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A Novel Usability Matrix for ERP Systems using Heuristic Approach

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Abstract—**There are two types of systems; computerized and socio-technical systems. Socio-technical systems are complex and deals with technical operations by involving users. The usability is the study that discusses the user philosophy in Socio-technical systems. It is very older term and previously named as software psychology. It debates on diverse variables that help to improve the software usability. The continuous changes in user' demands, situations, and environment also have deep impact on software usability. These changes acquire experts and developers intention to gather more and more humans' factors. In this extended paper we proposed a usability heuristic for the appraisal to the context of ERP applications. Enterprise resource planning system (ERP) used to manage business-processes and to provide past records for decision-making. The proposed heuristic for evaluation is based on qualitative review of previous literature. Beside literature the series of empirical studies were also conducted by segregating the user' on the bases of their roles in organization.**

Keywords-human computer interaction, usability engineering, user interfaces, heuristics evaluation, enterprise recourse planning.

I. INTRODUCTION

Investment in information systems is to compete in the business market. The Information Technology has becomes strategic and competitive advantage especially in the context of ERP systems [1]. EPR empowers the users to access the knowledge and information for decision marking. The access of information is only possible by shifting the control of information from information creator to information users [2]. Except the strategic benefits of ERP, it also offers other tremendous benefits to organizations. The benefits like business process management, coordination, cross functional activities and to establish relationships in-between employees, partners and customers. The corporate level organizations are moving toward ERP system to attain these benefits. The ERP systems are complex, comprehensive and are the combinations of different business application to manage and to integrate the

business functions. [3-10]. Business process incorporation is irrefutably a perilous issue for organizations to maintain competence and maybe it is a key success factor for organizations. The competitive advantage means the unlocking of strategic information for decision-making and to make it accessible anytime. The assess ability of strategic information is only possible with well-connected business function that carry fast flow of information and lead toward success. The Fig.1 shows the basic structure of ERP system that includes different modules for manufacturing; order tracking, payable and receivable accounts, general ledger, purchase & inventory management, warehousing, transportation and human resources. Enterprise Resource Planning (ERP) systems are disreputably problematic to use. The latitude and intricacy of their functionality can be irresistible for users, who must classically undergo wide training before they can make effective use of these systems [5-9]. Thus there is a need to work on ERP systems from users' perspective.
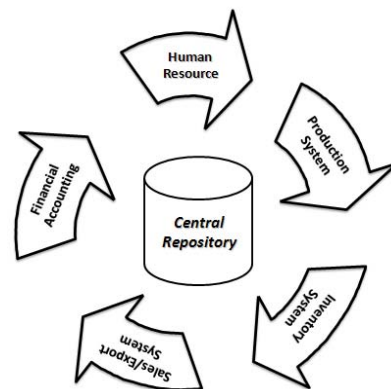

Figure 1. Basic structure of ERP system

This research paper is divided into following sections. Section 2 describes the literature review of existing usability assessment methods. Section 3 and 4 includes research design particularly research methodology and discussion about the results were empirically found in investigations. Section 5 defines the proposed usability heuristic for ERP systems.

II. BACKGROUND

Information systems requirements are segregated on two bases functional and non-functional specifications. Previously allot of work has been done for the identification of functional and non-functional requirements. Numerous tools and techniques are available to facilitate in system development processes. Non-functional requirements are more complex than functional requirements [27]. Somerville [27] classifies the non-functional requirements into following sub components; organizational specifications, product and external specifications.

