Chapter 4
A Method to Evaluate E-Government Service Quality Attributes

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Abstract Many government organizations attempted to leverage Internet-based technologies to improve public service through electronic means, termed as e-service. Besides the tangible services, government increasingly encounter and adopt intangible services to meet user needs. Government invests significant financial amounts alongside the non-financial resources to keep e-services up-to-date. E-government service assessment ensures the quality of their services, resource allocation priorities and potential service factors to identify what services may work together to engage users to the government policies. Although a limited studies have been done, researchers proposed several multicriteria decision methods to index e-service quality based on user survey profiles. This study presents a multicriteria decision model combining Analytic Hierarchy Process and entropy weight technique to demonstrate e-government service priority selection. The model synthesize a local and global index priorities among 18 different categories of e-services, classified into three quality dimensions. The presented analysis do not offer the complete roadmap of e-government evaluation. Further research needed to set priorities to specific e-services. The empirical result indicates that improving *e-Efficiency* is the top priority, followed by *e-Support* commitment and *e-Reliability* information in tracing e-government service and engagement.

Keywords E-government • Service quality attributes • Entropy method • Resource allocation

1 Introduction

The evolution of e-government engagement and e-service access in the public domain in both developing and developed nations have changed the way government and policy makers communicate with their citizens. Government services using the web technologies and electronic communication to provide efficient, transparent

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and reliable information are essential for effective governance. The government e-services include developing user-friendly websites with information, guidelines, electronic forms and Frequently Asked Questions etc. In recent years, nearly all transactions with government tend to use electronic communications. Service members use multiple communication channels such as telephone, e-mail, message boards to interact with users for personal advice, track the progresses and update status report of a pending transaction. However, e-government suffers from many fiscal limitations often experienced by general users, and private and public sectors. Users can be significantly affected by the public policies due to unfamiliarity and uncertainty about the future of the policy. The users can significantly contribute to the improvement and the success of e-government development and policies by offering their individual experience, unique insight and knowledge. The e-government success depends on the ability to interact with users and collect interrelated information and communication from the user feedback. The multicriteria method has the potential for e-government personnel to identify the key attributes to focus and allocate resources to keep the e-services on track.

E-service increasingly encounter many intangible service attributes alongside the tangible services. Intangible service attributes include innovative technology ideas, new service attributes, learning principles, and self-service assistance have great impacts on policy success and user satisfaction. These attributes are associated with service personnel actions, interoperability, understanding, preparedness on service tools and technologies, service awareness, and information sharing with users. Improving e-service quality is vital to any government in order to engage users for more effective participation and contribution. The evaluation of e-government service quality attributes can be critically appraised using Multi-Criteria Decision Models (MCDM). A major contribution of MCDM is to identify the high priority weight factors to increase service efforts and resource allocation for improved performance. The study of a multi-dimensional decision making approach helps to understand social signals and recognize users intention to the high priority government services offered in the public sectors. This definitely helps to realign the focus the quality and performance of underlying system, processes and incorporate resource to enhance e-service support.

Previous studies have shown that there are direct connections between e-service quality and specific goals and performance of traditional service channels. E-service quality largely depends on user perception of the service quality, resources and satisfaction. As soon as the user needs are identified, government organizations initiate the arrangement to provide e-services such as creating electronic document, e-forms, up-to-date reports and up-to-date financial statement to meet the expectations. The prerequisite to achieve a high level service quality is mainly the ability to categorize desirable e-services offered, analyze future demand, and effectively manage the needs by anticipating interests and properly allocating resources to respond the evolving needs. E-service attributes are directly associated with design, personalization, interaction between users, private and public sectors, vendors, and professional partners and inter departments between the government organizations.

However, user perception about e-service quality and responses are often not incorporated as a tool to evaluate e-learning and service quality.

The majority of service quality models emphasize e-service reliability, web support by the government personnel, and efficiency of the government website. The factoring analysis of the proposed e-service priority attributes is absence in the model. In this global economy, the understanding of user expectation, service needs, perception of quality, weight factors and technical ability to provide quality feedback are crucial in order to achieve satisfaction. This study measures three dimensions of the e-service factors: 'efficiency of the e-service', 'e-support by the service personnel', and 'e-reliability on information' to develop a coordination between the government and users. This method embraces e-service quality factors existed in the literature and a multidimensional hierarchical model for e-service quality priority analysis. Following are the attributes:

1. E-reliability is the expected response quality of what a customer actually experiences as a result of user interaction with the government agencies. It is important to review the users' perception of quality to develop and enhance e-government facilities.
2. E-support is the perceived service that a user actually receives from the service firm in relation to waiting time to service, service time, and deviation request. This is important to review the users' views of e-service technical performance evaluation.
3. E-efficiency is the ability of a service or product to meet the needs and expectations of the users. This can be achieved by benefit service package, commitment to service, and other factors inclusive (effective e-government site's search engine, organized site map, completeness of information, and updated information).

A better performance in e-service quality in e-government domain gains a competitive advantage and cost effective services. The OECD defined e-government as the use of information and communication technologies, particularly the internet, as a tool to achieve better governance [1]. There are four pillars of e-Government, people, process, technology and resources. Decision making in relation to e-government service priorities is essential for delivering the highest quality services, increased participation, higher retention, and fewer mistakes requiring the e-service performance improvement. E-government engagement should be managed by teams with decades of service quality experience. The World Bank Group noted that e-government initiatives serve a variety of different ends including better delivery of government services to citizens, improved interactions with business and industry, citizen empowerment through access to information, or more efficient government management [2]. Decision-making to identify the best practicing service quality attributes critical to public is not an easy task due to the varying opinions of individuals, groups, and divisions of a public sector. However, a service oriented evaluation to improve the e-service quality performed on a regular basis. World Bank Group noted that the resulting benefits can be less corruption, increased transparency, greater convenience, revenue growth, and/or cost reductions [2].

