Control of Metrics Design on Mobile Quality Application

Ion IVAN*. Alin ZAMFIROIU.**
Cristian CIUREA*. Mihai DOINEA****.**

** Department of Economic Informatics and Cybernetics,*
The Bucharest University of Economic Studies, Romania
(e-mail: ionivan@ase.ro)
*** Department of Economic Informatics and Cybernetics,*
The Bucharest University of Economic Studies, Romania
(e-mail: zamfiroiu@ici.ro)
**** Department of Economic Informatics and Cybernetics,*
The Bucharest University of Economic Studies, Romania
(e-mail: cristian.ciurea@ie.ase.ro)
***** Department of Economic Informatics and Cybernetics,*
The Bucharest University of Economic Studies, Romania
(e-mail: mihai.doinea@ie.ase.ro)

Abstract: Mobile applications structures are presented and their quality characteristics. The development cycle for m-applications is analyzed in the context of ensuring TQM requirements. A system of quality indicators of m-applications is designed and properties of these indicators are analyzed in relation to the operationality and representation of provided results. Practical arrangements for checking the metric for general classes of m-applications are established. The considered experiments come to emphasize the need to use metrics and the aggregate quality indicator.
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1. STRUCTURES OF MOBILE APPLICATIONS

There are several criteria for the classification of mobile applications. After the data entry criteria these are:

- mobile applications without data entry, which means that the application is selected through the phone button and information provided by it are simply displayed, the user is using this information and the application is completed, the application resume is done by repeating button; there is an application that gives lottery numbers - when application is started appear on the screen the 6 numbers that the user can play to the well-known game Lotto 6/49, another application of this kind is one that provides information on hardware components of the phone, such as Stats App and SysStat, applications for Symbian OS.
- mobile applications with keys options selection, the up and down arrows, then the OK button or the joystick; there is a list of options, the user is walking on the list and select the desired item; he can select movies, TV programs in real time and is able to leave the application with an EXIT button or to return in the list with the Back button; the Acronym Finder application from the BADA operation system has in the first part the selection of the desired acronym for description, and after the user selects the desired acronym, appears its description, where the user can return to the list with the BACK button or he came out of the application with the EXIT button;
- applications where the user enters the first few letters to select countries, locations, hours, days; the AccuWeather application on Symbian expects to introduce the first letter of a city or country then it make suggestions based on them and the user chooses one of suggestions provided by the application; if there are too many hints the user types more characters until appear the city looking for selection; after selection appear weather information for that city;
- mobile applications with input strings that validates and create the premise to personalize transactions; the string is a name, address, IBAN account, a unique identifier or text discretion; in the case of CV presentation, the user by pressing the SEND button validates on his own responsibility the text sent and any allocations of resources; as not to make repeated introductions of items are stored as a list the last strings that matches the options and the user just selects in the next uses; sometimes the texts are validated to not enter forbidden words;
- mobile applications where the data are multimedia, text, sound, images or video; the applications that read QR codes open your mobile device camera and the user positions the phone to make photo of QR code; the image is processed automatically and the user is provided with information existing in the code; by opening the camera which is equipped the mobile device are eliminated the cases where the

user will enter other images in the application and will get error; the picture is taken automatically when the application identifies the existence of a QR code; applications that read QR codes are: Quick QR Reader for BADA, BeeTagg for Symbian.

- mobile applications in which the user builds models or customized functions to be used in the following uses of the application; the SportsTracker application allows creating activities by the user; he says if in the newly created activity will use or not the GPS receiver, if the used pedometer sensor will be used to count the steps taken, if it displays the average speed or to a low speed the recording stops working or not; after creating the activity the user can choose it from the list to use; something similar is also when creating profiles for the mobile phone;

In relation to provided results criterion by the software products, they are:

