Quality Analysis of Mobile Applications

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Mobile applications are defined and different types of mobile applications are identified. Characteristics of quality are defined and their indicators are constructed to measure levels. Take into account 11 parameters analysis for mobile applications, which are arranged using weights and do a detailed analysis of the system of weights. For SMSEncrypt application performance measurement is done using an aggregate indicator based on the obtained weights system.
Keywords: *Mobile, Application, Quality, Analysis, Indicator*

1 Mobile applications

Nowadays, electronic devices become smaller and more powerful and can be taken by humans in all possible places. An evolution of the electronic devices with computing power is shown in Figure 1.

Fig. 1. The evolution of electronic devices

In 1973 Motorola launches the first cell phone MotoralaDynaTAC 8000X [1].
In [2] is an analysis of the rapidly evolving of mobile devices. How they came to be sold in a number of 1.2 billion in 2009. A very rapid evolution compared to other electronics such as cars or televisions.
In [3] it is presented an analysis of categories of mobile phones and their differences.
The presented categories are:

- Basic terminal class – devices that can perform basic functions such as send / receive SMS, receive / initiate calls ;
- Multimedia terminals – these terminals have attached the basic functions and additional functions like a performed camera, a large media, audio and video player;
- Fashion terminals - these terminals include both best performing certain functions and particular design;
- Smartphones - these terminals have lots of business functions, office, internet and multimedia terminal specific functions.

Internet on the telephone is cheaper and a more practical solution for all internet users. This can provide an online presence anywhere and anytime on your mobile phone.
In [4] it is presented the classification of wireless networks:

- Wireless Wide Area Networks (Wireless WAN) - achieved through mobile networks;
- Wireless Metropolitan Area Networks (Wireless MAN) - networks with a larger area of coverage. Can cover up and an entire city, can be extended to 50 km.
- Wireless Local Area Network (Wireless LAN) - Network used for some office buildings, university, airport and hospitals.

- Wireless Personal Area Networks (Wireless PAN) - these networks are carried on a restricted area, but offer the possibility of connecting a printer to the computer wirelessly. Bluetooth technology is used [4].

Mobile applications have seen a great diversity lately, due to the fact that mobile phones are the most used electronic devices.
These applications are divided into several categories:

- Applications for general information - are available to anyone wishing to get information in a particular area such as weather, TV program, horoscope;
- Applications using personal data to login - are applications in which a certain personal information is required for authentication, information which is verified with ones already existent on the server;
- Network communication applications - are applications through which users can communicate with other remote users;
- Economic applications - are applications which can be made through purchases of goods, payments can be made, or other economical activities;
- Games - entertainment applications which users choose to access in their leisure (free) time.

Applications where the user must log in using personal data require a higher level of security. Data provided by the user must run on a secure channel, and if possible, it must be encrypted in order not to be obtained by unauthorized persons. These applications are used for login into a bank account or providing you your bank card details for the purchase or certain things via your mobile phone.

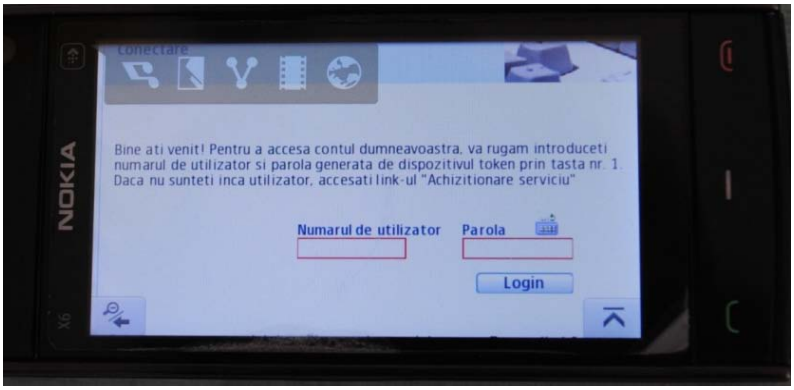

Fig. 2. Logging into a bank account [5]

In Figure 2 it is presented the bank account application login. This requires the user number and its password. This information must be encrypted on a communication channel between mobile device and the bank's database. If the channel is not secured against malicious attacks by people, the information used for login can be obtained by unauthorized persons, which will certainly not good for the user who has logged. In [6] it is given the complexity of the banking system applications, such as the number of operations that it carries.
Network communications are login applications that use personal data through which users can communicate with friends and relatives from other districts or countries using a mobile phone. These applications make the connection between the mobile and social networks or mail servers. These applications also require a high level of data security, because the information used is confidential, and nobody should have access to it. In [7] iPhone Facebook application is presented, the application is for the use of the Facebook social networking on iPhones devices.
Economic applications for mobile devices are designed to bring things closer to users. Thus, they can make purchases directly from the mobile phone.

2 Quality characteristics of mobile applications

In [8] are presented characteristics of quality and their types. Are presented two kinds of features: internal and external. Internal characteristics are those which examine the software's development process, and external features are those which examine the user software.

Generality of the application – it is a characteristic through which the target group size is measured, people who will use the application.

