

# Usability and Functionality: A Comparison of Key Project Personnel's and Potential users' Evaluations

F. Calisir, C.A. Gumussoy, A.E. Bayraktaroglu, and E. Saygivar

**Abstract**—Meeting users' requirements is one of predictors of project success. There should be a match between the expectations of the users and the perception of key project personnel with respect to usability and functionality. The aim of this study is to make a comparison of key project personnel's and potential users' (customer representatives) evaluations of the relative importance of usability and functionality factors in a software design project. Analytical Network Process (ANP) was used to analyze the relative importance of the factors. The results show that navigation and interaction are the most significant factors, and satisfaction and efficiency are the least important factors for both groups. Further, it can be concluded that having similar orders and scores of usability and functionality factors for both groups shows that key project personnel have captured the expectations and requirements of potential users accurately.

**Keywords**—Functionality, software design, usability.

## I. INTRODUCTION

FUNCTIONALITY and usability are the sub-features of usefulness, which is a critical factor for acceptability of a system [1]. Usability assesses the extent a software facilitates users utilize the offered functions easily and appropriately. Functionality estimates the extent the software operates in the way it is structured and is expected to perform as users desire [2], [3].

Users tend to use functional and usable products more frequently. Reference [4] states that the majority of the users prefer products that are "simple and easy to use" and it is adequate if they merely function, as they are expected to or slightly better. Reference [3] states that usability and functionality are quality characteristics that evaluate an interface design. It is also possible that a functional software is not usable or vice versa [1], [3], [5]. The functionality of a software package becomes obvious to users through its interface and users interact with the system via this interface. Although it would appear that the usability feature is related

F. Calisir is with Industrial Engineering Department of Istanbul Technical University, Turkey (phone: +90 212-293-1300; e-mail: calisirfet@itu.edu.tr).

C.A. Gumussoy is with Industrial Engineering Department of Istanbul Technical University, Turkey (phone: +90 212-293-1300; e-mail: altinci@itu.edu.tr).

A.E. Bayraktaroglu is with Industrial Engineering Department of Istanbul Technical University, Turkey (phone: +90 212-293-1300; e-mail: bayraktaroglu@itu.edu.tr).

E. Saygivar is with Digiturk, Turkey (phone: +90 212-326-0226; e-mail: esen.saygivar@digiturk.com.tr).

only to the interface and not to the logic of available functions, Reference [6] asserts attributes of a system can affect the usability of the whole system. Successful usage of a software package depends on the ability of users to understand the functionality of the system. Functionality can have positive impact on the usability of the system, such as a "back" function [7]. After all, evidence shows that the majority usually uses only a small part of the available functions of a system [8]. At some point, the greater the functionality offered to the users the more skilled users must cope with the complex and time-consuming structure of the system [9]. Therefore, superfluous functionality can actually bring about a decrease in the usability of the software [8], [10]. To ensure users' needs are met, it is critical to balance functionality and usability in the design of the software. A user-centered design should consider both aspects — the interaction between user and the software as well as the operations performed by the system [11].

Since meeting users' requirements is one of the project success factors [12]-[14], understanding the user expectation of balance between functionality and usability is crucial for project team to implement a user-centered design. A mismatch between the expectations of the users and the perception of the project managers on what is required can be counted as one of the leading software project risks [15].

The aim of this study is to make a comparison of the information technology (IT) employees and potential users' evaluations of the relative importance of usability and functionality factors in software designed.

## II. FUNCTIONALITY AND USABILITY FACTORS USED IN THIS STUDY

Literature review was performed to determine the usability and functionality factors that are important for the software we analyzed. The literature reviewed on usability and functionality included studies on web sites and software packages designed for organizations such as libraries. The list of usability and functionality factors is presented in Table I.

The usability factors are navigation, interaction, learnability, ease of use, response time, memorability, efficiency, and satisfaction.

- *Navigation*: It refers to finding one's way to the desired information through menus, graphical components, links and page sequence, and layout [16] as well as, even while doing this, knowing where one is at the instant [17].