Following the quality management ideas from W.E. Deming, Joseph Juran and Kaoru Ishikawa to improve organizational effectiveness. There is an emphasis in the use of statistical quality control applications to manage quality assurance and quality control [3]. They also noted that quality as a preventive approach which was integral to everyone's job, rather than the traditional inspection-led reactive approach. The e-service can be attributed to check-do-act (CDA) quality plan and a continuous-improvement-process (CIP) approach to measure the effectiveness of service performance. Other authors explored e-government quality improvement in Australia by the application of information and communications technologies (ICT) to the organization and operation of government [4]. They conclude that there is major difficulties and a careful reworking of the concepts and tools is needed to be applied to the public sector. Developing a service quality index is a major strategy which employs a set of principles and practices to achieve a sustainable competitive advantage in the service industry.

The selection of e-service attributes with respect to improving the service quality is widely varied depending on the implicit expectations of the users. The perception of service quality varies from person to person. People perceive quality differently for the same services and e-learning features. In diverse decision-making groups, members have different experiences, values, attitudes, and cognitive approaches; consequently, they bring divergent perspectives to the group's problem [5]. It is also difficult to measure the quality of a service that is performing well today, but can go wrong tomorrow due to changes in customer needs or behavior, changes in competitive markets, innovations facilitating competitor advantages, and new self-serving technologies. Although the quality of a service means professionalism in all aspects, the expectation is even greater for user satisfaction. Thus, defining a service quality index is unique for a particular service and requires a dynamic, multi-dimensional approach for evaluation.

An ongoing set of studies refer that potential e-government benefits include reduced waiting time, increased level of accessibility, 24/7 access to services, greater transparency of information, and increased levels of citizen participation and satisfaction [4, 6]. Many e-government facilities have limited amounts of resources and capital to invest. The evaluation of e-service attributes is to prioritize service efforts and resource allocation for improved service performance, believed to be a Multi Criteria Decision Making (MCDM) problem which has grown significantly in past decades. In the area of MCDM, fuzzy set theory has given a significant contribution by accepting uncertainty and inconsistent judgment as a nature of human decision making [7]. The purpose of this study is to develop an e-service quality index (e-SQI) essential in the e-government service measures for quality management. The AHP technique prioritizes attributes in a hierarchical decision-making structure, which can be easily modified to incorporate specific attributes [8]. In this study, the hierarchical model technique is adopted to synthesize a systematic decision-making process to prioritize the e-service quality attributes. The ability to determine and analyze users' priority and measure the impact on e-service attribute are likely the

procedures to determine the success or failure of e-government. Identification of the desired service quality attributes is essential for government entities to endure effectiveness to its users in an increasingly complex, technological environment. A comprehensive, multidimensional assessment of e-service quality characteristics provides the scope to allocate limited resources, revitalize efforts towards e-services that have the greater impacts on successful e-government implementation. The resource allocation also improve user engagement, enhance the execution of public policies, and increase the provision of government services to benefit its users [9]. Undertaking the e-service priority selection, this study examines the role of quality dimension using multicriteria decision theories integrating entropy technique. The proposed model helps to determine the attributes desired to the users, likely to contribute e-government success. Attribute categories have collected from existing literatures. The pairwise orders based on their relative importance among the e-service factors in the AHP method will identify the factor priorities in a specific e-government domain.

The rest of the chapter is organized as follows: The next section illustrates the background of e-government service, review of popular models and role of government to improve e-service quality. The research methodology adopting the hierarchical model philosophy and entropy technique to prioritize e-service attributes is presented in the next section. An empirical illustration, results, and discussion adopted in this study are presented in the following section. Research findings, limitations, and outlining recommendation for future research is in the conclusion.

2 Literature Review

Over the past decade, many government sectors have established e-services that increasingly affects the lives of people in ever-increasing numbers. There is a considerable amount of literature review on e-government models used in the online environment regarding the effectiveness of e-service quality factors, outcomes and deliverables. Most popular models presented in the earlier literature always receive positive assessment of e-government development. The depth of information technology, easiness of internet service, wave of innovation technology revolutionize users' involvement and interaction with government policy and decision making process. Use of Internet reduces the service costs than traditional government service. The tremendous growth in e-government has created awareness among the users. However, e-government engagement have slowed in growth significantly in recent years, but lack the infrastructure, staffing, and expertise to provide meaningful and relevant services to its users [10]. Re-alignment of service focus and resource allocation is very important to ensure quality services.

Response quality to customer needs has consistently been at the core of research into service organization because it is recognized as a critical determinant of service performance and used as a strategic tool for firms wishing to gain long-term

viability [11]. Customer interaction is an important service quality attribute for the successful implementation of service. Reputable customer interaction motivates, avoids misunderstanding, and reduces the cost of quality by avoiding mistakes [12]. Researches showed the interaction with customers helps to provide a better control of processes, which ultimately improves quality [13]. The level of customer knowledge is an important attribute to measure. Response quality may be positively impacted if industries effectively relay information to enhance the knowledge of their customers. Knowledge becomes more important if industries offer tangible and intangible services that become increasingly complex in nature. Thus, an industry's ability to relay accessible information clearly and accurately will be highly valued. Customers will feel more confident and empowered in their decision making and will be less likely to experience feelings of regret or dissatisfaction with services offered. Transparency of information will enable customers and lead to increased levels of trust and perceived service quality [14, 15]. Processing time management is critical for improving service quality that emphasizes waiting time to service, service time (50th percentile), product shortages upon demand, technician evaluation performance, and deviation request. Process management emphasizes conformance to customer requirements by means of error-free services in an efficient manner [16]. A systemic decision-making process enables businesses to achieve an effective approach and process.