Thus, based on the categories of which the application belongs, the dimension of the target group can be established. The general the application is, the bigger the possible number of users, and so, the dimension of the target group is bigger.

Reliability represents the degree in which the application continues to function despite the arisen problems, without affecting the user (error tolerance) and the degree in which it is operational despite the hardware and software system failure (availability). According to [8] reliability is one of the most important quality characteristics.

Accuracy is the characteristic that requires no error in the application, (is the characteristic that implies lack of errors within the application) the application's ability to produce correct results for the basic data entered correctly.

In [8] it is presented the fact that the correctness properties are so important as to be separate. Internal correctness properties are associated with individual components, or contextual, associated with the way the components are used in context.

Friendly interface of the application is a very important feature especially for applications on mobile devices. This requires the application to be closer to the user interface to be as usable and intuitive as possible. Applications that are difficult to use will consume more time for such use and users will move to other applications more easy to use, considering this one an application with a low quality.

Continuity is the characteristic through which applications use familiar elements from other software applications so that the user may not make effort to learn to use new applications. This feature supports the characteristic presented earlier because if within the application are presented already known elements by the user, its friendly character is bigger, and thus the application is closer to the user.

Portability is a characteristic of quality through which the possibility that the application can run on different mobile devices is measured. That can be measured by running the application on different mobile traversing. Mobile devices present a wide range of models and it is therefore very important for an application to be able to be run on a large number of them. This ensures continuity and omnipresence of the application supposing the user will change the phone model.

Security - is the ability to conserve all resources to parameters defined by the developer and the user.

In [8] is shown that the new level in security organizations is securing mobile phone information, because mobile use is becoming more frequent, regular data able to make the transition from desktop to pocket devices such as smart phones and PDAs. But users can lose these mobile devices and information stored on them as well.

In [9] are presented the ways in which mobile devices can facilitate access to a large extent on the same data, same services and applications, as their counterparts, desktop computers.

In [10] it is shown the security of the mobile applications. It is presented the security architecture of the WiFi and the WEP login.

Also for this, mobile application security is as important as desktop security applications, or perhaps even more important.

Compared to traditional applications, the quality of mobile applications must be superior because they have certain features such as:

- high diversity of devices - this involves the application of high quality for all types

of terminals. It is also important the application's portability from one terminal to another.

- users are both numerous and heterogeneous - this diversity requires the application to have a character as friendly as can be and the modules to be easily accessed by all users;
- applications are with resource allocation in real time- requires a high security for the information used on the mobile applications;
- real-time decisions applications - requires correctness and speed in mobile applications
- Works 24/24
- Size of display - imposes restrictions related to the size of content displayed on the volume controls that can be used and their size.

Mobile applications are of several types:

Applications of information. These applications are divided into two categories:

- with stable content: the virtual museum and maps;
- with dynamic content: weather, road traffic.

The quality of these applications is given by the accuracy of the data and ease of update for those with dynamic content.

Using personal data logging applications. The quality of these applications is given by the security of confidential data transfer and storage of personal data under high security.

Applications of network communication. This being also a login application, they require a high level of security, both for the personal data used when login and for the content used to communicate with others.

Economic applications. The quality of these applications involves data transfer security. In these applications sums of money for the payment of goods purchased will be handled, and that is why the level of security must be very high.

Games. Friendly nature of the application plays the largest role in determining the quality of entertainment applications. The more attractive and easier to use this application is, the bigger the quality, and thus, a larger number of people will use it.

3 Parameters describing a mobile application

Parameters for describing an application intended to run on mobile devices are:

Quality of instructions sequences it is a feature through which the quality of certain modules of the application are highlighted, the quality of certain functions or methods within it. To determine these characteristics someone may determine the number of instructions initiated and successfully completed by the user without getting errors.

Quality indicator of the sequences of instruction:

$$I_{CS} = \frac{NT}{NTOT}$$

where:

NT - number of initiated and successfully completed instructions;

NTOT - total number of instructions.

Number of written instructions influences the complexity of the application, the volume of functions and methods implemented by the application developer.

Indicator number of written instructions is the number of functional methods within the application:

$$I_{NI} = \frac{\sum_{i=0}^{nc} I_i}{NPI}$$

where:

nc - number of classes in the application;

I_i - number of instructions in the class i.

NPI - planned number of instructions

Respecting the deadline is a very important feature because it depends on the seriousness of the developer and its ability to develop a project plan in accordance with reality.

Indicator of respecting deadlines:

$$I_{TP} = \frac{\min(NZED, NZND)}{\max(NZED, NZND)}$$

where:

NZED - estimated number of days for the development of the application

NZND - number of days necessary for the development of the application

Quality of testing process influences the future behavior of the application by the processing incidents and resources needed for recovery.
Testing is an important step in the process of development software.
Quality indicators of the testing process will be the total number of tests successfully completed on the application of all tests performed. This one tends to value 1 an optimal:

$$I_{PT} = \frac{TTS}{TT}$$

where:
TTS - the number of tests whose results are the same as those expected to be achieved at the application level within a set of tests;
TT - total number of tests performed in the application.