- *Interaction*: Responses to the user's actions are produced by the system [16]. Along with navigability, interaction with system helps users to find easily the desired information [18].
- *Learnability*: It is associated with the skill levels of a user and thereby the level of effort needed to learn how to operate the system [19]. For success of a system, the time a user needs to learn how to operate the system should be very small [20].
- *Ease of use*: It refers to being able to operate a web site without experiencing any difficulty and trouble. According to Reference [21], ease of use is one of the most important components along with navigation for usability and plays a significant role in the adoption of a system by users.
- *Response time*: It is the time needed by the system to respond to the activity of a user [16].
- *Memorability*: It is the ease of recall of the main functions and their presentation on the web site when a user revisits the page [3]. Reference [6] points out that an inconsistent interface structure raises the memory load on users.
- *Efficiency*: It is the ability of the web site to allow users to work quickly to attain their desired goal with the minimum number of clicks [3], [22].
- *Satisfaction*: It is the general pleasure a user feels making use of the software. Satisfaction is primarily affected by the perceived efficiency and effectiveness, and emotions and thoughts arising from the usage [23]. Functionality factors are security, search options, information provision, services/facilities, user guidance or support, customizability, and autorun.
- *Security*: The security features provided by the system protect users' privacy. Security is accounted as a functionality factor in the studies [19], [24], [6].
- *Search Options*: Systems offer both simple- and advanced search strategies and enable additional eliminations in retrieved results [2], [25]. That the search function helps users quickly and precisely finds what they are looking for.
- *Information Provision*: It supplies users with adequate information about company, products and services [26].
- *Services/Facilities*: They are purposive services/facilities offered to the user to assist in achieving the related goal of the system. Reference [25] mentions this functionality factor in their research on online public access catalogues, e.g. renewal and reservation services.
- *User Guidance or Support*: Web sites offer customers uncustomizable (such as FAQ) or/and customizable help (such as online help) [26], and describe the necessary information about these steps which users can follow when they have a request or when they encounter a problem. According to Reference [17], an adequate user guidance and support feature would reduce their cognitive load and pave the way for them to learn how to operate the web site.
- *Customizability*: It is the flexibility to change system navigation to a level that meets users' needs or

preferences. Reference [27] suggests that customization increases user satisfaction by limiting information overload on users with respect to their preferences [21]. Reference [16] points out that customization is an extension of the interaction provided by the web site.

- *Autorun*: It enables the system to run some operations automatically.

TABLE I  
USABILITY AND FUNCTIONALITY FACTORS USED IN THE  
EVALUATIONS

| Usability Factors | Functionality Factors        |
|-------------------|------------------------------|
| U1. Navigation    | F1. Security                 |
| U2. Interaction   | F2. Search options           |
| U3. Learnability  | F3. Information provision    |
| U4. Ease of use   | F4. Services/ Facilities     |
| U5. Response time | F5. User guidance or support |
| U6. Memorability  | F6. Customizability          |
| U7. Efficiency    | F7. Autorun                  |
| U8. Satisfaction  |                              |

As seen above, not only functionality and usability of a system, but also some of their other factors are related to each other. Hence, these interactions go to create a complex model composed of dependence and feedback among the factors. In evaluating software, such a model can be treated with the Analytic Network Process (ANP) proposed by [28] in order to determine the relative importance of both usability and functionality factors.

### III. ANP

When the factors in a complex structure of a decision making process are interrelated to each other, which means there are dependence and feedback among the factors, then this setting can be patterned only as a network. ANP enables decision makers as individuals or groups to cope with the factors interconnected with each other in the decision making problem [28], [29].

ANP can deal with the complexities of real-world problems of making societal-, governmental-, and corporate decisions because it takes complex interrelationships among factors into account [30]-[33].

ANP has three stages: structuring (design), assessment (comparison), and synthesis (computation).

At the structuring stage, pertinent factors and alternatives, if necessary, are determined. Next, associations between pairs of factors are identified by experts. As a result, a network model, which consists of factors and relations among them, is constructed.

At the assessment stage, a nine-point scale suggested by [28] is used by the decision makers to make pairwise comparisons of the factors in the network. Saaty's scale asks, "of the dependent factors, which one influences the common factor more and how much more?" According to this scale, a value of 1 shows that both factors compared have equal influence levels on the affected factor, while a value of 9 shows that one factor has extremely more influence than that of

the other on the affected factor. To obtain the aggregated group judgment, the geometric means of all individual paired-comparison judgments for each question are calculated. Using these aggregated group judgments, pairwise-comparison matrices are generated.

