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A Computer Support System for Evaluating Software Quality in e-Book

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ABSTRACT

Electronic Book or e-Book has become a new medium in education. An important consideration of e-Book in the education system is the quality of software product that is shipped with it. The e-Book program in Malaysia began in 2009 with the free distribution of e-Book to primary school children. The e-Book is a version of the Intel Classmate PC and shipped with five specific applications: Digital Textbook, MyKamus, Fasohah Jawi, Fardhu Ain, and Digital Quran. This paper presents the design and development of a computer support system for evaluating software quality in e-Book based on the ISO9126 model. There are four quality characteristics evaluated: Functionality, Reliability, Usability and Efficiency using four rating levels: Excellent, Good, Fair and Poor. Results, in the form of total response for each metric is displayed statistically, including the number of respondents and school. The overall percentage for a particular software product is also displayed, revealing the general perception of users for the product.

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INTRODUCTION

The exponential growth of Information and Communication Technology (ICT) has changed the education system from traditional teaching process to smart classrooms and online examination. Studies have revealed that ICT has a positive effect on students' performance and teachers' productivity. Advancement in computing technology has witnessed a revolution with the use of Electronic Book or e-Bookin the education system. Several countries including the United Kingdom and Canada have incorporated e-Book in compulsory education. In Malaysia, the state of Terengganu is leading this initiative through its e-Book program.

The Malaysian e-Book program started in 2009 with the distribution of e-Book to primary school children (aged 11 - 12). To date, more than 70,000 students have received e-Books involving huge sum of investments. The e-Book is a mini laptop that is installed with five specific applications: Digital Textbook, MyKamus, Fasohah Jawi, Fardhu Ain, and Digital Quran. The aim of this program is to support learning activities and exposing students to ICT at the same time. Although this effort is much applauded, it prompts the question of software product quality in e-Book.

It is stipulated that in order to get the best result from e-Book and on-line learning, quality of the software product should be of 'acceptable' standard. A systematic approach should be used to evaluate the software product quality in e-Book. Unfortunately, there has been limited attention given (if any) for this purpose despite the substantial investment involved.

This work is part of an on-going research effort in e-Book software product quality (Fahmy *et al*., 2012; Roslina *et al*., 2012; Roslina *et al*., 2013; Haslinda *et al*., 2012). Work to date has successfully outlined research directions for e-Book; proposed a quality model for e-Book; proposed an approach for quality metrics evaluation based on questionnaire; and report on the effects of e-Book on students' learning styles. This paper presents the design of a computer support system for evaluating software product quality in e-Book based on the ISO 9126 model.

2. Literature Review:

This section presents the review of relevant literature in the field of software quality in order to better understand the research domainand identify research efforts in this area. Discussions include *Software Quality*, the *ISO 9126 Model*, and the *Malaysian e-Book*.

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Software Quality:

Definition:

Software Quality is defined as '*conformance of software to state and implied needs*'(ISO 9126, 2001). It is a set of desirable features that are incorporated into a product so as to enhance its lifetime performance (Panovski, 2008).*Quality Models* are often used to measure quality and understand how quality metrics relate to each other.

Software Quality Model:

A quality model is a set of quality metrics and relationships between them, which provides the basis for evaluating software product and specifying its requirements (ISO 9126, 2001). There are several models for assessing software products including *McCall*(McCall *et al*., 1997), *Boehm*(Boehm *et al*., 1978), *FURPS*(Grady, 1992), *Dromey*(Dromey, 1995), and *ISO9126*(ISO9126, 2001). ISO9126 is based on previous models, and covers crucial characteristics such as structure, evaluation criteria, expression, definitions; and relationships (Fahmy *et al*., 2012). Although the ISO has announced the ISO25010 (ISO25010, 2011) to succeed the ISO9126, the quality model remains the same in many aspects and would produce the same result in this work.

Quality Metrics:

There is no singleformal method or technique to specify software quality metrics. The standardization process is on-going through the ISO (ISO 1061, 1992). The quantification of metrics reduces the subjectivity in software product evaluation. Results of measurement are valued on the scales of metrics such as 1 to10 or binary responses (Yes/No). For a measured value, a rating level is required. ISO9126 proposes four rating levels: *Excellent*, *Good*, *Fair* and *Poor*.