The cost to the developer includes costs attainment for the development of the application.
Indicator of cost to the developer:

$$I_{CD} = \frac{\min(CL + CC + CFM + CS, CPD)}{\max(CL + CC + CFM + CS, CPD)}$$

where:
CL - the cost of licensing software for application development;
CC - the cost of purchasing computers and hardware;
CFM - the cost of labor required application development;
CS - the cost of renting space.
CPD - cost of planned development

The cost for user is bought new price of the license for that application that the end user is willing to pay, and new items that appear in the current use and maintenance. The user must consider both the purchase price and maintenance price items. There are cases where the purchase price is very low and prices are high maintenance thus leading to higher prices.
Indicator to the user cost, I_{CU}:

$$I_{CU} = \frac{PA + PI + PU}{PPS}$$

where:
PA - supported price (cost) to acquire the product;
PI - price caused by the use product and / or training assistance;
PU - due process of price maintenance, product updates;
PPS – supported price to acquire a similar product.

User satisfaction is the feature that measures the ability to satisfy the user application.
Indicator of user satisfaction:

$$I_{GSU} = \frac{\sum_{i=1}^{noc} ps_i}{nop}$$

where:
noc - number of operations carried out completely by the user with or without assistance;
nop - the total number of operations started by the user in the system;
psi - the degree to which the user's problem was solved after performing the i operation , with i from 0.00 to 1.00.

Complexity, reliability and maintainability are quality characteristics which the developer must take into account, since the amount of resources necessary for the delivery of planned levels strictly depends on the application of these characteristics. According to [11], modularized software‘s maintainability is assured easier. Thus to achieve the maintenance products, the modules in which the application is divided, must be defined more clearly. Complexity, reliability and maintainability indicator for this application:

$$I_{CFM} = 1 - \frac{T_{\mathrm{mod}\,if}}{T_{dezv}}$$

where:
T_{modif} – necessary time for the change of the application;
T_{dezv} – necessary time for the development of the application

The risks and vulnerabilities are the characteristics through which are measured the effects generated by the vulnerabilities involuntary included in the application. Because the behavior of distributed applications is influenced by many factors, the different types of vulnerabilities associated to the application are estimated and it is correlated to its size, expressed as instructions number. In [12] are presented the vulnerabilities that affect the citizen-oriented mobile applications.
Indicator for risk and vulnerability:

$$I_{RV} = 1 - \frac{\sum_{i-0}^{NTI} V_i}{NTOT}$$

where:
NTOT - total number of instructions
V_i - the number of vulnerabilities during the performance of the "i" instruction.

The user security is the feature which highlights user-level application security. How can the user bring (generate, make) problems to this application?
Security indicator is the average time users need for decrypting a message. The higher the indicator's level, the greater the security for all users.

$$I_{SU} = \frac{\sum_{i=0}^{nt} t_i}{nt}$$

where:
nt - number of tests performed related to the decrypting of messages;
ti- the time in minutes required decrypting a message.

Security of application management is the feature that highlights the application-level security management resources for optimum operation.
Indicator security management, I_{SA} is given by the number of cases in which the application does not properly use the mobile device resources, uncontrolled events occurring per unit time, UT:

$$I_{SA} = 1 - \frac{NTEN}{UT}$$

where:
NTEN - the total number of unforeseeable and uncontrollable events.

These indicators are examined in relation to the properties described in [13]:

- Sensitivity - variations of the independent variables must be small variations, also the indicator i, respectively, the variations of independent variables to obtain large variations in the indicator i;
- Non-catastrophic - very small changes in independent variables may not obtain large variations of the variable result which gives a characteristic quality;
- Non-compensatory character - for different values of independent variables to obtain different values of the indicator associated with software quality characteristic;
- Representativeness - the way of formal correspondence with levels of quality indicator values;
- Comparability - comparison with other indicators

An indicator like $I_0 = \frac{a}{b}$ is in terms of analysis

- Sensitive: $I = \frac{x * a}{b}$ if x is less than the indicator value I increases, if x is large, I grows
- Non catastrophic: if b>0;
- Compensatory: if $I_0 = \frac{a}{b}$ and $I_1 = \frac{c}{d}$ and if **c=k*a** and **d=k*b**.

4 The weights of the quality characteristics

Collectivity considered for making entries contain 120 people. It is a homogeneous community because:

- People who make it up are aged between 23 and 25 years
- People have an experience in developing computer applications between 4 and 6 years

From the analysis of the data survey (questionnaire), could be observed the fact

that most of the characteristics obtained at least one maximum score (150) from one person, and one minimum score (0). Except for the characteristic *number of written instructions*, for which the maximum obtained score is 55, and the characteristic *complexity, reliability and maintainability* for which the minimum score is 5. These are outlined in Table 1.

Table 1. The maximum and minimum values for all features

Characteristic	1	2	3	4	5	6	7	8	9	10	11
Maximum	150	55	150	150	150	150	150	150	150	150	150
Minimum	0	0	0	0	0	0	0	5	0	0	0

Frequencies of these minimum and maximum values are presented in Table 2.