E-government can engage its users more effectively by utilizing web technologies, electronic communication and social media. Social media has both the capability to reach out to a large volume of individuals while at the same time interact with citizens personally and allow their collective voice to be heard. Utilizing these technologies can open up opportunities for its citizens to become engaged and allow governments to learn from the collective knowledgebase of its citizens [17]. To benefit appropriately from the government e-services, users can integrate themselves in the open source e-learning platform to accustom with a wide range of information and communication technology (ICT) system. Amongst a variety of e-Learning systems, researchers evaluated the usability issues of open source e-Learning platform such as WebGoat, so that its future versions can improve on usability aspects [18]. The e-service improvement upon yielding the greatest return on investment while maintaining the linear trajectory proposed by earlier models to ensure continued success and growth of e-government facilities depends on the users' participation in the services [19].

The dimension of e-service quality measurement on e-government domain has received attention in recent years. The models of service quality in literature contributed unique perspectives of how service quality can be measured and improved upon. There are a range of factors that may influence how service quality is perceived, measured, and quantified [9, 20]. The purpose of categorizing each model is to examine and observe the similarities and differences between the e-services. It also provides insight into how quality attributes can be further implemented, identified and prioritized. Three main attribute categories: E-Government website

reliability (e-Reliability), employees' support (e-support) and website efficiency (e-Efficiency) are determined after assessing the core conceptual attributes of most e-government facility service. The study implements the e-government service evaluation to provide the understanding of e-service factors that are important to users and potential for development of e-government as a good government practice.

A growing number of researches referred e-government services as the degree to which an E-government website facilitates that competent to deliver efficient e-services to help users, businesses and agencies in achieving their governmental transactions [21]. There are several critical factors that have contributed to a decline in e-government adoption and effectiveness. A lack the basic skills, access to the Internet, lack of assistance, low return on investment and unsatisfied demand from users and businesses contributes greatly to the failed initiatives of e-government. Past research indicated in 2001 that 60% of white households in the U.S. had Internet access, while only 34% of African American and 38% of Latino households did. Likewise, roughly 78% of households with income between $50,000 and $75,000 had Internet access compared to only 40% of those with household incomes between $20,000 and $25,000 [22]. Analyzing the basic abilities and services researchers recognized many people lack the basic skills needed to interact with computer hardware and software [23]. Researchers have established that the old, less educated, poor and minority individuals are more likely to need computer assistance, such as help using the keyboard or e-mail [24].

There are other challenges in e-government services such as difficulty in verifying the identity (e-identity), e-security, difficulty in finding reliable models. Public management outcomes are more difficult to discern and measure due to the varying nature of political agendas, strict adherence to the law, negative government reputation, and uncertain methods to measure the success of service deliverables [25]. E-government facilities is well-known to reach out to a diverse population and engage them to the service policies in an effective way. As an alternative, private providers are typically focused on targeting their customers in a way that will maximize profits [4]. The authors also noted that if a service quality problem is accurately defined and disseminated, e-government personnel have a greater likelihood to improve the way in which services are delivered and made transparent to the users. The studies are best described by three generic steps common in all models' construction and verification that include (1) conceptualization, (2) design, and (3) normalization [26]. Steps are the following.

(a) The first step of a model relates to conceptualization of the need of the e-services critical to public after an extensive literature survey.
(b) The second step focuses on validity and reliability analysis given the sample of items on operational issues and users' response.
(c) The third step concerns the effort to normalize the scale to rationalize the model, and e-service verification and validation.

Social media is another mean to connect e-government services via a set of online tools that are designed to provide social interaction and electronic communication. Further, the descriptions of government policy on social media can found in [12]. A collection of web-based technologies and services include blogs, Twitter, social sharing services (e.g., YouTube, Flickr, Stumble Upon, Last.fm), text messaging, discussion forums, collaborative editing tools (e.g., wikis), virtual worlds (e.g., Second Life), and social networking services (e.g. Facebook, MySpace) [27]. Managing perceived service quality means that the user has to match the expected service and perceived service to each other so that consumer satisfaction is achieved [20]. However, e-government provides productivity and efficiency of public services, as well as, provide better and more easy to use services. Three categorical quality attributes are chosen, which further organized with a number of sub-attributes to develop pairwise comparisons. The weights determination of quality factor is crucial in order to facilitate the ranking decision of quality criteria and sub-criteria. This study implements user feedback to determine the e-service priority using the AHP model integrated with entropy weight technique. The motivation to develop the priorities among the e-services factors and sub-factors given the chosen quality dimensions is to demonstrate the quality evaluation of e-service systems and electronic communication.

3 Quality Factor Analysis

A plethora of government agencies offer services through web portals and other Internet based technologies to improve users' relations and services. At the global level, the United Nations (2003) observed that "Governments are increasingly becoming aware of the importance of employing e-government to improve the delivery of public services to the people" [28]. The e-government development index and e-participation index of 10 ten countries is collected from UN e-government survey 2016 [29]; presented in Appendix 1. Key policy and research questions on privacy, security, accuracy, governance policy objectives are in Appendix 2.1 [30].

This study uses a decision-making process model to establish the priorities of government e-service quality attributes by building a service quality index. The study considers global weight factor and local weight factor to identify explicit and implicit e-service attributes at the group service quality and sub-factor levels. Hierarchical model helps to obtain priorities among service quality factors relevant to e-government services that are critical to public. In the pairwise comparison and the attribute selection process, one of the weakness in the AHP model is to find the proper standardized weight vectors. Application of one method often receives criticism for its inability to adequately handle the inherent uncertainty of priority and unknown attribute weights. Merging steps from multiple models and aggregating preferences of different decision makers in the selection process can avoid the biasness in the selection attribute weights and scales. In association with AHP, the entropy based method can improve decision-maker's perception

on priority and attribute weights. Using the strength of hierarchical model and entropy method, one can set priorities among different quality factors in systems to underlie different service phenomenon. The integration of AHP with entropy weigh technique strategy is aimed at reducing the uncertainty and inconsistency in human judgment during decision making processes by the policy makers. Based on the interaction with quality management officials and from literature review, three main categorical quality factors and 18 sub-criteria have been identified. Once the e-service priorities are established resources can be allocated according to priority index in order to achieve the maximum benefits from the e-service. The following ten steps demonstrate the AHP approach to identify priorities of the 18 criteria under three quality factors. The priorities are identified according to the global and local quality factor analysis.