- applications that provide results in the form of text; the Trivia application on Android platform provides the final result of the game in text format; the user is notified with the number of points scored in the game;
- applications that provides the result as a picture; the SuperSudoku application on Android after completion of the popular Sudoku game provides an image with the complete matrix of all values; the matrix completed by the user during the game;
- applications that provide results in tabular form; different information are grouped into categories in a user friendly presentation; the SportTracker application shows the statistical results of the runner after the running activity as a table presenting the activity duration, the start timing, the average speed, the maximum speed with which it ran, and other information;
- applications that provide results in the form of graphics; the graphical representation of the output information help users to better understand such diverse statistical results to be presented not merely figures, they are graphically presented and the user stores more easily these results; the SportTracker application provides as results the speed change in time, so the user see where he ran at a higher or lower speed and draw some conclusions as he notice that in the first part of the activity the speed was very high, then it plummeted, so to the following activities he must try not to make efforts at the beginning of the activity, but to reserve his energy for whole activity duration;
- applications that provide results in the form of a map to locate an address or a route to be presented; the BeeTag application on Symbian if it read a QR code that contains also an address it has the option display on the map this address so the user can find a venue more easily.

In relation to existing information in the application before to be accessed by the user, they are:

- applications without existing information; they are the applications that does not contain information and based on the user input do some calculations and get results based only on what was introduced at that time by the user; the user enters both values and operations that are applied to the values;
- applications with minimal existing information in the form of diagrams or models; they are the applications that hold a minimum amount of information, and based on which are analyzed information received from the user, the user enters values that are inserted into an existing model into the application and it obtain a result that is supplied to the user; these applications are for the calculation of body mass index or to determine a certain level based on existing intervals into the application;
- applications with bushy existent information from which the user just selects what he want in order to be informed at that time.

All mobile applications should be characterized in relation to these criteria. It is necessary to create a decision support system based on theory to determine the mobile applications quality, (Seok, 2012).

2. QUALITY CHARACTERISTICS OF MOBILE APPLICATIONS

Mobile applications, as all software products must be reliable, portable, operational, safe, friendly, simple, integrated, fast, easy to handle, without errors. These quality characteristics form an analyzed system in (Li et al., 2000; Balog, 2011; Hung et al., 2011).

It follows that must be identified as many features, obtaining a new subsystem of quality characteristics specific to mobile applications, listed below:

- the interaction way represent the use of appropriate controls to achieve the application interface so that the user have a natural interaction with it without documenting in advance;
- the speed of commands represent the speed at which m-application commands are executed;
- the interaction duration is the time spent by the user to solve the whole problem, not just a single command;
- maneuverability is the ease with which the user uses the application, it is influenced by the controls used in making the m-application interface;
- the amount of information provided represent the amount of data and information displayed at a time on the mobile device screen through the application; in (Chen et al., 2013) the AMOLED screen's are presented;
- the errors management or fault tolerance is the ability of the m-application to work even in cases where operational errors appear, these being properly managed for continuing the activity;
- regenerability represent the recovery ability of the modules affected by certain attacks;

- integrability is the m-application ability to take other existing components with which users are already familiar, but also the way to structure it so that it becomes a component in other m-applications;
- data security is how to ensure data privacy in the mobile device;
- transactions security represent the way to ensure the confidentiality of personal or important data in the transactions with applications from another mobile devices or with the server where the database is located (Kasai and Mogi, 2012).

Figure 1 presents the connection between these quality characteristics.