Table 2. Frequencies of the minimum and maximum values

Characteristic	1	2	3	4	5	6	7	8	9	10	11
The frequency of maximum	3	1	1	5	1	3	29	26	4	7	9
The frequency of the minimum	20	66	17	6	20	25	3	2	5	8	5

Based on the obtained data, the sum of the awarded points was made, the average of these scores highlighting the level at which the feature was in terms of the experts point of view, experts that participated in filling out the form and weight. The weight of each characteristic (feature) represents the importance coefficient of that certain feature. These values are presented in Table 3.

Table 3. Average of data obtained

Characteristic	1	2	3	4	5	6	7	8	9	10	11
Amount	1685	420	1780	2620	2220	2440	6805	6645	3185	3470	4370
Average	19,14	4,77	20,22	29,77	25,22	27,72	77,32	75,51	36,19	39,43	49,65
Weight	0,05	0,01	0,05	0,07	0,06	0,07	0,19	0,19	0,09	0,1	0,12

The weights defining characteristics are presented graphically in Figure 3. It can be noted that the experts have given a high importance to the degree of user satisfaction, which has the largest weight.

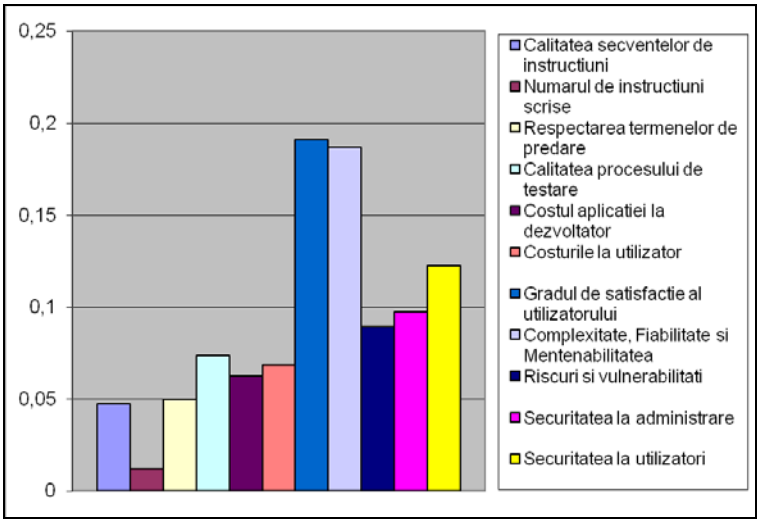

Fig. 3. Importance coefficients of the characteristics

If we eliminate the maximum and minimum values of the amounts calculated, the weights of the characteristics will be modified. In Table 4 are presented the new amounts and new weights calculated without taking out the maximum and minimum values.

Table 4. The weights of features without minimum and maximum scores

Characteristic	1	2	3	4	5	6	7	8	9	10	11
Amount	1235	365	1630	1870	2070	1990	2455	2735	2585	2420	3020
Weight	0,06	0,02	0,07	0,08	0,09	0,09	0,11	0,12	0,12	0,11	0,13

In Figure 4, the new weights are presented graphically. It can be seen that the highest importance was given to user security.

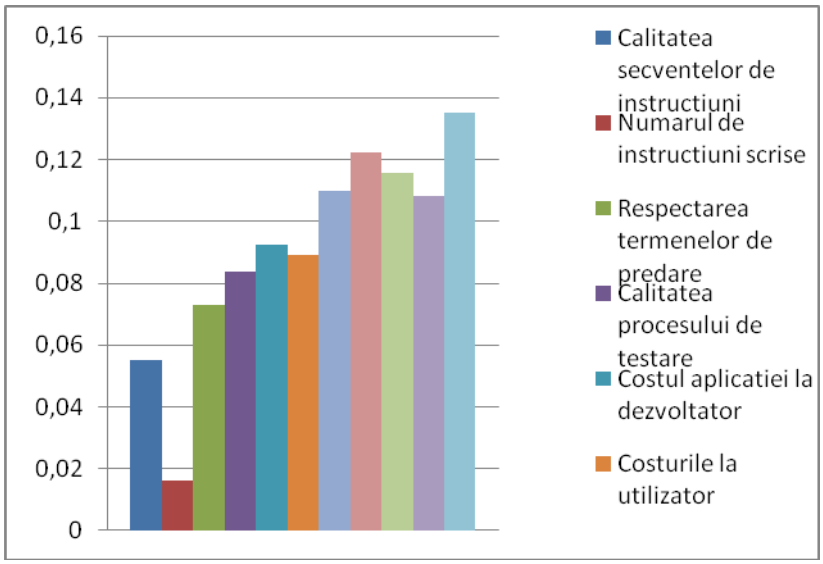

Fig. 4. Importance coefficients of the characteristics, in the calculation of which was not taken into account the minimum and maximum values

The correlation coefficient between the two sets of ratio is 0.771016.

To verify the awarded scores, random samples of the total population will be taken (selected) and new calculations of the characteristic's weight will be made, and the newly appeared changes will be analyzed. Thus, we perform two sets of data with a population of 60 specialists. They are randomly chosen from a total of 88 specialists who were interviewed.

Weights determined on the basis of two data sets do not show major differences between them, or to the weights calculated on the basis of all data. This is revealed in Table 5.