The attributes were selected from the opinions of experts, service personnel, and a brief field survey where the respondents stated their expectations about e-service experiences and perceived quality. At the first level, three categorical quality factors are selected to meet the goal and objectives of e-service quality. In the next level, a total of 18 sub-criteria are identified to support the quality attributes. In this hierarchy, the evaluation process measures the priorities among these sub-criteria within a quality factor and the global priority ranking between the factors. These attributes are then used to build a mathematical model to analyze the e-service quality opinion. The model objective is to identify users' perceptions of e-service quality effective to government service via web sites or portals. Prioritization of e-service quality not only provide potential applications and limitations of e-government service, but also involves users in the process through customer feedback in the online environment to improve link and satisfaction.

3.1 Step I: Identify Major Quality Factors

The first step is to identify major e-service quality factors in government service systems. Three major citizen support dimension of service quality factors are identified: (1) government facility website reliability (*e-Reliability*), (2) service support through government employees (*e-Support*), and (3) usability and e-service efficiency (*e-Efficiency*). A number of sub factors under each e-service quality factors have been identified in most literature. Service response measures the quality of the service and customer interaction. Waiting time is the response time to deliver a service, processing time and other service related experiences. Warranty service delineates the contractual service rights and obligations of the purchases. Some of these factors, such as warranties, are not always mandatory for a service industry. However, these factors foster the responsibility of better service quality performance. Figure 4.1 shows the hierarchy framework of service quality factors and the corresponding criteria to each factor.

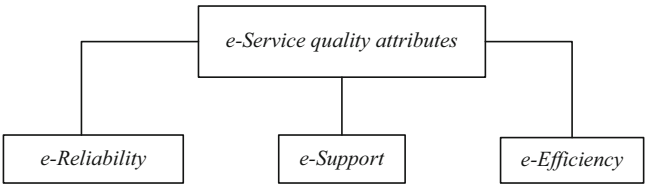

Fig. 4.1 E-service quality factors used in hierarchical decision model

3.2 Step II: Decompose Quality Factors into Criteria or Sub-criteria

This step involves the decomposition each quality factor into several relevant criteria and sub-criteria. Identifying quality factors that affect these attributes may be used to better understand the needs and perceptions of its citizens [26]. Developing a comprehensive model for discerning citizen engagement and satisfaction is an important process necessary to improve a government practice and electronic communication. Following are the quality factors adopted from e-government service quality research [25].

E-government Website Reliability (*e-Reliability*)

1. Fast downloadable e-government forms available at the website.
2. Website is always available and accessible.
3. Website performs the service successfully upon first request.
4. Website provides services in time.
5. Website pages are downloaded quickly enough.
6. Website works properly with users default browser.

E-government Employee's Support (*e-Support*)

1. Employees showed a sincere interest in solving users' problem.
2. Employees give prompt replies to users' inquiries.
3. Employees have the knowledge to answer users' questions.
4. Employees have the ability to convey trust and confidence.
5. Acquisition of username and password in this e-government site is secure.

E-government Website Efficiency (*e-Efficiency*)

1. This e-government site's structure is clear and easy to follow.
2. This e-government site's search engine is effective.
3. This e-government site's site map is well organized.
4. This e-government site is well customized to individual users' needs.
5. The information displayed in e-government site is appropriate detailed.
6. The information displayed in this e-government site is fresh.
7. Information about field's completion in this e-government site is enough.

3.3 Step III: Evaluate Weight Factor Using Entropy Technique

Entropy weight coefficient method determines weight $\widetilde{w}_j$for each criteria, C_j ($j = 1, 2, \ldots, n$). Using the general normalized decision matrix, P_{ij}, entropy weight coefficient E_j is calculated as follows:

$$E_j = -k\sum\nolimits_{j=1}^{n} p_{ij} \ln p_{ij} \tag{4.1}$$

where $p_{ij} = x_{ij} / \sum_{i=1}^{m} x_{ij}$, k (constant) $= 1/(\ln (m))$.

The proposed AHP methodology can be integrated with entropy technique to determine the quality factor weights and uncertainty using the subjective reasoning. The principle of entropy method refers that a criterion tends to be more important, if a greater dispersion is observed in the evaluations of the alternatives. The higher D_j value indicates the importance of the criterion in the decision matrix. The measurement of dispersion D_j for a criterion is calculated as the following:

$$D_j = 1 - E_{j.} \tag{4.2}$$

Weight W_j for each attribute is calculated by using the following:

$$w_j = \frac{D_j}{\sum_{k=1}^{n} D_k} \tag{4.3}$$

$w_j = \widetilde{w}_1, \widetilde{w}_2, \ldots, \widetilde{w}_n$, where $\widetilde{w}_j$is the weight of jth criterion C_j.

3.4 Step IV: Pair-Wise Comparison for Each Quality Factor and Criteria

After identifying weights of quality factors and the corresponding criteria, the next step is to determine how important a quality factor is relative to other factors. The relative priority of a rating is assigned a weight factor between 1 (equal importance) and 9 (extreme importance) to the more important criterion. The study espoused scale of relative preference for pair-wise comparison.