The organizational specification; drives from organizational policies and procedures (i.e. delivery, implementation and standards) [27]. The external specifications; based on factors that externally influence the system / system development (i.e. Interoperability, ethical, safety and privacy) [27]. The products specifications; drive from the products behaviors (i.e. Performance, reliability, portability, space and usability) [27]. Usability is one facet of non-functional specifications and is very significant in system development / product development. As without usability, there is no grantee for the successfulness of product / system although if it functionally precise and accurate [29]. Usability cannot be measure directly but can be quantify using attributes analysis. It discusses the objects that are related to humans' and evaluation methods such as; website, tool, machine, process, books and any things have interface for humans.
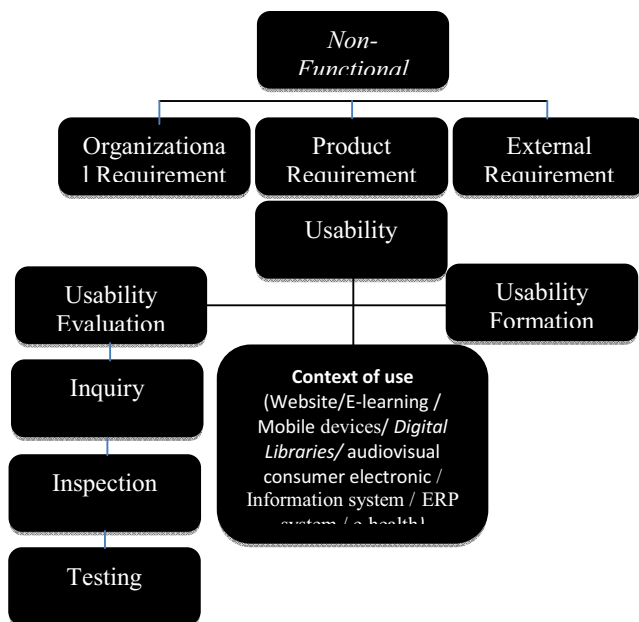

Figure 2. Non-functional specifications

Software's using advance technologies are developed to support the users' in various contexts where the usability is specifically used to evaluate these technologies to gather additional requirements that help to design them more useable. It not only deals the functional specifications delivered by the system but also discuss the emergent system properties, features and interface, etc. Thus usability is a discipline that helps the investigator to uncover the usability related issues and to improve the usability of any product. Generally there are three types of usability evaluation methods as given in Fig.2: testing, inspection, and inquiry.

A. Usability Testing[11-14]

In usability testing the users have to work on the precise tasks using well-defined scenarios on system or software prototype. Usability testing includes following testing strategies: Coaching Method, Co-discovery Learning, Performance Measurement, Question-asking Protocol, Remote Testing, Retrospective Testing, Shadowing Method, Teaching Method, and Thinking Aloud Protocol.

B. Inspection [11-14]

In usability Inspection, the usability specialist, software developer, designers', users and experts examine usability related harms or feature on user interface. Usability Inspection includes the following techniques; Cognitive Walkthroughs, Feature Inspection, Heuristic Evaluation, Pluralistic Walkthrough, and Perspective-based Inspection.

C. Inquiry [11-14]

In usability Inquiry, the usability evaluators gather the information from users about their likeness, dis likeness, needs, and understanding for a system by observing and letting them answer /questions orally and in written form. Usability Inquiry includes strategies: Field Observation, Focus Groups, Interviews, Logging Actual Use, Proactive Field Study, and Questionnaires.

The study of usability [19] discusses the software psychology and with the passage of time the focus of usability is shifted towards the context of use. The concept and context of use means the identification of further human's aspects for software usability. These variables are based on situational and environmental context for which the particular product or application were adopted. Thus usability is getting more and more value. Fig.1 shows the various contexts for usability evaluations which also were communicated in previous work.

Usability Matrix for Website: In 2001 Agarwal & Venkatesh presented five categories for usability assessment; Content, Ease of use, Promotion, Made-for-the-medium and Emotion with Sub-categories Relevance, Media use, Depth/breadth, Structure, Feedback, Community, Personalization, challenge and Plot [15]. *Usability Matrix for Digital Libraries:* In 2005 Jeng proposed a usability assessment models for digital libraries which is based on ISO 9241-11 (ISO, 2004) as given; Effectiveness, Efficiency, Satisfaction, Learnability, The assessment method for digital libraries was further extended with additional components; Ease of use, Organization of information, Clear labeling, Visual appearance, Contents, Error corrections [16]. Usability Matrix for audiovisual consumer electronic products: In 2001