Table 5. Weights calculated on the basis sets with a population of 60 specialists

	1	2	3	4	5	6	7	8	9	10	11
Normal weights:	0,047	0,011	0,049	0,073	0,062	0,068	0,190	0,186	0,089	0,097	0,122
Weights for set 1	0,047	0,010	0,051	0,074	0,058	0,081	0,187	0,188	0,089	0,095	0,114
Weights for set 2	0,045	0,013	0,054	0,087	0,063	0,065	0,187	0,187	0,092	0,094	0,108

In Figure 5, Table 5 is presented graphically. Among the three sets of weights there are no major differences.

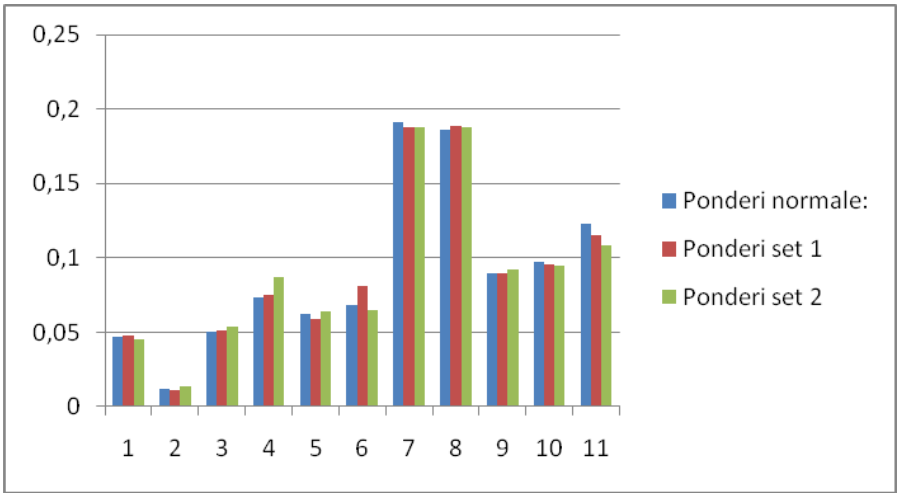

Fig. 5. Weights calculated on the basis sets with a population of 60 specialists

To observe the behavior weighted values, another two data sets will be taken, with a sample of 40 specialists. And these sets will be randomly chosen from the 88.

Weights determined on the basis of two data sets also do not differ very much from one another, neither do the weights calculated on the basis of all data. This is apparent in Table 6 and Figure 6.

Table 6. Weights based on sets with a population of 40 specialists

	1	2	3	4	5	6	7	8	9	10	11
Normal weights:	0,047	0,011	0,049	0,073	0,062	0,068	0,190	0,186	0,089	0,097	0,122
Weights for set 1	0,051	0,014	0,058	0,068	0,054	0,085	0,197	0,181	0,076	0,104	0,106
Weights for set 2	0,046	0,012	0,047	0,075	0,064	0,060	0,204	0,204	0,082	0,089	0,111

In Figure 6, Table 6 is presented graphically. Among the three sets of weights there are no major differences.

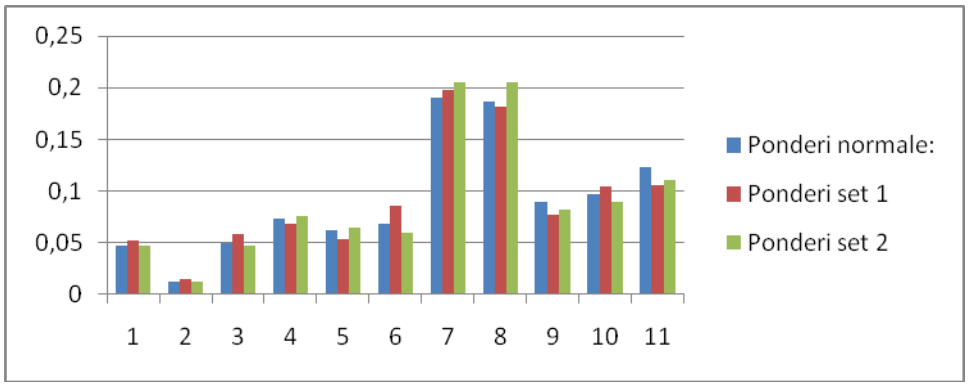

Fig. 6. Weights calculated on the basis sets with a population of 40 specialists

Data, from which these weights were obtained, are of a great quality, thing that is reinforced by the fact that in the 11 characteristics doesn't exist 2 that have the same value, therefore the experts differentiate them very well.

Another reason for which data are of a good quality is the fact that the group of specialists has been consistent. The weights obtained from the smaller parties from the group of specialists are very close to those obtained using data from all specialists. Therefore, the homogeneity of the group is the reason why they obtained data are of a higher quality.

5 Analysis of weights

Following (on the score of the) the analysis of the obtained data, it was determined that two experts have given the same scores (marks / drafts) for the 11 features. Thus the two experts gave similar scores for the 11 characteristics, namely: 20, 0, 5, 30, 0, 15, 150, 10, 40, 80, 55.

