of medical science	0.7470
3	Shiraz university of medical science	0.7189
4	Mashhad university of medical science	0.7051
5	K.N. Toosi University	0.6985
6	Kharazmi	0.6908
7	Tabriz university of medical science	0.6807
8	Shahid Beheshti	0.6798
9	Tabriz university	0.6725
10	Alzahra university	0.6688
11	Shahid Beheshti university of medical science	0.6685
12	Shiraz university	0.6648
13	Allameh tabaei university	0.6509
14	Iran university of science and technology	0.6356
15	Ferdowsi University	0.6248
16	Isfahan university of technology	0.6165
17	Iran university of medical science	0.6124
18	Tehran university of medical science	0.5879
19	Sharif university of technology	0.5734
20	Tehran university	0.5669
21	Amir kabir university of technology	0.5383

design, participation, support and maintenance, services and usability and relevant indicators for measuring indexes.

Since the e-services development is different in countries, therefore proposing a comprehensive model being compatible with all countries is impossible therefore previous studies have conducted their research on a specific territory. Manzoor et al. (2019) suggested a model for e-services of university websites in the US, Europe and Canada. Benaida et al. (2018) conducted a study for evaluating Arabic university websites. Faustina and Balaji (2016) carried out a research on assessing the quality of Indian university websites. Previous studies show that each model is context-based and suitable for a specific country and cannot be applied for other territories. Consequently, having a model for assessing Iranian e-services of university websites is essential to be designed.

In this study 9 indexes are taken into account for assessing the readiness of e-services websites while previous studies considered the limited number of indexes. Manzoor et al. (2019) mostly focused on usability of university websites. Benaida et al. (2018) considered wider aspects of e-services websites by considering following indexes trust, support and maintenance, website design and usability. Faustina and Balaji (2016) concentrated on website responsiveness and website design. Additionally, one of the main objectives of e-services is increasing people's involvement in organizational activities and processes, however, none of the previous studies have taken

participation index into account. The proposed model is comprised of more various indexes and indicators which is able to provide more precise and accurate result in comparison with previous studies.

Assessing and ranking the readiness of e-services websites are conducted based on conflicting qualitative and quantitative indexes and indicators which is seen as a Multi Criteria Decision Making (MCDM) problem (Abdel-Basset et al. 2018; Burmaoglu and Kazancoglu 2012). The preference and importance of extracted indexes and indicators are obtained by MCDM methods. The indexes are assigned a weight by AHP method and indicators are ranked using PROEMTHEE method. The preference of indexes are obtained as: security, trust, responsiveness quality, content and information quality, website design, support and maintenance, usability, services and participation.

The extended model is proposed for assessing e-services of Iranian university websites. The Iranian e-services development is medium (ranked as 86th country in the world) (Pena-Lopez 2018). The preference ranking of indexes shows that infrastructural indexes (such as security, trust, responsiveness quality and content and information quality) receive higher weight comparing to other indexes which assess the ease of use of websites and citizen's involvement (such as participation, support and maintenance, services and usability). The final result of the model is supported by Asian countries whose e-services developments are similar to Iran's. Table 10 indicates the preference of indexes in different countries and continents:

As shown in Table 10, the infrastructural indexes received better ranking and higher weight in Chinese, Asian and Indian countries whose e-services development are close to Iran (Pena-Lopez 2018).

The model assigned lower weight to the indexes which assess the citizen's involvement and ease of use of websites such as services, support and maintenance, participation and usability. The Asian and Chinese studies supported the research result which is shown in Table 11:

Table 10 Preference of Infrastructural indexes in previous studies

Index	Country	Ranking	Number of indexes	Weight	Reference
security	China	3	6	0.113	(Liu and Wang 2008)
	China	7	19	0.032	(Yuan and Yuan 2009)
	Europe	6	15	0.030	(Burmaoglu and Kazancoglu 2012)
Responsiveness quality	Asian Countries	2	6	0.255	(Dominic et al. 2010)
	India	1	8	0.300	(Faustina and Balaji 2016)
Content and information quality	China	1	4	1	(Guo et al. 2010)
	China	1	4	0.483	(Yuan and Yuan 2009)
	China	2	6	0.249	(Liu and Wang 2008)
	China	1	5	0.403	(Zhu et al. 2007)
	China	1	5	0.416	(Zhou et al. 2013)