Han et al, 2002 Kwahk & Han and 2003 Hassanein & Head proposed a usability evaluation framework for audiovisual consumer electronic products. The framework is consist two layers, formation of usability and Usability evaluation. The formation of usability layer proposed with four contextual-components and it also suggested by Kwahk & Han and Shackel, as good design principle components in HCI (Human Computer Interaction); Product, User, User activity and Environment. The usability evaluation layer was proposed with three major groups of variables; Design variables (Product interface features), Context variables (Evaluation context), and Dependent variables (Measures of usability) [17-18]. Usability Matrix for Mobile: In 2011 Constantinos K. Coursaris and Dan J. Kim proposed a framework for mobile usability. The consequences of this framework are to improve the systems integration, Increasing adoption, retention, loyalty and trust. Basically the framework based on the components proposed by j Nelison. The proposed usability framework consists of four contextual variables; Technology (Device type Interface - Input mode), Task/Activity (Realism: Open (user defines outcome) Vs Closed (pre-defined outcome or goal) / Task descriptions (open/unstructured)), Environment (Physical (Auditory, visual, co-location, experiment type) / Psychosocial /social conditions), User (Demographics / culture / Knowledge /experience /self-efficacy /Perception /cognitions /Emotional and psychological context) [19]. Usability Evaluation Matrix for Information system / Business systems: In 2006 Jen-Yin YEH discuss the system measurement model that was proposed by Sanders and Garrity (1998) and is the extended version developed by DeLone and Mclean in 1992. DeLone Proposed sex dimension for Information systems assessments; Information Quality, System Quality, User Satisfaction, System Use, Individual Impact, and Organizational Impact. Further Sanders and Garrity (1998) proposed following two major factor for the assessment of ERP systems: Organizational and Socio-Technical. The model also identifies four sub-dimensions of User Satisfaction; Interface Satisfaction, Decision Support Satisfaction (DSS), Task Support Satisfaction (TSS), Quality of Work Life Satisfaction [20-22].

In 2009 Akash Singh and Janet Wesson proposed a usability heuristic for ERP that were specially designed for ERP system evaluation. This empirical work was conducted on SAP business. The proposed model for assessment includes following components; Navigation; Learnability; Task support; Presentation (input and output); Customization [23]. This model proposed by Akash Singh 2009 is originally based on Nielson's ten heuristics and Shneiderman's heuristics were developed in 1994 and 1998.

Nielson's heuristics: visibility of system status, match between system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, help users recognize, diagnose and recover from errors and help and documentation [24].

Shneiderman's heuristics includes Strive for consistency, Cater to universal usability, Offer informative feedback, Design dialogs to yield closure, Prevent errors, Permit easy reversal of actions, Support internal locus of control and Reduce short-term memory load [25-26].

The heuristic evaluation is an informal way for measuring the usability by involving small number of experts and allocating a severity rating using a set of usability guidelines or heuristics. It is most commonly adopted methodology due to ease in which these evaluations can be conducted and executed. Some of the benefits of heuristic evaluations include low-cost, earlier use in the development process, no need for advanced planning, can be conducted effectively without using professional evaluators, and easy to learn [23].

III. RESEARCH DESING

This research based on two case studies conducted in production-oriented organizations. The formation of case study 2 entirely depends on the results taken from case study 1. The basic objectives of imperial investigations in industry were to gather reliable and detailed information. The investigation in both case studies were based on personal observation, experts interviews and assessment tool that were designed using [24] Nielson's heuristic. The first case study was conducted in two industries where oracle financial is implemented. The objective of this case study was to evaluate the selected ERP systems from users' perspective.

- What values users perceive from the ERP system in their daily working life.

- Why novice users take too long operating time.

The results of this case study were presented in, International Conference on Graphic and Image Processing ICGIP, 2011 Cairo, Egypt [13]. The second case study was conducted in 14 textile industries. The primarily aim of this study was to evaluate the decision-making and knowledge capability of the selected application.

- What strategic information and knowledge ERP system should deliver to helps in decisions-making.

The results of this case study were presented 5th Malaysian Conference in Software Engineering MYSEC 2011, Malaysia [28].

Sample size: 50 managers as experts were selected from nominated industries to assess the selected modules in ERP system.

User Modelling: Selected participants had more than 3 year experience on selected applications. The formation of user was with respect to their job of. The **fig.3** shows the segregation of users. The formation of user modelling based on nature of jobs, strategical and operational nature.
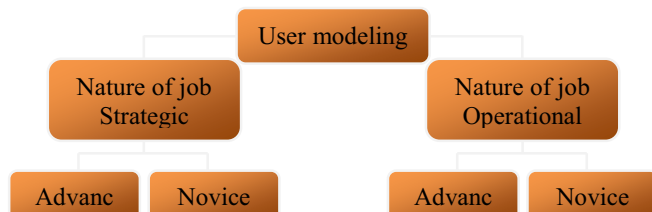

Figure 3.   User modeling

Methodology: The evaluation was carried out using an automated assessment tool. The assessment tool was developed using oracle and integrate it with ERP system as shown in *Fig4, Fig5*. The criterion and the formation of assessment tool were based on previous literature and industrial observation with following attributes; Usefulness, Ease of Use, Easy of Learning, Satisfaction, Efficiency, Memorability, Error Prevention, Aesthetic, Help & Support, Decision Making, Knowledge ability.