ISO 9126:

The ISO 9126 is an international standard for the evaluation of software product (ISO9126, 2001). It specifies and evaluates software product in terms of its internal and external qualities and their connections to quality metrics. ISO 9126 identifies six main quality metrics: *Functionality*, *Reliability*, *Usability*, *Efficiency*, *Maintainability* and *Portability*.

Functionality defines the purpose of any product or service and explains what has to be done by identifying necessary task, action or activity that must be accomplished (ISO9126, 2001). *Reliability* expresses the ability of a software product to maintain a specified level of fault tolerance. *Usability* refers to the design of a user interface but efforts are made to broaden the metric to include other areas such as safety (Bevan, 2009). *Efficiency* expresses the ability of a software piece to provide appropriate performance and the ability to improve performance without affecting specifications. *Maintainability* describes the ability of a software product to be modified(corrections, improvements, adaptations, etc). *Portability* is a measure of effort that is needed to move the software to another computing platform

ISO 9126 has been applied in strategic-decision making activities (Quirchmayr *et al*., 2007), e-Learning systems(Chua and Dyson, 2004) and Business-to-Business (B2B) applications (Behkamal *et al*., 2009).

Malaysian e-Book:

The Malaysian e-Book is a version of the Intel Classmate PC, produced by Intel for the *World Ahead Program* (Wilson and Landoni, 2003). The e-Book is used in traditional classroom, test, and in smart classrooms; using multiple media applications. Apart from the *Operating System* (MS Windows) and MS Office applications, the e-Book is shipped with five specific applications: *Digital Textbook*, *MyKamus*, *Fasohah Jawi*, *Fardhu Ain*, and *Digital Quran*.

*Digital Textbook*is digital copies of the official textbooks for Year 4,5 and 6inthe Malaysian school system. In total there are 14 titles including English, Mathematics and Science. *MyKamus* is a dictionary application that contains more than 85,000 English and Malay words. Translation can be done from English-Malay and Malay-English. *Fasohah Jawi* is an application for learning *Jawi*, the traditional Malay script based on Arabic alphabets. This multimedia application helps student to identify and write Jawi through sounds and shapes. *Fardhu Ain* is another multimedia application for learning the fundamentals of Islamic teachings such as prayer and doa'. *Digital Quran* is a digital copy of the Quran, listing all 114 *surahs*. This multimedia application enables users to browse through the surahs where text, sound and translation (to Malay) are used to facilitate learning.

One interesting application that is shipped with e-Book is *Blue Dolphin*, which replaces the standard Windows desktop with an interactive application launcher which streamlines the application launching process (Fig. 1). Blue Dolphin provides a simpler way to start programs, with a more touch-friendly application for common tasks such as switching between wireless networks and managing power profiles.

Fig. 1: Blue Dolphin Desktop.

Based on discussions in this section, it can be concluded that the *ISO 9126model* can be used as a foundation to evaluate software quality product in e-Book; evaluation should include five applications namely *Digital Textbook*, *MyKamus*, *Fasohah Jawi*, *Fardhu Ain*, and *Digital Quran*; and rating levels of *Excellent*, *Good*, *Fair* and *Poor*are used in the evaluation. However, only four quality metrics are applicable for e-Book: *Functionality*, *Reliability*, *Usability* and *Efficiency*. *Maintainability* and *Portability*are not included since these metrics are usually evaluated by the developers, and not the end-users.

3. System Design:

This section presents the design of a *Computer-Aided Software Quality Assessment* (CASQA) system for the Malaysian e-Book. The main objective of this systemis to support the evaluation of software product in e-Book based on four quality metrics: *Functionality*, *Reliability*, *Usability* and *Efficiency*.The proposed system environment is depicted in Fig. 2.