At the synthesis stage the relative importance of the factors is computed. Importance is viewed as the influence of the factors on a common goal. To synthesize aggregated judgments to compute the relative importance of the factors, the computation of the eigenvector for each pairwise-comparison matrix, the generation of a supermatrix and a weighted supermatrix (if necessary), and the computation of the convergence of the supermatrix (limit matrix) are requisite. The relative weights (desired priorities) of the factors in the decision network are the values of the limit matrix.

IV. EVALUATION OF THE SOFTWARE

First, the structuring stage was performed; the usability and functionality factors were determined as described in Section 2. After the determination of usability and functionality factors, the group of experts whose working areas are usability engineering filled in a pairwise relationship matrix separately. To aggregate these matrices into groups matrix majority rule was used (Fig. 1). The asterisk (\*) entered in this matrix indicated that there is a direct relationship of factor i to factor j: If factor i affects factor j, the cell a<sub>ij</sub> was filled with an asterisk (\*). Where there was no relationship, the cell was not filled. Then the ANP model representing the associations between factors is generated using the Super Decisions software.

|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|
|    | U1 | U2 | U3 | U4 | U5 | U6 | U7 | U8 | F1 | F2 | F3 | F4 | F5 | F6 | F7 |   |
| U1 | -  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | * |
| U2 | *  | -  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | * |
| U3 |    |    | -  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | * |
| U4 |    |    | *  | -  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | * |
| U5 | *  |    | *  | *  | -  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | * |
| U6 | *  |    | *  | *  | *  | -  | *  | *  | *  | *  | *  | *  | *  | *  | *  | * |
| U7 |    |    |    |    |    | *  | -  | *  | *  | *  | *  | *  | *  | *  | *  | * |
| U8 |    |    |    |    |    | *  | *  | -  | *  | *  | *  | *  | *  | *  | *  | * |
| F1 | *  | *  | *  | *  | *  | *  | *  | *  | -  | *  | *  | *  | *  | *  | *  | * |
| F2 | *  | *  | *  | *  | *  | *  | *  | *  | *  | -  | *  | *  | *  | *  | *  | * |
| F3 | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | -  | *  | *  | *  | *  | * |
| F4 | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | -  | *  | *  | *  | * |
| F5 | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | -  | *  | *  | * |
| F6 | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | -  | *  | * |
| F7 | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | *  | -  | * |

Fig. 1 Aggregated pairwise relationship matrix

In the judgment assessment stage, the second stage of the process, 22 potential users and 10 key project personnel filled a pairwise comparison questionnaire. The questionnaire mainly consists of two main parts. The first part designed to solicit information about the respondents. Table II presents a summary of the demographic profiles of the respondents. Among potential users, the average age is 27 and 14 of them were female; most of them possessed at least an undergraduate degree; the number of respondents with more than 5 years full time professional experience was 8; the average computer use per week was 65 hours and the average duration of computer use was 9 years. Among key project personnel, the average age is 34 and only 3 of them were female; all of them possessed at

least an undergraduate degree; the number of respondents with more than 5 years full time professional experience was 9; the average computer use per week was 54 hours and the average duration of computer use was 16 years.

In the second part, a pairwise comparison was conducted by key project personnel and potential users. An example question from the questionnaire can be seen in Fig. 2.