A number of 0 specialists have given scores in ascending order (0, 0, 5, 10, 15, 20, 30, 40, 55, 80, 150).

A number of 0 specialists have given scores in descending order (150, 80, 55, 40, 30, 20, 15, 10, 5, 0, 0).

Table 7 summarizes the frequencies of occurrence of the scores for each feature.

Table 7. Frequencies of each score for features

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
0	20	66	17	6	20	25	3	0	5	8	5
5	17	1	17	13	8	3	5	2	5	11	6
10	9	7	11	14	8	2	6	2	7	12	11
15	13	4	14	12	6	10	2	5	11	6	5
20	13	5	6	9	9	14	6	8	7	8	3
30	4	3	4	13	13	6	6	7	16	7	10
40	4	1	7	6	10	12	6	13	14	9	5
55	3	1	7	5	6	7	8	10	15	7	19
80	2	0	4	5	7	6	17	15	4	13	15
150	3	0	1	5	1	3	29	26	4	7	9

Figure 7 depicts the frequency histogram showing the marks awarded for each feature.

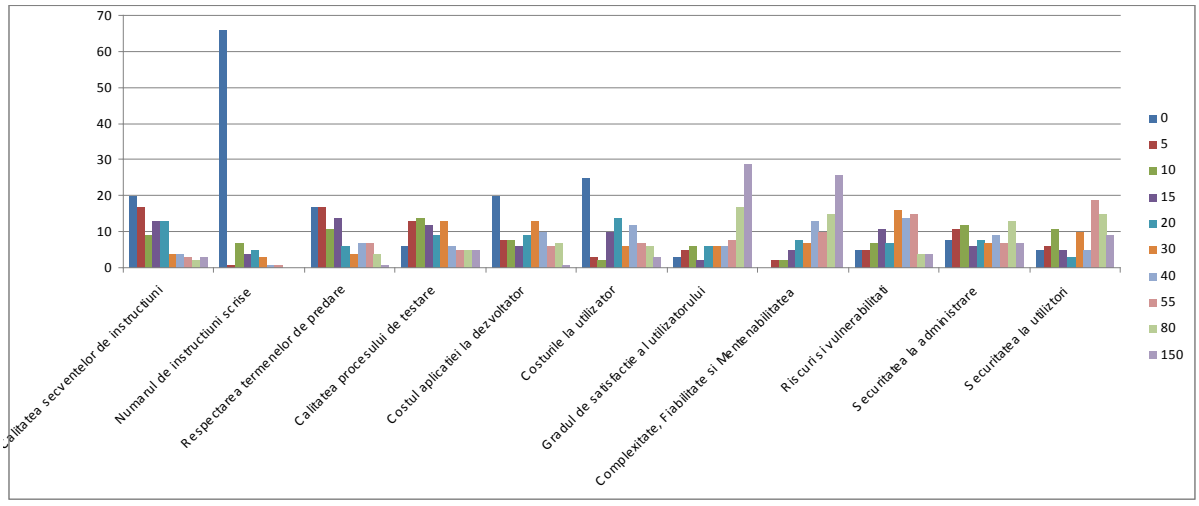

Fig. 7. Histogram frequency of occurrence of each score for features

Experts, because they are people with experience in programming, are oriented to distinguish these features as it does not consider them all important. Most of them have indicated that two of the 11 features are most important and gave them higher scores.
Based on records obtained scores can be seen the fact that the group of specialists is a homogeneous group, a quality group, a group of experienced people. Obtained data do not show subjectivity from their part, which shows the professionalism of the specialists. The questionnaire was taken seriously, and there haven't been any specialists who votes in ascending or descending order. Based on the obtained data, the correlation between scores given to all of the 11 features is analyzed. Thus, results the correlation between the characteristic pairs, taken in pair wise. These correlations are shown in Table 8.

Table 8. Correlation characteristics scores

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1		0,035	0,109	-0,084	-0,179	-0,193	-0,226	-0,086	0,027	0,047	-0,096
2			-0,077	0,157	0,082	-0,057	-0,239	0,069	-0,151	0,148	-0,157
3				0,148	0,005	-0,092	-0,034	0,092	-0,128	-0,259	-0,422
4					0,079	-0,159	-0,141	-0,051	-0,189	-0,231	-0,212
5						-0,040	0,074	-0,094	-0,250	-0,128	-0,231
6							-0,002	-0,057	-0,138	-0,079	-0,144
7								-0,296	-0,149	-0,371	-0,175
8									-0,246	-0,278	-0,247
9										0,102	0,168
10											0,200
11											

The correlation coefficients of a series of weights based on total population and two samples of 60 specialists are shown in Table 9. This shows the big proximity (closeness, approach) of the weight values calculated in the basis of the 2 sets of weight values, and on the basis of all data.

Table 9. Correlations series of weights based on sets of 60 specialists

Weights	Original	Set 1 of 60 specialists	Set 2 of 60 specialists
Original		0,995982	0,993156
Set 1 of 60 specialists			0,991757
Set 2 of 60 specialists			

The correlation coefficients of a series of weights based on total population and two samples of 40 specialists are shown in table 10. It looks very close to the weights calculated on the basis of two sets of data weighted based on all data.