In the AHP approach, the relative importance of a factor is measured by pair-wise comparisons and the results are placed into a matrix form. After identifying the relative importance among the quality factors, relevant empirical information is placed in a matrix form. Comparing the service response and waiting time in Table 4.2, evaluators favor service response as being three times more important over the waiting time. Thus it takes value 1/3 in row 1 and column 2 of the matrix. It is convenient to fill out the upper triangular matrix first. If a_{ij} is the element of row i and column j of the matrix, then the lower diagonal is filled using the reciprocal

Table 4.1 Pair-wise comparison of service quality factor

E-Gov. service quality factors	*e-Reliability*	*e-Support*	*e-Efficiency*
Website reliability (*e-reliability*)	1	*1/3*	1/5
Employee's support (*e-support*)	3	*1*	1/3
Website efficiency (*e-efficiency*)	5	3	1

Table 4.2 The weight is determined as the following weight $m = 3$

Entropy weight method	*e-Reliability*	*e-Support*	*e-Efficiency*
$E_j = -k\sum_{j=1}^{n} p_{ij} \ln(p_{ij})$	0.7963	0.7181	0.8528
$D_j = 1 - E_j$	0.2037	0.2819	0.1472
$\boldsymbol{w_j} = D_j / \sum_{j=1}^{n} D_j$	**0.3219**	**0.4455**	**0.2326**

values of the upper diagonal using the formula, $a_{ji} = 1/a_{ij}$. Table 4.1 demonstrates the pair-wise comparison of e-service quality factors.

In this step, the focus is to create the weight factors for the three main e-service quality factor using a normalized matrix and entropy values. The procedure to get normalized weight is summing each column, and then, dividing each element of the matrix by the summed value of the corresponding column. The priority of weight factors is obtained by computing values obtain in normalized matrix and entropy principles. Table 4.2 presented the weight coefficient of e-service quality, calculated using the entropy method, discussed in Step II.

From Table 4.2, it is clear that the priority is given to perceived e-Support (0.445) by the government employees, followed by e-reliability (0.322) of government website, and efficiency (0.233). Next step computes Eigenvector multiplying the matrix in Table 4.1 with weight factors vector in Table 4.2 to obtain the eigenvector.

$$\delta = \begin{bmatrix} 1 & 1/3 & 1/5 \\ 3 & 1 & 1/3 \\ 5 & 3 & 1 \end{bmatrix} \begin{bmatrix} 0.322 \\ 0.446 \\ 0.232 \end{bmatrix} = \begin{bmatrix} 0.516 \\ 1.244 \\ 1.646 \end{bmatrix}$$

3.5 *Step V: Pair-Wise Criteria Comparison Under Each Quality Factor*

Tables 4.3, 4.4 and 4.5 present the pair-wise comparisons of the sub-criteria under each quality factor. Maturing e-service quality lead to increase in e-government participation.

In pair-wise comparisons, six sub-criteria have been selected for *e-Reliability*, five criteria for *e-Support*, and seven criteria for *e-Efficiency*. Focus here is to find individual quality level influence on e-government participation.

Table 4.3 Pair-wise comparison of government website reliability (*e-Reliability*)

Website reliability (*e-reliability*)	Download forms	Available accessible	Service at first request	In-time service	Fast download	Default browse
Forms downloadable	1.00	3.00	0.50	5.00	4.00	6.00
Available and accessible	0.33	1.00	0.33	4.00	3.00	5.00
Service at first request	2.00	3.00	1.00	6.00	7.00	9.00
In time Services in time	0.20	0.25	0.17	1.00	0.50	2.00
Quick downloadable	0.25	0.33	0.14	2.00	1.00	3.00
Works with default browser	0.17	0.20	0.11	0.50	0.33	1.00

Table 4.4 Pair-wise comparisons of government employee support (*e-Support*)

Employee's support (*e-support*)	Sincere interest	Prompt replies	Knowledge to answer	Trust and confidence	Secure logon
Showed a sincere interest	1.00	0.50	5.00	6.00	3.00
Give prompt replies	2.00	1.00	7.00	9.00	5.00
Have knowledge to answer	0.20	0.14	1.00	3.00	2.00
Convey trust and confidence	0.17	0.11	0.33	1.00	0.50
Secure username and password	0.33	0.20	0.50	2.00	1.00

Table 4.5 Pair-wise comparison of government website efficiency (*e-Efficiency*)

Website efficiency (*e-Efficiency*)	Clear and easy	Search effective	Well organize	Customize to users	Correct fact	Fresh data	Sufficient information
Structure is clear and easy	1.00	5.00	3.00	4.00	3.00	2.00	7.00
Search engine is effective	0.20	1.00	0.50	0.50	0.33	0.20	3.00
Site map is well organized	0.33	2.00	1.00	2.00	2.00	1.00	2.00
Site is customized to users	0.25	2.00	0.33	1.00	0.50	0.33	4.00
Correct Facts displayed	0.33	3.03	0.50	2.00	1.00	0.17	5.00
Fresh data information	0.50	5.00	1.00	3.00	6.00	1.00	9.00
Sufficient Information	0.14	0.33	0.50	0.25	0.20	0.11	1.00

3.6 Step VI: Investigating Consistency in Pair-Wise Comparison

The perceived value of the e-service quality includes reliability, trust, electronic interaction, access to application forms and e-forms, efficiency critical towards establishing effective e-government facilities. Governments thus need to measure the e-service attributes both in financial and non-financial terms and deploy appropriate resources to ensure the quality of the e-services to be upheld and up-to-date. In the pair-wise comparisons, the assigned weights of the e-service quality factors reflect the evaluator's opinion. The weights of e-service quality are critical in the decision making. The inconsistence and differences in weights may affects the efficiency and effectives of the service priority selection process. Therefore,

it is important to observe whether the assigned weight factors are consistent. The equation to compute the eigenvector (λ) is the following

$$\lambda = \frac{i_{th} \text{ entry in } \delta}{i_{th} \text{ entry in priority weight}} \tag{4.4}$$