TABLE II  
DEMOGRAPHIC PROFILES OF KEY PROJECT PERSONNEL AND POTENTIAL USERS

| Potential users  |                        |              |
|--|------------------------|--------------|
| <b>Gender (number of respondents)</b>                                |                        |              |
| Female: 14   | Male: 8                |              |
| <b>Age</b>   |                        |              |
| Min: 22  | Max: 36                | Average: 27  |
| <b>Education level (number of respondents)</b>                       |                        |              |
| High school: 9   | Undergraduate: 12      | MSc: 1       |
| <b>Work experience in full time position (number of respondents)</b> |                        |              |
| <6 months: -   | 6 months<...<1 year: - | 1-2 years: 4 |
| 2-5 years: 10  | >5 years: 8            |              |
| <b>Computer use (year)</b>   |                        |              |
| Min: 4   | Max: 15                | Average: 9   |
| <b>Computer use in a week (hour)</b>                                 |                        |              |
| Min: 12  | Max: 90                | Average: 65  |
| Key Project Personnel  |                        |              |
| <b>Gender (number of respondents)</b>                                |                        |              |
| Female: 3  | Male: 7                |              |
| <b>Age</b>   |                        |              |
| Min: 29  | Max: 40                | Average: 34  |
| <b>Education level (number of respondents)</b>                       |                        |              |
| High school: -   | Undergraduate: 6       | MSc: 4       |
| <b>Work experience in full time position (number of respondents)</b> |                        |              |
| <6 months: -   | 6 months<...<1 year: - | 1-2 years: - |
| 2-5 years: 1   | >5 years: 9            |              |
| <b>Computer use (year)</b>   |                        |              |
| Min: 10  | Max: 21                | Average: 16  |
| <b>Computer use in a week (hour)</b>                                 |                        |              |
| Min: 35  | Max: 70                | Average: 54  |

Of the factors given below which one influences "navigation" more and how much more?  
1=Equally 3=Moderately more 5=Strongly more 7=Very strongly more 9=Extremely more

|               |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |             |
|---------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-------------|
| Interaction   | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9           |
| Response Time | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9           |
| Memorability  | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9           |
|               |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | Interaction |

Fig. 2 A part of pairwise comparison questionnaire

The respondents judged the relative importance of the affecting factors on the affected factor for all possible pairs. Then, the geometric means of all paired comparison judgments for each question were computed for each group (key project personnel and potential users) in order to arrive at the aggregated group judgments. Utilizing the Super Decisions software, these responses were formed into pairwise comparison matrices.

In the synthesis stage of the process, the relative importance of the factors was computed using the Super Decisions software for both groups, which performed all the algebraic computations of the matrix. As pointed out before, the output of the limit matrix can be converted to the descending priority order: the relative importance of the factors (Table III and IV) for both groups.

#### V. CONCLUSION

As it can be seen in Table III and IV, the most important factor in terms of usability and functionality for both groups is “navigation” with a relative importance of 22%. This shows that finding the relevant information with the least effort through menus, graphical components, sequences, and layout was considered as the important factor by potential users and key project personnel. In addition, the second most important factor for both evaluation groups is “interaction”. It seems that “interaction” has a slightly more relative importance for key project personnel than for potential users. Similar to our findings, Reference [34] found that customers of online auction and shopping web sites give higher priority to usability factors than to functionality factors, with navigation and interaction being the factors of highest relative importance.

For both evaluation groups, the most important functionality factors are “search options”, “information provision” and “auto-run”. The only difference is that “information provision” is in the third rank among potential users, whereas it is the second most important functionality factor for key project personnel. However, “information provision” has a slightly lower relative importance for key project personnel than potential users.

The least important factors are “satisfaction” and “efficiency” for both groups. “Satisfaction” was considered more important by key project personnel, whereas “efficiency” was considered more important by the potential users.

TABLE III  
THE IMPORTANCE OF THE FACTORS FOR KEY PROJECT PERSONNEL

| Sub-Factors                 | Priorities |
|-----------------------------|------------|
| U1 Navigation               | 0.22453    |
| U2 Interaction              | 0.12069    |
| F2 Search options           | 0.08508    |
| F3 Information provision    | 0.07232    |
| F7 Auto-run                 | 0.07009    |
| F5 User guidance or support | 0.06845    |
| U6 Memorability             | 0.06541    |
| U4 Ease of use              | 0.05174    |
| U5 Response time            | 0.05151    |
| U3 Learnability             | 0.04848    |
| F4 Services/Facilities      | 0.0482     |
| F1 Security                 | 0.04548    |
| F6 Customizability          | 0.03471    |
| U8 Satisfaction             | 0.0088     |
| U7 Efficiency               | 0.00452    |