Table 11 Preference of participation and ease of use of websites indexes in previous studies

Index	Country	Ranking	Number of indexes	Weight	Reference
Participation	China	2	4	0.720	(Guo et al. 2010)
	Europe	4	14	0.122	(Burmaoglu and Kazancoglu 2012)
	Australia	1	18	0.18	(Hensriksson et al., 2007)
Website design	China	4	4	0.720	(Guo et al. 2010)
	China	5	5	0.028	(Yuan and Yuan 2009)
	China	5	6	0.079	(Liu and Wang 2008)
	China	3	5	0.091	(Zhu et al. 2007)
Usability	China	4	5	0.067	(Yuan and Yuan 2009)
	Australia	1	18	0.18	(Henriksson et al. 2007)
Support and maintenance	China	3	5	0.124	(Zhou et al. 2013)
Services	Europe	1	3	0.646	(Burmaoglu and Kazancoglu 2012)

Findings show that the preference of citizen's involvement and ease of use of websites indexes are less important than infrastructural indexes in Chinese studies whose e-services development is similar to Iran's. On the flip side, the situation is different in more developed countries such as Australia. The importance of infrastructural indexes are less evaluated while ease of use of websites and citizen's involvement receive higher preference.

8 Conclusion

In this paper, an extended model is proposed for assessing the readiness of e-services of university websites. The most influential and relevant studies with the title of university website assessment are reviewed. The most important indexes and indicators are extracted from previous studies that are capable of evaluating various dimensions of e-services websites. Assessing e-services website is a Multi Criteria Decision Making problem so the extracted indexes and indicators are assigned weight and ranked by hybrid MCDM methods such as AHP and PROEMTHEE methods respectively. A pairwise comparison questionnaire was disseminated between 80 experts in the sphere of e-services and Information Technology (IT) to assess indexes and indicators. The experts are selected based on a purposive sampling technique. The most important indexes are obtained as security, trust, content and information quality, responsiveness quality, website design, participation, support and maintenance, services and usability. Finally, the model was applied for assessing the readiness of 21 top-leading Iranian university websites. The final result shows that Tabiat Modares and Amirkabir university websites have the highest and lowest readiness respectively.