The consistency ratio (CR) technique provides a measure of the inconsistencies in the AHP model [31]. The consistency ratio (CR) is calculated according to the following equation: $CR = CI/RI$. Consistency index (CI) is obtained by the following equation.

$$CI = (\lambda_{max} - n) / (n - 1) \tag{4.5}$$

The consistency ratio random number index (RI) is computed as.

$$RI = 1.98 \ (n - 2) / n \tag{4.6}$$

Using $CI = 1.38$, and the corresponding random index (RI) = 0.58 (for n = 3), the consistency ratio (CR) = 0.0643. If CR is sufficiently small, the evaluators' comparisons are perceived to be consistent and reliable to provide useful estimates of the priority of the quality factors. If $CR < 0.10$, the degree of consistency is acceptable [29], but if $CR > 0.10$, serious inconsistencies may exist, and the AHP may not yield meaningful results. In such cases, the assessment should be revised. In this example, the maximum value of CR is '0.0643' (in Table 4.6) indicates that the degree of consistency in the model is satisfactory ($CR < 0.10$). The measures of e-service index need to be based on a proper understanding of the factors.

3.7 Step VII: Calculate the Global Weights of Each Criteria and Sub-criteria

In this step, overall ranking for quality factor and criteria under each factor have been identified. The hierarchical model establishes the priority of weights for each quality factor at the individual level as well as the quality factors in group levels.

Results of the pair-wise comparisons of sub-criteria under each quality factor is presented in Table 4.6. The study used the same scale presented in [32]. The nine-point relative preference for pair-wise comparison is presented in Appendix 2.2.

Two types of ranking is provided, (1) rank by 'local weight factors'—the priority weight with respect to the quality factor located under the preceding hierarchical level, and (2) rank by 'global weight factors'—the priority weight with respect to the highest hierarchical level to meet the goal. Tables 4.7 and 4.8 illustrates the local and global weights of quality factor and sub-criteria, respectively.

The rank by 'global weights' is performed by the following equation.

Table 4.6 Pair-wise comparisons of E-Government service criteria

		Weight (w)	Factor (δ)	Eigen vector (λ)	*CI*	*RI*	*CR*
Website reliability (*e-Reliability*)	Forms downloadable	0.269	1.726	6.417	0.083	1.24	0.067
	Available and accessible	0.160	0.996	6.234	0.047	1.24	0.038
	Service at first request	0.408	2.583	6.330	0.066	1.24	0.053
	In time services in time	0.053	0.321	6.031	0.006	1.24	0.005
	Quick downloadable	0.076	0.463	6.092	0.018	1.24	0.015
	Works with default browser	0.034	0.208	6.127	0.025	1.24	0.020
Employee's support (*e-Support*)	Showed a sincere interest	0.287	1.552	5.412	0.103	1.12	0.092
	Give prompt replies	0.484	2.582	5.332	0.083	1.12	0.074
	Have knowledge to answer	0.103	0.524	5.079	0.020	1.12	0.018
	Convey trust and confidence	0.043	0.221	5.079	0.020	1.12	0.018
	Secure logon	0.082	0.413	5.028	0.007	1.12	0.006
Website efficiency (*e-Efficiency*)	Structure is clear and easy	0.316	2.409	7.620	0.103	1.32	0.078
	Search engine is effective	0.055	0.409	7.422	0.070	1.32	0.053
	Site map is well organized	0.140	1.065	7.623	0.104	1.32	0.079
	Site is customized to users	0.079	0.581	7.371	0.062	1.32	0.047
	Correct Facts displayed	0.111	0.807	7.253	0.042	1.32	0.032
	Fresh data information	0.269	2.019	7.510	0.085	1.32	0.064
	Sufficient information	0.030	0.235	7.778	0.130	1.32	0.098

Table 4.7 Rank quality factor by local and global weights

Factors	E-government service quality	Local weights		Global weights	
		Weights	Rank	Weights	Rank
Main factors	Website reliability (*e-Reliability*)	0.106	3	0.106	3
	Employee's support (*e-Support*)	0.261	2	0.261	2
	Website efficiency (*e-Efficiency*)	0.633	1	0.633	1

Table 4.8 Rank quality sub-criteria by local and global weights

Website reliability (*e-Reliability*)	Forms downloadable	0.269	2	0.028	10
	Available and accessible	0.160	3	0.017	14
	Service at first request	0.408	1	0.043	8
	Provide in time e-services	0.053	5	0.006	17
	Quick downloadable	0.076	4	0.008	16
	Works with default browser	0.034	6	0.004	18
Employee's support (*e-Support*)	Showed a sincere interest	0.287	2	0.075	5
	Provide prompt replies	0.484	1	0.126	3
	Have knowledge to answer	0.103	3	0.027	11
	Convey trust and confidence	0.043	5	0.011	15
	Secure logon	0.082	4	0.021	12
Website efficiency (*e-Efficiency*)	Structure is clear and easy	0.316	1	0.200	1
	Search engine is effective	0.055	6	0.035	9
	Site map is well organized	0.140	3	0.089	4
	Site is customized to users	0.079	5	0.050	7
	Correct Facts displayed	0.111	4	0.070	6
	Fresh data information	0.269	2	0.170	2
	Sufficient information	0.030	7	0.019	13

$$\text{Global weights} = \Sigma\,(\text{Weight factor } i \times \text{weight criterion } j \text{ under factor } i) \quad (4.7)$$

There are immense benefit of e-government in the developing counting since Internet uses reduce the service cost, as well as increase the e-contact between regular users and government employees. Table 4.8 summarizes the priority and rank of e-government service quality factors. In order to make these ranks more effective, the factors weight below 0.01, concerning ranks from 16 to 18 may be viewed as less significant attributes. The rest 1–15 factors can be viewed as representative e-government service criteria. The resource allocation according to suggested priority would provide the maximum benefit in evolving e-government service quality.