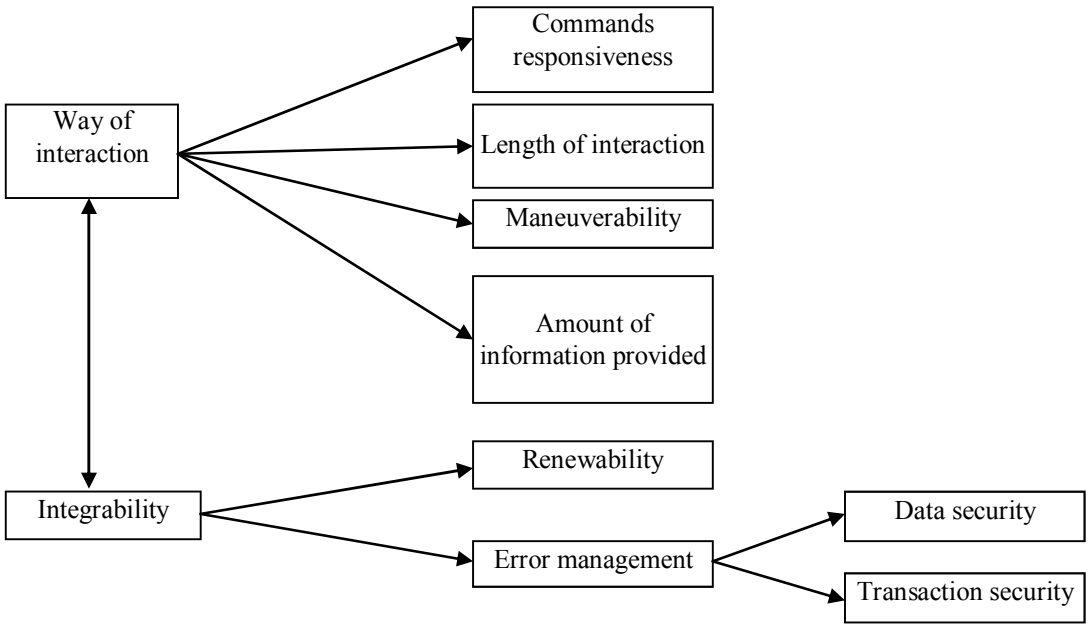

Fig. 1. Influences between the quality characteristics of mobile applications

It is necessary that in order to supply the correct resources in practice, the characteristics must be differentiated. Let $S = \{S_1, S_2, ..., S_{NS}\}$ be a group of NS specialists who are developing mobile applications and a grading system for the NC characteristics is defined with grades from the set $A = \{A_1, A_2, ..., A_{NC}\}$. To get the weights for each characteristic grades from A are given uniquely to the MC characteristics. The relation between the set A and MC is a one to one relation, to each element from A, a single element from MC is associated and to each element from the MC, a single one from A is given. In this way the set of grades given by the SP_i specialist is constructed:

$$A_{SP_i} = \{as_1^{SP_i}, as_2^{SP_i}, ..., as_{NC}^{SP_i}\}, \quad i = 1,2,..., NS$$

To verify the principle to each the grades were given uniquely, totals are calculated which must be equal to ST.

$$\sum_{k=1}^{NC} as_k^{SP_i} = ST; \quad i = 1,2,..., NS$$

The set of MC characteristics is composed by the aforementioned ten characteristics, NC=10; the number of specialists, NS=78; the set of grades given represented by A={0, 5, 10, 20, 30, 50, 70, 90, 120, 150}.

The sum of all the grades from the set A is ST=545.

In (Pocatilu et al., 2013) are presented the weights calculated and processed based on the grades given by the NS specialists in February, 2013, table 1.

Table 1. Characteristics weights

No.	Characteristic	Weight (W)
1	Way of interaction	0,13
2	Commands responsiveness	0,15
3	Length of interaction	0,07
4	Maneuverability	0,08
5	Amount of information provided	0,06
6	Error management	0,1
7	Renewability	0,03
8	Integrability	0,05
9	Data security	0,17
10	Transaction security	0,15
	Total	**1**

In this way the importance of each characteristic is determined differently and representative due to the fact that each specialist that attended the grading process has lot of expertise in the field of mobile applications, equally as developer as a user of such applications.

Based on these indicators for each characteristic the level P_i is determined for the application. The value of IA, the aggregated value for mobile applications is determined based on the following formula:

$$IA = \sum_{i=1}^{NC} W_i * P_i$$

The aggregated value of IA represents the quality level of the mobile application.