The second case study included following attributes knowledge towards decision, efficiency, and satisfaction. Responses' received from all participants were stored in Database of concerned department. The participants had to rate the question as per value they perceived from selected module. Finally the department received the response from all 50 participants precisely and completely.
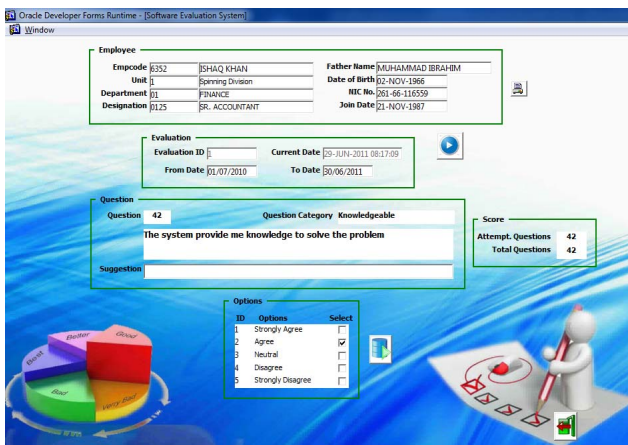

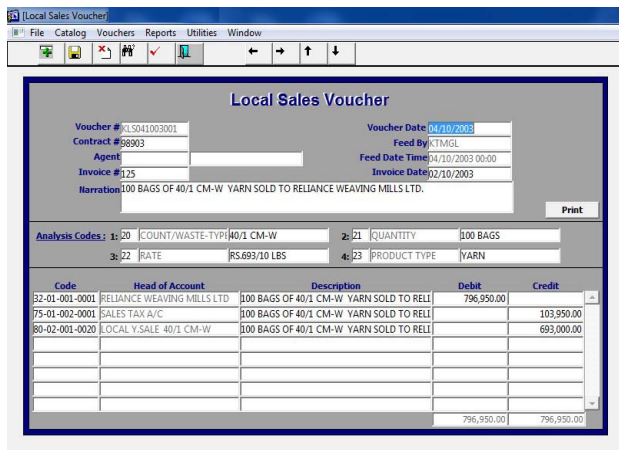Figure 4. Automated assessment tool

Figure 5. Aautomated assessment tool

A. Case 1 discussion [13]

The results reveal from the empirical investigation show that the experts engaged during assessment were very concerned about the following factors; Learning, Aesthetics sense, Decision-making

Learning: the system interface did not provide learning opportunity to the users about the software. Lack of understanding about the system is the major cause of excessive training in ERP system. The organizations had to invest a heavy amount for providing trainings to employees. The difficulties in operating such applications directly affect the users' efficiency. An interactive and learnable system always provides opportunities to work efficiently which is directly related to users' satisfaction [13].

Aesthetics sense: It is the technique towards the graphic wisdom of any software. The selected modules in the ERP system were not attractive or eye catching. A graphics based application always attracts users and continuously engages them during working. The arrangement of information using graphics could enhance the users' understanding about the application interface. Graphical and aesthetical sense supports for memorization and navigation which alternatively enhance the system usability [13].

Decision-making: The ERP system only performs the tasks that are related to business process management. The management of business information is the basic requirement in ERP system. The operational information helps to manage and to take strategic decisions. Due to diverse changes in textile sector mangers are responsible to maintain the production to compete in the international market. It was also found that currently ERP system poorly helps in decision-making process [13].

B. Case 2 discussions [13-28]

The first case study involved the general usability heuristics to evaluate the usability of selected application in ERP. It was proved that except the general usability issues the results also showed the mangers key concern regarding decision-making empowerment that system should provide to them. Therefore the second case study was particularly designed to assess the ERP system for those users who have strategic nature of job. The formation of usability assessment matrix included following variables; Knowledge ability towards Decision-making, Efficiency and Satisfaction. The results revealed that users' satisfaction towards efficiency was just for sake of operational activities in selected application but not for decision-making [28].

The knowledge, experience and group discussions proved to be major factors for decision-making. The lack of knowledge abilities in EPR system is because these systems only acquire and equipped explicit nature (Operational Data) of knowledge which is not sufficient to empower the users [28]. Therefore, there is a need to apply the efforts to enrich the information system with knowledge for decisions. The decision-making capabilities, operational, organizational and strategic benefits are only possible due to well-designed ERP system. Thus these capabilities can be only achieved when industrial systems provide key services to users [28].