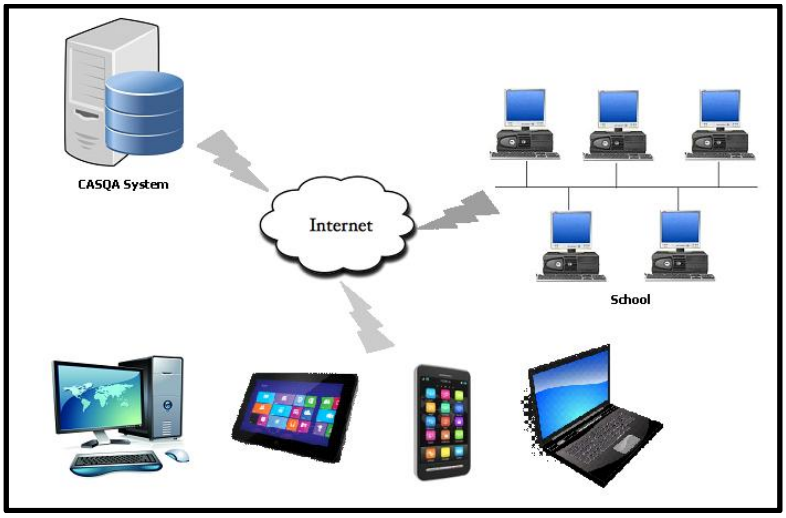

Fig. 2: CASQA System Environment.

CASQA is a web-based systemused by primary school teachers in the state of Terengganu. The server (and database) will be placed at a central locationsuch as the State's Education Office where it will be monitored and maintained.Access to the system is through the Internet either by wired or wireless connectivity. Computer laboratories can be used to access the system during school hours while off-hours access can be done through various peripherals including laptops, smart phones and tablet PCs.

Access is via the web-browser and security measure used by the system is a combination of school name, username and password. User selects the school from a list and then enters the provided username and password. The flow of the system is illustrated in Fig. 3.

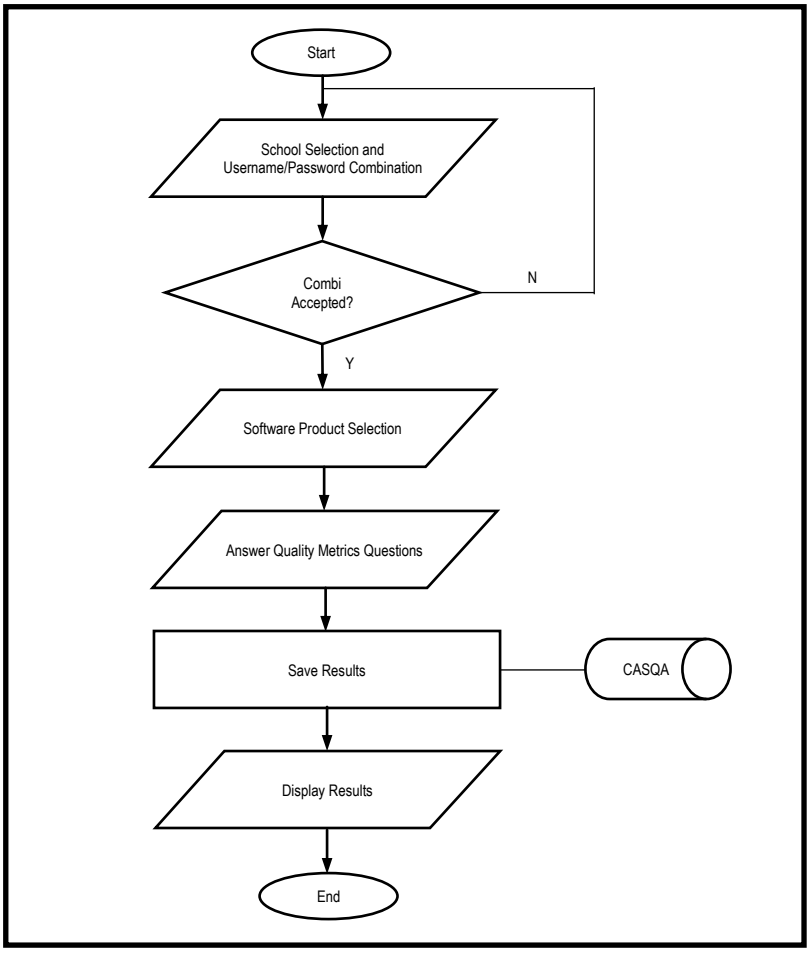

Fig. 3: CASQA System Flowchart.

Once access is granted, the user then selects the software product to be evaluated. There are fivesoftware productslisted; *Digital Textbook*, *MyKamus*, *Fasohah Jawi*, *Fardhu Ain*, and *Digital Quran*; based on the softwarethat are installed in e-Book.

The user then answers a series of questions regarding the *Functionality*, *Reliability*, *Usability* and *Efficiency*aspects of the product. Answers are based on a rating of *Excellent*, *Good*, *Fair* and *Poor*. A rating of Poor means the product does not conform to the ISO 9126 standards. All other ratings are deemed acceptable, thus meeting the standard. In total there are 16 questions for each product.