3. METRIC VALIDATION

Let be eight mobile applications: MyLuckyNumbers, SAW, CameraSnap, MobileDecision, Catalog, ButtonDimension, SimInformation, VibrateState, grouped in the following set

$$MAG = \{MA_1, MA_2, MA_3, MA_4, MA_5, MA_6, MA_7, MA_8\}$$

For these mobile applications the estimated quality levels, NES_{ij}, are determined, for the ten characteristics belonging to the MC set, levels presented in table 2. NES_{ij} represents the estimated quality level for the *i* characteristic belonging to the *j* mobile application.

Table 2. Estimated values

No.	Characteristic	Estimated values							
		MA_1	MA_2	MA_3	MA_4	MA_5	MA_6	MA_7	MA_8
1	Way of interaction	0,13	0,11	0,12	0,11	0,11	0,13	0,13	0,13
2	Commands responsiveness	0,13	0,12	0,14	0,13	0,14	0,15	0,15	0,15
3	Length of interaction	0,06	0,06	0,07	0,06	0,06	0,07	0,07	0,07
4	Maneuverability	0,08	0,06	0,08	0,07	0,07	0,08	0,08	0,08
5	Amount of information provided	0,06	0,05	0,06	0,05	0,06	0,06	0,06	0,06
6	Error management	0,07	0,08	0,04	0,09	0,08	0,09	0,09	0,08
7	Renewability	0,02	0,03	0,02	0,03	0,02	0,03	0,02	0,03
8	Integrability	0,04	0,04	0,05	0,04	0,05	0,03	0,05	0,04
9	Data security	0,12	0,15	0,16	0,15	0,16	0,17	0,15	0,17
10	Transaction security	0,14	0,12	0,14	0,13	0,14	0,14	0,15	0,15
	Total	**0,85**	**0,82**	**0,88**	**0,86**	**0,89**	**0,95**	**0,95**	**0,96**

The applications are put into production for measuring the levels of the NEF_{ij} indicator. The actual levels are presented in table 3.

Table 3. Actual levels

No.	Characteristic	Actual level							
		MA_1	MA_2	MA_3	MA_4	MA_5	MA_6	MA_7	MA_8
1	Way of interaction	0,12	0,11	0,11	0,09	0,1	0,11	0,12	0,11
2	Commands responsiveness	0,11	0,11	0,13	0,12	0,13	0,14	0,13	0,14
3	Length of interaction	0,05	0,05	0,06	0,06	0,05	0,06	0,06	0,07
4	Maneuverability	0,08	0,05	0,07	0,06	0,07	0,08	0,07	0,06
5	Amount of information provided	0,05	0,04	0,06	0,05	0,05	0,06	0,05	0,06
6	Error management	0,06	0,07	0,04	0,08	0,07	0,08	0,09	0,07
7	Renewability	0,02	0,02	0,02	0,03	0,02	0,03	0,02	0,03
8	Integrability	0,04	0,04	0,03	0,04	0,04	0,02	0,03	0,04
9	Data security	0,11	0,14	0,14	0,13	0,14	0,15	0,14	0,15
10	Transaction security	0,14	0,12	0,12	0,12	0,13	0,13	0,13	0,14
	Total	**0,78**	**0,75**	**0,78**	**0,78**	**0,8**	**0,86**	**0,84**	**0,87**

The differences between the actual and estimated levels for determining the indicators representativeness are calculated.

$$DIF_{ij} = \left| NES_{ij} - NEF_{ij} \right| \quad i = 1,2,...,10; \quad j = 1,2,...,8.$$

The differences are given in table 4.

Table 4. The differences between estimated and actual levels

No.	Characteristic	Level differences							
		MA_1	MA_2	MA_3	MA_4	MA_5	MA_6	MA_7	MA_8
1	Way of interaction	0,01	0	0,01	0,02	0,01	0,02	0,01	0,02
2	Commands responsiveness	0,02	0,01	0,01	0,01	0,01	0,01	0,02	0,01
3	Length of interaction	0,01	0,01	0,01	0	0,01	0,01	0,01	0
4	Maneuverability	0	0,01	0,01	0,01	0	0	0,01	0,02