4 Results

This study examines the most significant quality factor through decision-making procedures in support to improve e-government service quality. Quality standard improvement happens when the government service providers set the strategic direction to identify public interests and service provider responsibilities with a relentless pursuit to the best of their ability. The prioritization of quality criteria and sub-criterion direct towards the attention of e-government to utilize resources more efficiently and positively to the best of public interests. The weights of the e-service factors was attributed following the entropy weight technique. The model is used to evaluate user feedback and develop quality index for e-government service improvement. The e-services are classified into 18 quality attributes under three main quality dimensions: *e-Reliability*, *e-support* and *e-Efficiency*. The perceived e-service feedback and data was collected from a pilot survey among a number of working professionals focusing on a western country local and federal government web service facilities. In the proposed hierarchical model, three main categorical quality factors in the first level were selected. In the light of the reviewed literature, these quality factors were then divided into sub-attributes. The *e-Efficiency* service factor has seven sub-criteria, while *e-Support* has five sub-criteria, and *e-Reliability* has six sub-criteria. Table 4.7 demonstrates the priority weights and consistency ratios of all quality factors and sub-criteria. The AHP analysis integrated with entropy weight factors used in the comparison matrix provided the rank of the high priority quality determinants.

After creating the conceptual model integrating entropy with AHP approach, the e-government quality attribute have been ranked constructing both the local and global weights factors. The rational of the e-service factor rankings are shown in Table 4.8. When dealing with priorities of the service quality factors, e-government website efficiency (*e-Efficiency*) ranked as the most important criteria, followed by the employee's support (*e-Support*), and the website reliability (*e-Reliability*) with weights of 63.3%, 26.1% and 10.6%, respectively. In the subsequent analysis, the sub-criteria at the second stage are ranked based on the local and global weights. The critical e-service factor priority results are reported separately with respect to local and global weights.

4.1 Local Weight Factor Ranking

The concept of e-service quality has been examined in several studies. In local weight factor analysis, this study reveals the service quality related to e-government website efficiency (*e-Efficiency*) is the most important factor. The corresponding criteria under 'e-Efficiency' prioritize as the following; *structure is clear and easy* (0.316) followed by *fresh data information* (0.269), *site map is well organized* (0.14), *correct facts displayed* (0.111), *site is customized to users* (0.079), *search*

engine is effective (0.055), and *sufficient Information* (0.03). The next important quality factor is the Employee's Support (*e-Support*). The order of the five criteria under '*e-Support*' is *employees provide prompt replies* (50th percentile) (0.484), *employees showed a sincere interest* (0.287), *employees have knowledge to answer* (0.103), *support secure logon* (0.082), and *employees convey trust and confidence* (0.043).

The remainder quality factor is website reliability (*e-Reliability*). The order of the six sub-criteria is *service at first request* (0.408), *forms downloadable* (0.269), *website available and accessible* (0.16), forms q*uick downloadable* (0.076), *provide in time Services* (0.053), and *website works with default browser* (0.034). Collectively, the result suggests that e-service quality is a multidimensional construct although the content of what constitutes e-service quality varies across studies. The e-service quality factors affecting e-government include convenience of using the web portal, faster processing time, ease of use, new technologies. Information security, transparency, and trust level are the dominant factor that inspire users to engage or disengage in the e-government involvement.

4.2 Global Weight Factor Ranking

The difficulty of dealing with e-service and website quality in public sector environment is the identification of the service priorities in meaningful ways. The responses of the global weights indicate that website information s*tructure is clear and easy* (0.2) is the most important factor among the 18 quality criteria. This is followed by *fresh data information* (0.170) and *employees provide prompt replies* (50th percentile) (0.126). These are the three most important quality criteria. The fourth factor is e-government provided *site-map is well organized* (0.089), followed by *employees showed a sincere interes*t (0.075), *correct facts displayed* (0.070), *site is customized to users* (0.050), provide service at first request (0.043), search engine is effective (0.035), and downloadable forms (0.028). The rest of the global order rankings are e-government employees *have knowledge to answer* (0.027), *support secure logon* (0.021), *sufficient Information* (0.019), *available and accessible* (0.017) employees convey trust and confidence (0.011), *quick downloadable forms* (0.008), *provide in time Services* (0.006), and employees works with default browser (0.004). Users will be more likely to engage in e-government service if information is presented clearly and found quickly.

The feasibility of ranking the priority and improving the quality standard depend on a specific e-government service domain. The type of service delivery, influences of policies and accountability and the technological means are the important determinants to the feasibility of such endeavors. There are other critical factors which are not included in this study include in the visual appeal, sensitivity to users' involvement, intuitive use across various devices, maintainability, and intractability of the e-government web portal. The results demonstrate the importance of electronic communication enhancing the decision making with creative and innovative

approaches supported by individual, group, and industry learning. In this finding, the e-service quality attributes are not necessarily integrated by the opinions of all participants in the final decision. Since the quality of the decisions are made vital to e-government service performance, both divergent and convergent thinking are needed for this decision-making process. The decision-making process by the AHP approach requires both a systemic and creative thinking approach: both of which are vital to rank quality factors for effective decision making.