Answers are stored into the database and results of evaluation are displayed to the user. Results can also be referred by stakeholders and developers since the system displays statistical analysis of the software product evaluation.

4. Implementation:

This section presents the implementation of the CASQA System. The system is developed using .NET framework with C# as the interface and MS Access as the database. A total of six developers are involved and development of all modules took approximately eight weeks with another four weeks for testing and debugging. Development is done in a local network setting where all modules are developed simultaneously according to phase. The system is deployed on *Internet Information Server 7* on a local network. A total of 20 Windows-based PCs are connected to the network to test the functionality of the system using popular webbrowsers including *Microsoft Internet Explorer*, *Mozilla Firefox* and *Google Chrome*.Two sets of test-cases are administered to verify the functionality of the system and validity of results. 20 testers are involved in this process. The first test-case uses data from 31 schools and 119 teachers, whilst the second test-case uses data from 24 schools and 100 teachers.Walkthrough and screen shots of the system are illustrated in Figures 4-7.

Fig. 4. depicts the main login page for the system. Using the web-browser, user navigates to the CASQA portal where the user selects a school from a drop-down list. There are a total of 346 primary schools in the system, as registered by the State's Education Office. The user then enters the username/ password combination to gain access to the system.

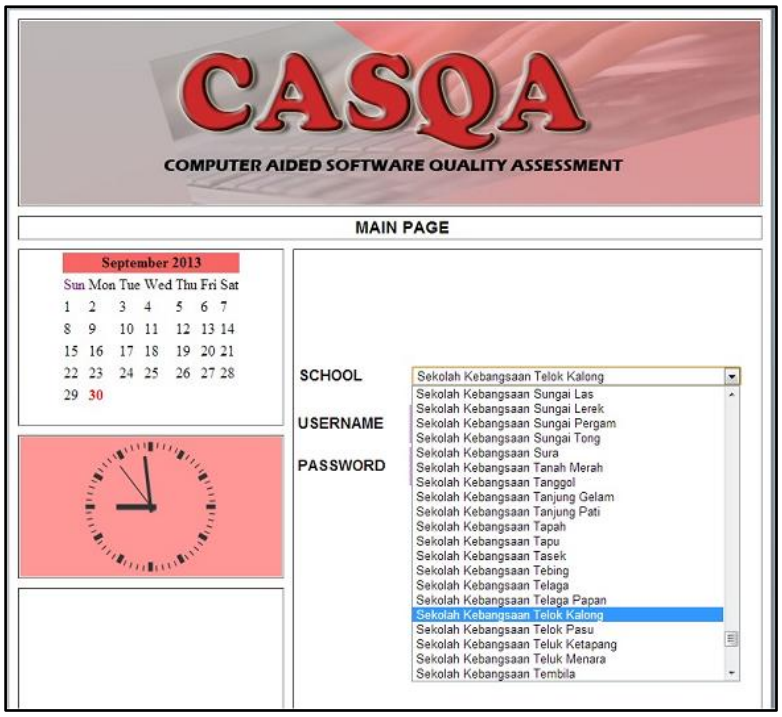

Fig. 4: Main Login Page of CASQA System.

After selecting the appropriate software product to evaluate, the user is then presented with a series of questions regarding the software product (Fig. 5). In total, there are 16 questions in four sections.

Once all questions have been answered, results are stored in the database and the overall statistics is displayed to the user. Fig. 6 and Fig. 7 illustrate the evaluation results for *Digital Quran* and *MyKamus* respectively.The total response for each metric is displayed statistically, including the number of respondentsand school. The overall percentage for a particular software product is also displayed at the top corner, revealing the general perception of users for the product.

Evaluation for *Digital Quran* reveals that the overall score (percentage of conformance to standard) is 97.6%, based on 119 respondents from 31 schools. It scored 94.8% for *Functionality*, 99.8% for *Reliability*, 99.6% for *Usability*, and 96.2% for *Efficiency*.

Evaluation for *MyKamus* indicates that the overall score is 99.7%, based on 100 respondents from 24 schools. Scores for *Functionality*, *Reliability*, *Usability*, and *Efficiency* are 99%, 100%, 99.8% and 100% respectively.