Table 10. Correlations series of weights based on sets of 40 persons

Weights	Original	Set 1 of 40 specialists	Set 2 of 40 specialists
Original		0,983155	0,992430
Set 1 of 40 specialists			0,979472
Set 2 of 40 specialists			

In Table 11 are highlighted the correlations between all five sets of weights. The values of these correlations mean that the weights are obtained and the community representative for the questionnaires is considered homogeneous.

Table 11. Correlations calculated series of weights on different data sets

Weights	Original	Set 1 of 40	Set 2 of 40	Set 1 of 60	Set 2 of 60
Original		0,983155335	0,992430344	0,99598159	0,993155966
Set 1 of 40			0,979472328	0,98932782	0,976249469
Set 2 of 40				0,98942781	0,994125524
Set 1 of 60					0,991756565
Set 2 of 60					

The 11 features are independent and the weights are meant to differentiate them. The highest percentage identifying the characteristic's maximum importance in relation to the group of experts, and the smallest weight identifying the characteristic's minimum importance in relation to the groups of specialists. These percentages are representative because of the fact that the group is homogeneous and it is composed of experts with extensive experience in developing software applications. Generalization of these shares will become effective when taken together heterogeneous groups of specialists. Each batch is homogeneous, but a lot between them is not homogeneous.

Thus the 11 characteristics must be submitted to a homogeneous group than the other criteria of experience in software development and a number of specialists.

6 Weights in the analysis of application SMSEncrypt

The software application called SMSEncrypt allows interactive communication with the use of text messages between two mobile devices (like PDA), with Windows Mobile Professional 6.0. This allows you to send and receive SMS (Short Message Service). Messages will be encrypted before sending using a key provided by the sender of the message. This key must be known by the message recipient to decrypt the message upon receipt.

Specifications:

- simple system to communicate via text messages;
- reduced energy consumption in terms of interactive communication;
- SMSEncrypt installed on each PDA device.

For the development (realization) of the application, the .NET technology was used. , Microsoft Visual Studio .NET 2008 development environment and C# programming language.

One of the most used facilities offered by the mobile devices is that of communicating through written messages. For that, the telephone companies provide communication through Short Message Service (SMS). These forms of communication are widely used in adverse conditions such as those in which the noise is disturbing or verbal communication is not allowed. Communication via messages is preferred from private reasons also (conversation voice could be heard by others) and from practical reasons (noise could hinder the conversation around). Many people choose written text messages because they are cheaper than voice call.

The application is designed for people who want a secure communication via SMS service provided by the mobile phone company.

SMSEncrypt software is composed of two parts: the first by sending messages encrypted with the specified key and the second part that allows you to receive messages and decrypt them with the secret key that the receiver of the message must know.

Architecture is shown in Figure 8.

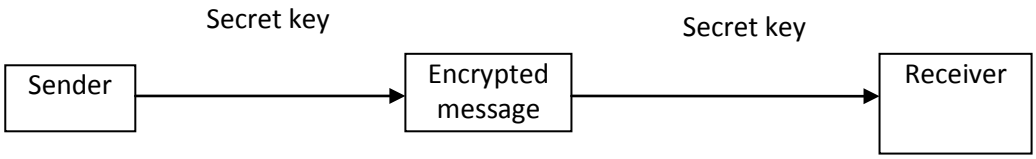

Fig. 8. Architecture communication through encrypted messages

Encryption key and decryption key must be the same and should be known only by his message transmitter and receiver.
To send a message the sender goes through the following steps:
• Write the message
• Specify the message encryption key
• Encrypting the message
• Sending the encrypted message
To receive a message and read it, the receiver goes through the following steps:
• The receiving of encrypted message
• Specify the key to decrypt the message
• Decrypting the message
• Read the decrypted message
These steps are shown in Figure 9.

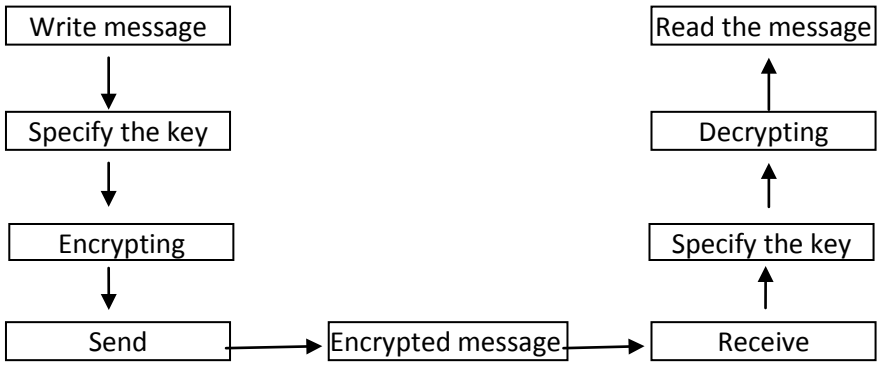

Fig. 9. Stages of communication through encrypted messages

In Figure 10 it is described the architecture of message encryption. Once the user has posted a message and chooses to sent, it is asked for an encrypting key and it is appealed the EncryptMesage method with the parameters key and message. This method will return the encrypted message, which will be sent.