TABLE IV  
THE IMPORTANCE OF THE FACTORS FOR POTENTIAL USERS

| Sub-Factors                 | Priorities |
|-----------------------------|------------|
| U1 Navigation               | 0.21884    |
| U2 Interaction              | 0.10385    |
| F2 Search options           | 0.09384    |
| F7 Auto-run                 | 0.07885    |
| F3 Information provision    | 0.07571    |
| U6 Memorability             | 0.07103    |
| F5 User guidance or support | 0.07037    |
| U4 Ease of use              | 0.06074    |
| U5 Response time            | 0.05372    |
| U3 Learnability             | 0.05242    |
| F6 Customizability          | 0.03644    |
| F1 Security                 | 0.03486    |
| F4 Services/Facilities      | 0.03459    |
| U8 Satisfaction             | 0.00761    |
| U7 Efficiency               | 0.00715    |

Having similar orders and scores of usability and functionality factors for both groups shows that key project personnel have captured the expectations and requirements of potential users accurately. This may have a positive impact on the project’s success. The findings of this study are important from the point of view that carrying out this study in the early stages of software design process can expose a mismatch between the expectations of users and the perception of key project personnel, a late discovery of which can otherwise cause irreversible results in the project.

#### ACKNOWLEDGEMENTS

This study was supported by a grant from DIGITURK.

#### REFERENCES

- [1] M. Lu and W. Yeung, “A framework for effective commercial web application development,” *Internet Research: Electronic Networking Applications and Policy*, vol.8, no. 2, pp. 166-173, 1998.
- [2] J.C. Bertot, J.T. Snead, P.T. Jaeger, and C.R. McClure, “Functionality, usability and accessibility,” *Performance Measurement and Metrics*, vol. 7, no. 1, pp. 17-28, 2006.
- [3] J. Nielsen, “Usability 101: Introduction to usability,” *Useit.com Alertbox: Current Issues in Web Usability*, August, 2003, available at: [www.useit.com/alertbox/20030825.html](http://www.useit.com/alertbox/20030825.html) (accessed on 7 September 2008).
- [4] C.S. Porter, J.M. Porter, and S. Chhibber, “Realpeople; capturing the emotions of product users,” in *Meeting Diversity in Ergonomics*, Ed. Pikaar, Koningsveld, and Settels, NJ: Elsevier, 2007, ch. 12, pp. 187-208.
- [5] T.A. Yeung and R. Law, “Extending the modified heuristic usability evaluation technique to chain and independent hotel websites,” *International Journal of Hospitality Management*, vol. 23, pp. 307-313, 2004.
- [6] A. Seffah, T. Mohamed, H. Habieb-Mammar, and A. Abran, “Reconciling usability and interactive system architecture using patterns,” *Journal of Systems and Software*, vol. 81, pp. 1845-1852, 2008.