IV. PROPOSED MATRIX FOR ERP EVALUATION

The business information systems are the backbone of any organization. The organizations adapt them to manage their business resources, operational and cross-functional activates. The organizations always demand for good system to meet

their business and operational requirements. These requirements only fulfilled when such information systems are developed by specifying the nature of business and requirements. Often the organizations purchase business application from various ERP vendors because it highly expensive and difficult to develop in-housed EPR system.

In textile sector the organization are facing competition in international market and trying to provide high quality products in short time. The quantity oriented products demand for high speed production which is only possible if system and users both equipped with past experience, knowledge and information. Typically the ERP systems manage operational and resource based information but it is unlikely to be equipped with experience and knowledge. Knowledge based experience and explicit knowledge is the mainstay of decision-making.

Figure 6.   ERP Assessment matrix

The purpose of this research is to identify the additional factors that have an impact on system usability. The true fact of usability is to design and develop application users' perspective. Normally large systems have a diverse user community where users have different requirements and priorities. The usability heuristic is effective technique to assess the applications in a specific context. In this empirical investigation we practically assess the ERP for decision-marking capabilities especially for those who have strategic nature of job. On the bases of both case studies we propose usability heuristic shown in Fig.6 with following assessment dimensions; Efficiency, satisfaction, task supported, decision-making, aesthetic sense/navigations, accuracy, learnability and knowledge ability.

- *Task supported:* the system should perform the task appropriately given by users.

- *Aesthetic sense/navigations***:** the system should equip with graphical wisdoms and the arrangement of content helps in navigations to access the appropriate information the user required.

- *Accuracy:* The system should provide precise and accurate information in timely manners.

- *Learnability:* The system should provide ease and comprehensible manners to understand the behavior of the system. Thus sufficient help, documentations and user manuals should be available to users which guide them about the software philosophy. It is found that the operations can be learned effectively by observing the objects.

- *Efficiency:* The efficiency can be defined from two perspective system and user efficiency. The users' efficiency always depends upon the system efficiency. A user can perform the task quickly after learning a system. The systems should be designed according to the context. It should fulfill the business requirement that user demands during work hours to accomplishing tasks efficiently.

- *Decision-making***:** Decision-making is an individual capability or a system that provide them in critical situations. Thus Usability assessment for the empowerment of prospective methods, techniques and collaborative technologies that support the individuals in different situations.

- *Knowledge ability:* Knowledge is the backbone towards decision-making. Therefore there is a need to assess the ERP system regarding the availability of knowledge in form of video, audio, guidelines and solutions for routine and non-routine problems.

- *Satisfaction:* It is most important factor that discusses the system evaluation by assessing user productivity and play fullness at work place

V.   CONCLUSION

Usability studies help the developers to design context-oriented systems. Continuously research is expanding the wing towards maturity but still evaluation matrixes and proposed criterion are very much generalized. The ERP systems are most adoptable system in business community to manage their business functions. But limited research preciously discusses the usability related issues in ERP system. Therefore there is need for the identification of more attributes to assess user-oriented products and applications

ACKNOWLEDGMENT

department of all selected industries by giving the access to the ERP system and for the development of automated assessment for ERP.

REFERENCES

[1] Arik ragowsky, what makes the competitive contribution of ERP strategic, the data base for advances in information systems, volume 39, number 2, may 2008.

[2] Siew kien sia, Enterprise Resource Planning (ERP) systems as a technology of power: empowerment or panoptic control? the data base for advances in information systems - winter 2002 (vol. 33, no. 1)

[3] Topi, H., Lucas, W., and Babaian, T. Identifying usability issues with an ERP implementation. In Proc. of ICEIS-05 (2005), 128–133.

[4] Babaian, T., Lucas, W. T., Xu, J., and Topi, H. Usability through system-user collaboration. In DESRIST, Lecture Notes in Computer Science, Springer (2010), 394–409.

[5] Davenport, T. Putting the enterprise into the enterprise system. HBR, 76, 4 (1998), 121-131.

[6] Markus, L., and Tanis, C. The Enterprise systems experience–from adoption to Success. In R.W. Zmud (Ed.) framing the domains of IT research: Glimpsing the future Through the Past. Pinnaflex Educational Resources, Inc., Cincinnati, OH, 2000, 173-207.