5 Conclusion

E-governments are increasingly becoming aware of the importance of e-services that need frequent communication with general users as well as public sectors and private businesses. The quality of e-government services has become the subject of great interest as it affects the public engagement in government-run activities, satisfaction and government policy success. E-government services involves financial and non-financial investments. Government cannot allocate equal amounts of effort or resources to each area of e-services due to the limitations of human and monetary resources. The methodology to identify e-service priorities plays a key role to improve government services by allocating resources to the important service areas. The model evaluated and indexed 18 e-services attributes, distributed into three quality dimensions: *e-Reliability*, *e-Support* and *e-Efficiency*. The data of the perceived e-government benefit used in the AHP model was collected from a pilot survey focusing on e-system reliability, service support and website efficiency of local and federal government e-service facilities in a western country. The findings of this study indicate that the e-service efficiency '*e-Efficiency*' generated the highest impact (which is about 63.3%). The next important e-service criteria to public engagement ranked the following. The employee's support to the users (*e-Support*) is the next highest priority, followed by e-government website information reliability (*e-Reliability*) with weights of 26.1% and 10.6%, respectively. The ranking of the sub-criteria based on the local and global weights provides a good understanding of how different factors work together to influence adoption of e-government services for public engagement. This study has reviewed literature to identify e-service factors associated with public interests, easy to understand and use, user friendly systems, technological skills, motivation for community engagement, as well as facilitating different conditions for adoption. The result obtained from this study is specific to the selected e-service factors, and may not be generalized to all other applications.

The multicriteria methods generally require subjective judgment to make decision on activities and direction which e-services to be offered. The experts who have substantial experience in the field of e-service quality should engage in decision planning. The entropy weight method is an easy to use model, avoids the shortcoming of the subjective judgement. There is an absence of a single model factoring both multicriteria decision making and weight factors of e-service

to evaluate whether a factor to adopt or not adopt. The study proposed the application of AHP method integrated with entropy weight technique to identify the e-service priorities, lead towards the effectiveness of e-service identification. The strategic analysis of the public response benefits government to improve e-service performance, critical to public engagement and satisfaction.

However, the study holds few limitations that it did not include few service quality dimensions which may be an interest for future research. For example, demographic variables such as race, education level, and ethnicity have an effect on e-service quality dimensions in both developed and developing countries. Further research may be directed to examine the interaction between larger decision-making processes and the relationships among different demographic variables to create an environment that fosters both a systemic approach and creative thinking. Since e-government expansion has now reached a point of critical form with services provide at cities, states, federal and government agencies, the study may be extended to adopt quantitative information and unanimous consent on operations and services to develop innovative prioritization of service index and advance theoretical models for the future services and quality implications.

Appendix 1: E-Government Development Index

E-government development index top 12 countries		E-participation index 12 countries	
Country	Index	Country	Index
United Kingdom	0.9193	United Kingdom	1
Australia	0.9143	Japan	0.9831
Republic of Korea	0.8915	Australia	0.9831
Singapore	0.8828	Republic of Korea	0.9661
Finland	0.8817	Netherlands	0.9492
Sweden	0.8704	New Zealand	0.9492
Netherlands	0.8659	Spain	0.9322
New Zealand	0.8653	Singapore	0.9153
Denmark	0.851	Canada	0.9153
France	0.8456	Italy	0.9153
Japan	0.8440	Finland	0.9153
United States	0.8420	United States	0.8983

Source: UN E-Government Survey 2016 [29]

Appendix 2

Appendix 2.1: Key Policy and Research Questions Related to Privacy, Security, Accuracy, and Governance Policy Adopted from [30]

Privacy, security, accuracy, and archiving

- How will agencies ensure the privacy of individuals, particularly when data may not be owned by government agencies?
- What data and information search tools are necessary to facilitate access to and location of government data?
- What review processes are required prior to government data dissemination through open government initiatives such as data.gov to ensure privacy, security, and accuracy?
- What data validity, reliability, and quality check processes could be adopted in order to ensure appropriate uses, combinations, and extrapolations of combined government (and other) datasets?
- What cybersecurity measures, tools, and approaches are necessary to ensure national, agency, and individual security?
- What tools and applications do agencies need to archive and preserve their social media-based activities?
- What is the "document" that agencies preserve based on their social media activities?
- What policies and procedures are necessary to govern the scheduling and archiving of government social media activities?
- What is the role of GPO and the FDLP, if any, in the social media technology environment of the federal government?

Governing and governance

- How do we build social and political trust and who/what makes decisions on what authority?
- What collaborative governance processes and structures do social media technologies enable?
- What policy structures and frameworks are necessary to government use and interaction with social media technologies?
- In what ways can the federal government harmonize across a range of policy instruments to comprehensively account for the evolving policy context of social media technologies?
- Will social media technology privilege certain types of policy substance over others?
- Will social media technology result in new policies that rely on the existence of viable social media?

- What policy barriers to using social media technologies exist, and how to resolve the impediments?
- How do we create policies to encourage social media technologies?
- How can agencies and governments incorporate the results of social media technology use into agency strategies, goals, objectives, services, and resources?
- What review and analysis processes should agencies develop to assess social media-based participatory feedback and solicitations into agency workflows?

Access and social inclusion

- What tools and approaches best promote universal access to social media technologies?
- How do we ensure that social media technologies are inclusive, rather than exclusive?
- Are there social media technologies that can facilitate access to persons with disabilities?
- What mechanisms (e.g., partnerships, collaborations) can promote access to and participation in social media technologies to all members of society?
- How can agencies leverage partnerships to extend social media applications and use within communities across the country?
- What types of partnerships best promote use of and interaction with government through social media technologies?
- How can agencies and organizations develop mutually beneficial partnerships?
- What organizational, management, and operational structures are necessary to create successful partnerships?

Appendix 2.2: Saaty's Nine Point Scale [32]

Intensity of importance	Definition	Explanation
1	Equal importance	Two factors are equally contributing to objective
3	Moderate strong	One factor is marginally superior over other
5	Strong importance	One factor is strongly superior over other
7	Very strong or demonstrated importance	Experience and judgment strongly favor one activity over another
9	Absolute strong	The highest level of superiority of one factor over other
2, 4, 6, 8	Intermediate values	Scale between two factor, negotiation required

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