- [7] L. Bass and B.E. John, "Linking usability to software architecture patterns through general scenarios," *Journal of Systems and Software*, vol. 66, pp. 187-197, 2003.
- [8] S. Furnell, "Why users can not use security," *Computers and Security*, vol. 24, pp. 274-279, 2005.
- [9] C.D. Kavadias, S. Rupp, S.L. Tombros, and D.D., Vergados, "A P2P technology middleware architecture enabling user-centric services deployment on low-cost embedded networked devices," *Computer Communications*, vol. 30, pp. 527-537, 2007.
- [10] D.J.M. Saarloos, T.A. Arentze, A.W.J. Borgers, and H.J.P. Timmermans, "A multi-agent paradigm as structuring principle for planning support systems," *Computers, Environment and Urban Systems*, vol. 32, pp. 29-40, 2008.
- [11] R.B. Klein and A. Seffah, "Evaluation of integrated software development environments: Challenges and results from three empirical studies," *International Journal of Human-Computer Studies*, vol. 63, pp. 607-627, 2005.
- [12] S. Petter, "Managing user expectations on software projects: lessons from the trenches," *International Journal of Project Management*, vol. 26, pp. 700-712, 2008.
- [13] J.D. Procaccino and J.M. Verner, "Software project managers and project success: An exploratory study," *Journal of Systems and Software*, vol. 79, pp. 1541-1551, 2006.
- [14] D. White and J. Fortune, "Current practice in project management – an empirical study," *International Journal of Project Management*, vol. 20, pp. 1-11, 2002.
- [15] R. Schmidt, K. Lyytinen, M. Keil, and P. Cule, "Identifying software project risks: An international Delphi study," *Journal of Management Information Systems*, vol. 17, no. 4, pp. 5-36, 2001.
- [16] J.W. Palmer, "Web site usability, design, and performance metrics," *Information Systems Research*, vol. 13, no. 2, pp. 151-167, 2002.
- [17] M.C. Roy, O. Dewit, and B.A. Aubert, "The impact of interface usability on trust in web retailers," *Internet Research: Electronic Networking Applications and Policy*, vol. 11, no. 5, pp. 388-398, 2001.
- [18] G. Chakraborty, P. Srivastava, and D.L. Warren, "Understanding B2B corporate web sites' effectiveness from North American and European perspective," *Industrial Marketing Management*, vol. 34, pp. 420-429, 2005.
- [19] C. Calero, J. Ruiz, and M. Piattini, "Classifying web metrics using the web quality model," *Online Information Review*, vol. 29, no. 3, pp. 227-248, 2005.
- [20] J. Nielsen, "End of web design," *Useit.com Alertbox: Current Issues in Web Usability*, July, 2000. available at: [www.useit.com/alertbox/20000723.html](http://www.useit.com/alertbox/20000723.html) (accessed on 7 September 2008).
- [21] J.M. Pearson, A. Pearson, and D. Green, "Determining the importance of key criteria in web usability," *Management Research News*, vol. 30, no. 11, pp. 816-828, 2007.
- [22] E.F. Reilly, T.J. Leibrandt, A.J. Zonno, M.J. Simpson, and J.B. Morris, "General surgery residency program websites: usefulness and usability for resident applicants," *Current Surgery*, vol. 61, no. 2, pp. 236-240, 2003.
- [23] S.M. Ferreira and D.N. Pithan, "Usability of digital libraries," *OCLC Systems and Services*, vol. 21, no. 4, pp. 311-323, 2005.
- [24] A. Stefani, B. Vassiliadis, and M. Xenos, "On the quality assessment of advanced e-learning services," *Interactive Technology and Smart Education*, vol. 3, pp. 237-250, 2006.
- [25] K. Kapoor and O.P. Goyal, "Web-based OPACs in Indian academic libraries: a functional comparison," *Program: Electronic Library and Information Systems*, vol. 41, no. 3, pp. 291-309, 2007.
- [26] K. Waite and T. Harrison, "Internet archaeology: uncovering pension sector web site evolution," *Internet Research*, vol. 17, no. 2, pp. 180-195, 2007.
- [27] T. Liang, H. Lai, and Y. Ku, "Personalized content recommendation and user satisfaction: theoretical synthesis and empirical findings," *Journal of Management Information Systems*, vol. 23, no. 3, pp. 45-70, 2007.
- [28] T.L. Saaty, *Decision-making with dependence and feedback: The Analytic Network Process*. Pittsburg, NJ: RWS Publishing, 1996.
- [29] T.L. Saaty, *Multicriteria decision-making: The analytic hierarchy process*. Pittsburg, NJ: RWS Publishing, 1980.
- [30] R.W. Saaty, *Decision making in complex environments*. Pittsburgh: Creative Decisions Foundation, 2003.
- [31] A.A. Salo and R.P. Hamalainen, "On the measurement of preferences in the analytic hierarchy process," *Journal of Multi-Criteria Decision Analysis*, vol. 6, pp. 309-319, 1997.
- [32] S. Jharkharia and R. Shankar, "Selection of logistics service provider: An analytic network process (ANP) approach," *Omega*, vol. 35, pp. 274-289, 2007.
- [33] H. Shyur and H. Shih, "A hybrid MCDM model for strategic vendor selection," *Mathematical and Computer Modeling*, vol. 44, pp. 749-761, 2006.
- [34] F. Calisir, A.E. Bayraktaroglu, C.A. Gumussoy, Y.I. Topcu, and T. Mutlu, "The relative importance of usability and functionality factors for online auction and shopping web sites," *Online Information Review*, vol. 34(3), pp.420-439, 2010.