[7] Markus, M. L., Tanis, C., and Fenema, P. C. Multisite ERP Implementation. CACM, 43, 4 (2000), 42-46.

[8] Nahar, N., and Savolainen, V. IT-enabled international promotion of technology transfer in the enterprise resource planning space. Studies in Informatics and Control, 9, 3 (2000), 233-251

[9] Sammon, D., Adam, F., and Carton, F. Benefit realization through ERP: The re-emergence of data warehousing. EJISE, 6, 2 (2003), 155-164.

[10] [10] Shang, S., and Seddon, P. B. Assessing and managing the benefits of enterprise systems: the business manager's perspective, ISJ, 12, (2002), 271-299

[11] [11] F. Calisir, "The Relation of Interface Usability Characteristics, Perceived Usefulness, and Perceived Ease of Use to End-User Satisfaction with Enterprise Re-source Planning (ERP) Systems," Computers in Beha- vior, Vol. 20, No. 04 , 2004, 505-515.

[12] Ch. M. Nadeem Faisal et al., technical report "Usability form Industrial Pro-   spective,"   (cited)   01-05-2012. https://files.itslearning.com/data/640/8517/papers/3.pdf

[13] Chaudhry Muhammad Nadeem Faisalet et al, "Usability Evaluation of In-Housed Developed ERP System," 2011 International Conference on Graphic and Image Processing, Cairo, 1-3 October 2011, doi:10.1117/12.913212

[14] Mr. James Hom, Usability evaluation online http://www.usabilityhome.com/ retrieved date (25–02-2012)

[15] Agarwal, R., & Venkatesh, V. (2002). Assessing a firm's web presence: A heuristic evaluation procedure for the measurement of usability. Information Systems Research, 13(2), 168-186.

[16] Jeng, J. (2005). What is usability in the context of the digital library and how can it be measured? Information Technology and Libraries, 24(2), 47-56.

[17] Han, S. H., Yun, M. H., Kwahk, J., & Hong, S. W. (2001). Usability of consumer electronic products. International Journal of Industrial Ergonomics, 28(3-4), 143-151.

[18] Kwahk, J., & Han, S. H. (2002). A methodology for evaluating the usability of audiovisual consumer electronic products. Applied Ergonomics, 33, 419-431.

[19] Constantinos K. Coursaris, Dan J. Kim, A Meta-Analytical Review of Empirical Mobile Usability Studies, Journal of usability studies, Vol. 6, Issue 3, May 2011, pp. 117-171

[20] Jen-Yin YEH, Evaluating ERP Performance from User perspective, Proceedings of the 2006 IEEE Asia-Pacific Conference on Services Computing (APSCC'06), 0-7695-2751-5/06

[21] Garrity, E.J. and Sanders, G.L. (1998), "Dimensions of information systems success", Information Systems Success Measurement, Idea Group Publishing, Hershey, PA, pp. 13–45.

[22] DeLone, W.H and McLean. E.R, (1992), "Information systems success the quest for the dependent variable", Information Systems Research, Vol.3, pp. 60–95.

[23] A. Singh, "Improving the usability of ERP systems through the application of adaptive user interfaces," Proceedings of 11th International Conference on Enterprise Information Systems (ICEIS), Milan, SAICSIT'09,12-14 October 2009, pp. 87 – 88

[24] Nielsen, J. and Mack, R.L. (1994): Usability Inspection Methods. John Wiley & Sons, Inc.

[25] Shneiderman, B. (1998): Designing the user interface: strategies for effective human-computer interaction. Third Edition Edn, Addison Wesley Longman, Inc.

[26] Te'eni, D., Carey, J. and Zhang, P. (2007): Human Computer Interaction: Developing Effective Organizational Information Systems. John Wiley & Sons, Inc.

[27] Lan SommerVille, Software engineering, Pennon Education Limited, Eighth Edition 2007 ISBN 13: 978-0-321 -31 379-9, pp. 140-142

[28] Muhammad Nadeem Faisal et al., Assessment of Knowledge Ability Towards Decision-Making in Information Systems from Managers Perspective, 2011 5th Malaysian Conference in Software Engineering (MySEC), 978-1-4577-1531-0/11, 2011 IEEE

[29] Chaudhry Muhammad Nadeem Fasial, et al, "Usability evaluation of software as services from individuals",International journal of Human-Computer-Interaction, Spain, Vol 2, Issue No 7. ISSN: 1697-9613 (print) -1887-3022 (online).