5	Amount of information provided	0,01	0,01	0	0	0,01	0	0,01	0
6	Error management	0,01	0,01	0	0,01	0,01	0,01	0	0,01
7	Renewability	0	0,01	0	0	0	0	0	0
8	Integrability	0	0	0,02	0	0,01	0,01	0,02	0
9	Data security	0,01	0,01	0,02	0,02	0,02	0,02	0,01	0,02
10	Transaction security	0	0	0,02	0,01	0,01	0,01	0,02	0,01

For each characteristic a α_i value is determined, meaning the number of value greater than $\varepsilon = 0{,}1$ from the ones being calculated.

$$\alpha_i = count(DIF_{ij}) \quad where \quad DIF_{ij} > \varepsilon$$

Based on the number the representativeness ratio for each indicator is being determined, REP_i.

$$REP_i = 1 - \frac{\alpha_i}{NA}$$

where NA is the number of applications.

After a complete set of operations the following results are obtained and presented in table 5.

Table 5. Indicators representativeness

No.	Characteristic	α_i	REP_i
M_1	Way of interaction	3	0,62
M_2	Commands responsiveness	2	0,75
M_3	Length of interaction	0	1
M_4	Maneuverability	1	0,87
M_5	Amount of information provided	0	1
M_6	Error management	0	1
M_7	Renewability	0	1
M_8	Integrability	2	0,75
M_9	Data security	5	0,37
M_{10}	Transaction security	2	0,75

Considering the set of applications, the quality characteristics are grouped in two subsets:

$$MCR = \{M_3, M_4, M_5, M_6, M_7\}$$
$$MCN = \{M_1, M_2, M_8, M_9, M_{10}\}$$
$$MCR \cup MCN = MC$$

where:

MCR – the set of representative characteristics;

MCN – the set of non-representative characteristics.

These subsets where determined based on the results obtained for this class of mobile applications. The characteristics are grouped with regards to each class of mobile applications.

In this way the MC set is divided in two subset, with:

$$NR_{MCR} = \{3,4,5,6,7\}$$

and

$$NR_{MCN} = \{1,2,8,9,10\}$$

Due to the new regrouping of the quality characteristics for the *m*-mobile applications, the quality index, IA_{MAG}, based on the analysis of an application group MAG, has the following formula:

$$IA_{MAG}(X) = 2 * (\Delta_1 * \sum W_j P_j + \Delta_2 * \sum W_k P_k)$$
$$\text{with } j \in NR_{MCR} \quad and \quad k \in NR_{MCN}$$

where:

Δ_1 - weight for the set of representative characteristics;

Δ_2 - weight for the set of non-representative characteristics ;

The weights $\Delta_1 = 0{,}64$ and $\Delta_2 = 0{,}36$ are determined also by referring the group MAG.

4. EXPERIMENTAL RESULTS

Let MCS be a mobile application analyzed in (Pocatilu et al., 2013). By using the application a user profile is established. The subsets that represent the set of users are:

- *Software developers*, subset that includes programmers who develop software by writing code in different programming languages; the subset is described by:

$$UT^D = \{UT_1^D, UT_2^D, ..., UT_{nD}^D\};$$

- *Software designers,* a subset of students who design software applications, writes internal specifications of software applications; the subset is described by:

$$UT^P = \{UT_1^P, UT_2^P, ..., UT_{nP}^P\};$$

- *Testers,* the subset of students who are testing the software developed by software designers before releasing to end users; users who are testing the software do this by following the testing specifications and test cases found in the design plans of the application; the subset is described by:

$$UT^T = \{UT_1^T, UT_2^T, ..., UT_{nT}^T\}$$

The set of users is represented by the reunion of each homogenous aforementioned subset:

$$UT = UT^D \bigcup UT^P \bigcup UT^T$$

$$UT = \{UT_1^D, UT_2^D, ..., UT_{nD}^D\} \cup$$
$$\cup \{UT_1^P, UT_2^P, ..., UT_{nP}^P\} \cup \{UT_1^T, UT_2^T, ..., UT_{nT}^T\}$$

The number of users for the m-application, NrST, is given by the following formula:

$$NrUT = nD + nP + nT.$$

A user profile is shaped in order to determine the subset to which a user belongs. For building the profile, a questionnaire is designed in such a way that the answers received could shape the profile of a user. The results obtained in (Pocatilu et al., 2013) are presented in table 6.