References

- Abdel-Basset, M., Zhou, Y., Mohamed, M., & Chang, V. (2018). A group decision making framework based on neutrosophic VIKOR approach for e-government website evaluation. *Journal of Intelligent and Fuzzy Systems*, 34(6), 4213–4224.
- Abdulah, L., Chan, W., & Afshari, A. (2019). Applications of PROMETHEE method for green supplier selection: A comparative result based on preference functions. *Journal of Industrial Engineering International*, 15(2), 271–285.
- Al-dweeri, R. M., Ruiz Moreno, A., Motes, F. J. L., Obeidat, Z. M., & Al-dwairi, K. M. (2019). The effect of e-service quality on Jordanian student's e-loyalty: An empirical study in online retailing. *Industrial Management and Data Systems*, 119(4), 902–923.
- Ali, H. (2019). Measurement of e-services quality: An empirical study of University of Bahrain. *Education and Information Technologies*, 24(3), 1907–1924.
- Alotaibi, M. B. (2013). Assessing the usability of university websites in Saudi Arabia: A heuristic evaluation approach. In *Paper presented at the proceedings of the 2013 10th international conference on information technology : New generation, ITNG 2013*.
- Alzahrani, L., Al-Karaghoul, W., & Weerkkody, V. (2017). Analyzing the critical factors influencing trust in e-government adoption from citizen's perspective: A systematic review and a conceptual framework. *International Business Review*, 26(1), 164–175.
- Alzahrani, L., Al-Karaghoul, W., & Weerkkody, V. (2018). Investigating the impact of citizen's trust toward the successful adoption of e-government: A multigroup analysis of gender, age, and internet experience. *Information Systems Management*, 35(2), 124–146.
- Asees Awan, M., & Ali, Y. (2019). Sustainable modeling in reverse logistics strategies using fuzzy MCDM: Case of China Pakistan economic corridor. *Management of Environmental Quality: An International Journal*, 30(5), 1132–1151.
- Benaïda, M., Namoun, A., & Taleb, A. (2018). Evaluation of the impact of usability in Arabic university websites: Comparison between Saudi Arabia and the UK. *International Journal of Advanced Computer Science and Applications*, 9(8), 365–375.
- Burmaoglu, S., & Kazancoglu, Y. (2012). E-government website evaluation with hybrid MCDM method in fuzzy environment. *International Journal of Applied Decision Sciences*, 5(5), 163–181.
- Carfora, D., Dio Gironimo, G., Esposito, G., Huhtala, K., Maatta, T., Mäkinen, H., Micciché, G., & Mozzillo, R. (2016). Multicriteria selection in concept design of a diverter remote maintenance port in the EU DEMO reactor using an AHP participative approach. *Fusion Engineering and Design*, 112, 324–331.
- Concha, G., Astudillo, H., Porrúa, M., & Pimenta, C. (2012). E-government procurement observatory, maturity model and early measurements. *Government Information Quarterly*, 29(SUPPL.1), S43–S50.
- Darko, A., Chan, A. P. C., Ameyaw, E. E., Owusu, E. K., Pam, E., & Edwards, D. J. (2019). Review of application of analytic hierarchy process (AHP) in construction. *International Journal of Construction Management*, 19(5), 436–452.
- Devi, K., & Sharma, A. K. (2016). Implementation of a framework for website quality evaluation: Himachal Pradesh University website. *Indian Journal of Science and Technology*, 9(40).
- Dominic, P. D. D., Jati, H., & Kannabiran, G. (2010). Performance evaluation on quality of Asian e-government websites-an AHP approach. *International Journal of Business information systems*, 6(2), 219–239.
- Faustina, F., & Balaji, T. (2016). Evaluation of universities websites in Chennai city, India using analytical hierarchy process. In *Paper presented at the international conference on electrical, electronics, and optimization techniques, ICEEOT 2016*.
- Guo, S., Hai, M., & Wang, M. (2010). A performance evaluation model of e-government website based on public attention. In *Paper presented at the 2010 international conference on E-product E-service and E-entertainment, ICEEE 2010*.
- Hasan, L. (2013). Heuristic evaluation of three Jordanian university websites. *Informatics in Education*, 12(2), 231–251.
- Hatami-Marbini, A., Tavana, M., Moradi, M., & Kangi, F. (2013). A fuzzy group Electre method for safety and health assessment in hazardous waste recycling facilities. *Safety Science*, 51(1), 414–426.
- Henriksson, A., Yi, Y., Frost, B., & Middleton, M. (2007). Evaluation instrument for e-government websites. *Electronic Government*, 4(2), 204–226.
- Huang, Z., & Benyoucef, M. (2014). Usability and credibility of e-government websites. *Government Information Quarterly*, 31(4), 584–595.