Conclusion and Future Work:

This paper has proposed a computer-support system for evaluating software quality in e-Book. The web-based system evaluates five software products: Digital Textbook, MyKamus, Fasohah Jawi, Fardhu Ain, and Digital Quran. Software metrics used in the evaluation are based on the ISO 9126 model namely Functionality, Reliability, Usability and Efficiency. Users are asked to rate a product based on a rating of Excellent, Good, Fair and Poor. Results are stored in the database and provide statistical analysis of the perceived product quality by the users.

Works in the near future include the implemetation of the CASQA system based on the ISO-25010 model; development using open-source tools; and implementation at the state level, involving all 346 schools in Terengganu.

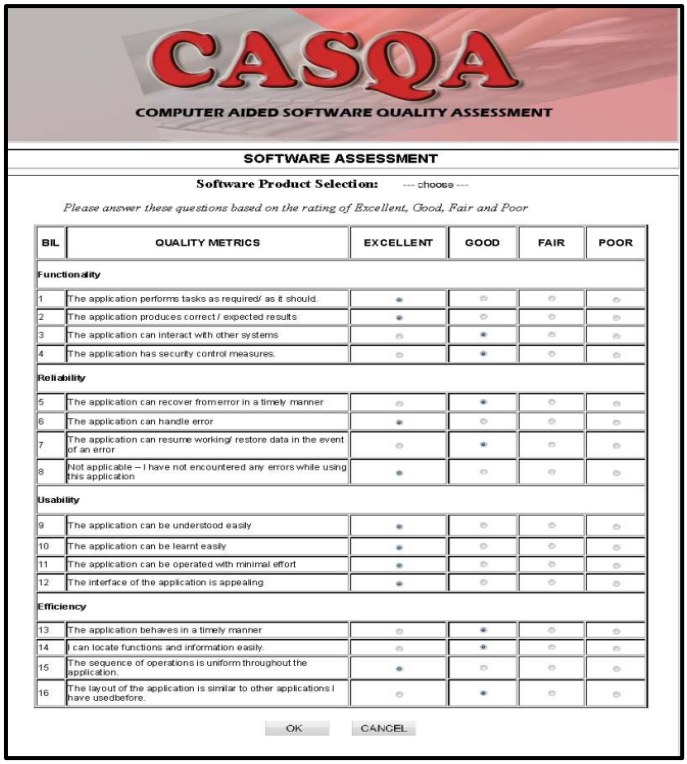

Fig. 5: Quality Metrics Evaluation.

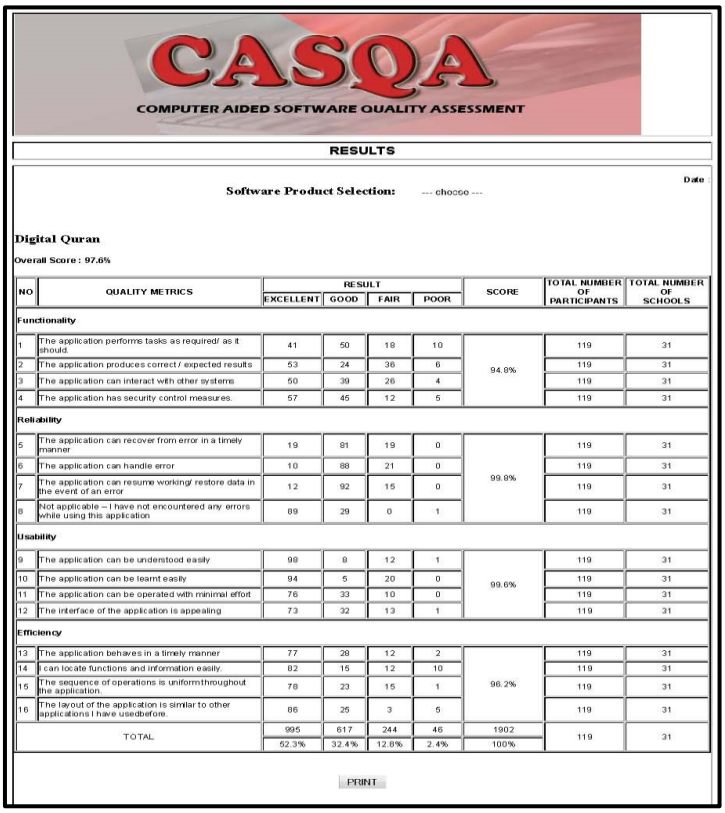

Fig. 6: Evaluation Results for *Digital Quran*.