Table 6. MCS mobile application figures

No.	Characteristic	Indicator	Weight(P)	Actual value for the indicator (W)	P_i*W_i
1	Way of interaction	IMI	0,13	1	0,13
2	Commands responsiveness	IRC	0,15	0,91	0,14
3	Length of interaction	IDI	0,07	0,96	0,07
4	Maneuverability	IM	0,08	1	0,08
5	Amount of information provided	VIF	0,06	0,87	0,05
6	Error management	ME	0,1	1	0,1
7	Renewability	IR	0,03	1	0,03
8	Integrability	IIN	0,05	0,4	0,02
9	Data security	ISD	0,17	0,8	0,14
10	Transaction security	IST	0,15	0,85	0,13
	Total		**1**	**-**	**0,89**

The value of IA(MCS) indicator is determined:

$$IA(MCS) = \sum_{i=1}^{10} P_i * W_i = 0{,}89$$

For this application the indicator IA_{MAG} is also determined:

$$IA_{MAG}(MCS) = 0{,}83$$

The difference $DIF_{IA} = 0{,}06$ shows the quality fluctuation level for the mobile applications from a set of applications point of view.

5. CONCLUSIONS

Mobile applications are analyzed in detail due of special characteristics presented by these. A computer application is used by a lot of users, but a mobile application is used only by a user; so this one should be customizable and to respond to that user needs. Software products developed for mobile devices are grouped in homogeneous crowds of mobile applications. A homogeneous crowd contains application with similar characteristics. By the union of homogeneous crowds of applications is obtained the general set of existing mobile applications.

Quality characteristics is made by grouping must highlight the particularities of mobile applications such as reliability, portability, operationality, safety, simple interface, integrability, speed, maneuverability. Based on homogeneous sets of applications and determined characteristics are built a metric which determine the quality of mobile applications. This requires a huge effort because the metric structure is dynamic; its structural stability is achieved over time and must build a database that includes many mobile applications and their behavior through data acquisition.

Refinement processes of metrics are going to define specific metrics for each set of mobile applications. Metric is used for acceptance or rejection of mobile applications in the auditing process, based on objective criteria.

REFERENCES

Balog, A. (2011). *Testing a multidimensional and hierarchical quality assessment model for digital libraries*, Studies in Informatics and Control vol. 20(3), pp. 233-246.

Chen, X., Chen, Y., Ma, Z., Fernandes, F.C.A. (2013). *How is energy consumed in smartphone display applications?*, ACM HotMobile 2013, The 14th Workshop on Mobile Computing Systems & Applications, Feb 26-27, 2013, Georgia, USA.

Seok, H., Nof, Shimon, Filip, F. (2012). *Sustainability decision support system based on collaborative control theory*, Annual Reviews in Control no. 36, 85–100.

Hung, R.Y.Y., Lien, B.Y.H., Yang, B., Wu, C.M., Kuo, Y.M. (2011). *Impact of TQM and organizational learning on innovation performance in the high-tech industry*, International Business Review, no. 20, 2011, pp. 213–225.

Kasai, H. and Mogi, R. (2012) *Implementation of distributed mobile storage and location-based message sharing among smart phones*, ACM SIGMOBILE Mobile Computing and Communications Review, Volume 16 Issue 4, October 2012.

Li, E.Y., Chen, H.G., Cheung, W. (2000). *Total quality management in software development process*, The Journal of Quality Assurance Institute, Vol. 14, No. 1, January 2000, pp. 4-6 & 35-41.

Pocatilu, P., Ivan, I., Zamfiroiu, A., Boja, C. (2013) *An integrated indicator for mobile application quality assessment* (to be published, 2013).