- Iannacci, F., Seepma, A. P., de Blok, C., & Resca, A. (2019). Reappraising maturity models in e-government research: The trajectory-turning point theory. *Journal of Strategic Information Systems*, 28(3), 310–329.
- Ismailova, R., & Inal, Y. (2018). Accessibility evaluation of top university websites: A comparative study of Kyrgyzstan, Azerbaijan, Kazakhstan and Turkey. *Universal Access in the Information Society*, 17(2), 437–445.
- Ismailova, R., & Kimsanova, G. (2017). Universities of the Kyrgyz Republic on the web: Accessibility and usability. *Universal Access in the Information Society*, 16(4), 1017–1025.
- Joshi, P. R., & Islam, S. (2018). E-government maturity model for sustainable E-government services from the perspective of developing countries. *Sustainability (Switzerland)*, 10(6).
- Karabatak, S., & Polat, H. (2019). The effects of the flipped classroom model designed according to the ARCS motivation strategies on the student's motivation and academic achievement levels. *Education and Information Technologies*.
- Konstantinos, I., Georgios, T., & Garyfalos, A. (2019). A decision support system methodology for selecting wind farm installation locations using AHP and TOPSIS: Case study in eastern Macedonia and Thrace, Greece. *Energy Policy*, 132, 232–246.
- Liu, J. S., & Wang, Y. Z. (2008). On the study of project evaluation of websites of e-government procurement of China. In *Paper presented at the 2008 international conference on wireless communications, networking and Mobile computing*, WiCOM 2008.
- Manzoor, M., Hussain, W., Sohaib, O., Hussain, F. K., & Alkhalaf, S. (2019). Methodological investigation for enhancing the usability of university websites. *Journal of Ambient Intelligence and Humanized Computing*, 10(2), 531–549.
- Pena-Lopez, I. (2018). *UN e-government survey 2018*. E-government in Support of Sustainable Development.
- Porumbescu, G. A. (2016). Linking public sector social media and e-government website use to trust in government. *Government Information Quarterly*, 33(2), 291–304.
- Rasyid, A., & Alfina, I. (2017). E-service quality evaluation on e-government website: *Case study BPJS Kesehatan Indonesia*. Paper presented at the journal of physics: Conference series.
- Singh, R. K., Kansara, S., & Vishwakarma, N. K. (2018). Vendor rating system for an Indian start-up: A combined AHP & TOPSIS approach. *Measuring Business Excellence*, 22(3), 220–241.
- Singla, B. S., & Aggarwal, H. (2018). Evaluation of Indian universities' websites in terms of information quality: Differences in the perspective of end users segments based on their socio-demographic characteristics. *International Journal of Business Information Systems*, 27(2), 135–176.
- Sivaji, A., Abdullah, A., & Downe, AG. (2011). Usability methodology: Effectiveness of heuristic evaluation in E-government website development. *Paper presented at the Proceedings-AMS 2011: Asia modeling symposium 2011- 5th Asia International Conference on Mathematical modeling and computer Simulation*.
- Tella, A. (2019). The determinants of library and information science undergraduate student's first impression of university library websites. *Education and Information Technologies*, 24(1), 277–294.
- Tsai, W. H., Purbokusumo, Y., Julian, M. S., & Tuan, N. D. (2009). E-government evaluation: The case of Vietnam's provincial websites. *Electronic Government*, 6(1), 41–53.
- Twizeyimana, J. D., & Andersson, A. (2019). The public value of E-government – A literature review. *Government Information Quarterly*, 36(2), 167–178.
- Unirank. (2019). Top Universities in Iran: 2019 Iranian University Ranking. Available at: <https://www.4icu.org/ir/>. (Accessed 10 October 2019).
- Verkijika, S. F., & De Wet, L. (2018a). A usability assessment of e-government websites in sub-Saharan Africa. *International Journal of Information Management*, 39, 20–29.
- Verkijika, S. F., & De Wet, L. (2018b). Quality assessment of e-government websites in Sub-Saharan Africa: A public values perspective. *Electronic Journal of Information System in Developing Countries*, 84(2).
- Wang, C., Niu, J., Zhang, Y., & Pan, D. (2019). An evaluation model based on the fuzzy AHP for teleoperation performance. *International Journal of Aerospace Psychology*, 29(1–2), 42–52.
- Wu, Y., Zhang, B., Wu, C., Zhang, T., & Liu, F. (2019). Optimal site selection for parabolic trough concentrating solar power plant using extended PROMETHEE method: A case in China. *Renewable Energy*, 143, 1910–1927.
- Yuan, K., & Yuan, J. (2009). Model of integrated assessment of e-government website based on analytic hierarchy process. In *Paper presented at the 2009 international conference on management of e-commerce and e-government, ICMCG 2009*.
- Zhou, X., Xie, H., & Yu, H. (2013). Determination of the weight values of assessment indexes of website based on AHP-take the website of university library as an example. *Paper presented at the proceedings – 2013 international conference on computational and information sciences, ICCIS 2013*.

- Zhou, R., Wang, X., Shi, Y., Zhang, R., Zhang, L., & Guo, H. (2019). Measuring e-service quality and its importance to customer satisfaction and loyalty: An empirical study in a telecom setting. *Electronic Commerce Research*, 19(3), 477–499.
- Zhu, Q., Du, J., & Han, X. (2007). The establishment and application of evaluation criteria system for Chinese e-government websites. *Paper presented at the 2007 international conference on wireless communications, networking and mobile computing, WICOM 2007*.
- Zyoud, S. H., Fuchs-Hanusch, D., Shabeen, H., Samhan, S., Rabi, A., & Al-Wadi, F. (2016). Utilizing analytic hierarchy process (AHP) for decision making in water loss management of intermittent water supply systems. *Journal of Water sanitation and Hygiene for Development*, 6(4), 534–546.

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