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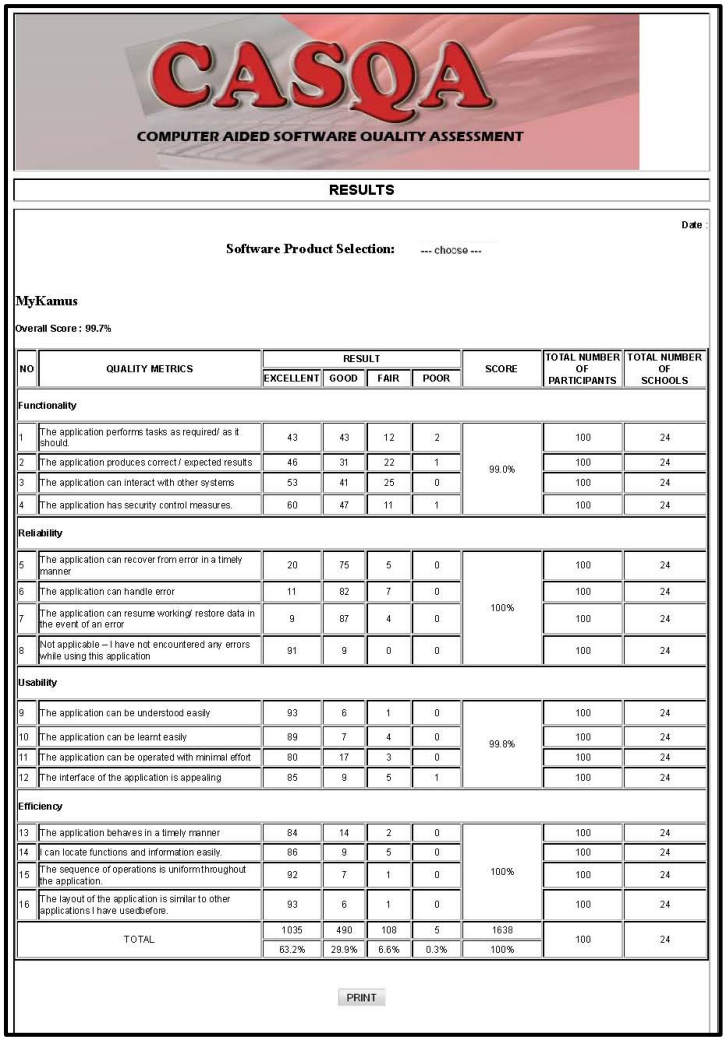

CASQA

COMPUTER AIDED SOFTWARE QUALITY ASSESSMENT

RESULTS

Date :

Software Product Selection: --- choose ---

MyKamus

Overall Score : 99.7%

NO	QUALITY METRICS	RESULT				SCORE	TOTAL NUMBER OF PARTICIPANTS	TOTAL NUMBER OF SCHOOLS
		EXCELLENT	GOOD	FAIR	POOR			
Functionality								
1	The application performs tasks as required/ as it should.	43	43	12	2	99.0%	100	24
2	The application produces correct / expected results	46	31	22	1		100	24
3	The application can interact with other systems	53	41	25	0		100	24
4	The application has security control measures.	60	47	11	1		100	24
Reliability								
5	The application can recover from error in a timely manner	20	75	5	0	100%	100	24
6	The application can handle error	11	82	7	0		100	24
7	The application can resume working/ restore data in the event of an error	9	87	4	0		100	24
8	Not applicable – I have not encountered any errors while using this application	91	9	0	0		100	24
Usability								
9	The application can be understood easily	93	6	1	0	99.8%	100	24
10	The application can be learnt easily	89	7	4	0		100	24
11	The application can be operated with minimal effort	80	17	3	0		100	24
12	The interface of the application is appealing	85	9	5	1		100	24
Efficiency								
13	The application behaves in a timely manner	84	14	2	0	100%	100	24
14	I can locate functions and information easily.	86	9	5	0		100	24
15	The sequence of operations is uniformthroughout the application.	92	7	1	0		100	24
16	The layout of the application is similar to other applications I have usedbefore.	93	6	1	0		100	24
TOTAL		1035	490	108	5	1638	100	24
		63.2%	29.9%	6.6%	0.3%	100%		

PRINT

Fig. 7: Evaluation Results for MyKamus.

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