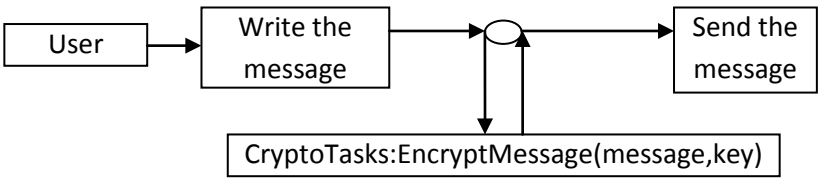

Fig. 10. Architecture of a message encryption

To decrypt a message, it is used the DecryptMessage method. Architecture is shown in Figure 11.

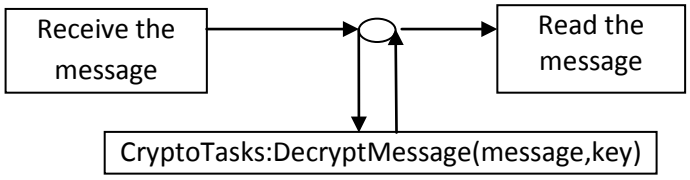

Fig. 11. Architecture decrypting a message

For the SMSEncrypt application measurements are made, for the quality characteristics of mobile applications, Table 12.

Table 12. Measurements made for the application SMSEncrypt

Measurement	Value
NT	68
NTOT	98
nc	2
I_1	80
I_2	18
NPI	100
NZED	14
NZND	17
TTS	129
TT	161
CL+CC+CFM+CS	17500
CPD	15000
PA	1000
PI	150
PU	200
PPS	1687,5
noc	10
nop	10
ps1	0,49
ps2	0,5
ps3	0,98
ps4	0,99
ps5	0,99
ps6	0,23
ps7	0,96
ps8	0,99
ps9	0,98
ps10	0,94
T_{modif}	2
T_{dezv}	14
$s1 = \sum_{i-0}^{NTOT} V_i$	5
nt	107
$s2 = \sum_{i=0}^{107} t_i$	1880
NTEN	4
UT	31

For NT=68 and NTOT =98 of table 12 shows that I_{CS} = 0.69. This is a low value for this indicator, showing that the sequences have a lower quality instruction.

For nc = 2, NPI = 100, I1 = 80 and I2 = 18 of table 13 shows that I_{NI} = 0.98. This shows that the planned number of instructions was nearly reached.

For NZED = 14 and NZND = 17 of table 12 shows that I_{TP} = 0.82. This shows that the application delivery has been delayed.
For TTS = 129 and TT = 161 of table 12 shows that I_{PT} = 0.8. This shows the quality of the testing process of application.
For MFF + CL + CC + CS = 17 500 and CPD =15 000 in table 12 shows that I_{CD} = 0.85. This is the level of overrun of proposed costs.
For PA = 1000, PI = 150, PU = 200 and PPS = 1687.5 of table 12 shows that I_{CU} = 0.8. This is the degree to which the user is willing to purchase this application, no another one.
For noc, nop and ps_i with i = 0…10 of table 12 shows that I_{GSU} = 0.805. This indicates that the user has a 80.5% satisfaction using this application.
For T_{dezv} and T_{modif} of table 12, shows that the I_{CFM} = 0.86. This shows that the application has a complex and high reliability and its improvement would be preferred rather than developing another application.
For NTOT and s1 = $\sum_{i=0}^{NTOT} V_i$ of table 12 shows that I_{RV} = 0.95. This shows that the application shows a few vulnerabilities but they are not permanently removed.
For nt and s2 = $\sum_{i=0}^{107} t_i$ of table 12 shows that I_{SU} = 17.57 '. This is the average length of the decryption of a message.
For NTEN and UT in table 12 shows that I_{SA} = 0.88. This shows that the application uses the mobile device and resources in an appropriate way, in 88% of cases.
Based on the values determined, the value of the aggregate indicator is calculated. In Table 13 are presented the calculated values.

Table 13. The calculated values for quality characteristics of the application SMSEncrypt

Indicator	Value provided QPL_i	Measured value QRE_i	Weights p_i	$\frac{\min(QPL_i, QRE_i)}{\max(QPL_i, QRE_i)}$	$p_i \frac{\min(QPL_i, QRE_i)}{\max(QPL_i, QRE_i)}$
I_{CS}	1	0,69	0.047278	0,69	0,03262
I_{NI}	1	0,98	0.011785	0,98	0,01155
I_{TP}	1	0,82	0.049944	0,82	0,04095
I_{PT}	1	0.8	0.073513	0,8	0,05881
I_{CD}	1	0,85	0.062290	0,85	0,05295
I_{CU}	0.9	0.8	0.068462	0,88	0,06025
I_{GSU}	1	0.805	0.190937	0,8	0,15275
I_{CFM}	1	0.86	0.186448	0,86	0,16035
I_{RV}	1	0,95	0.089366	0,95	0,0849
I_{SU}	120	17.57	0.122615	0,14	0,01717
I_{SA}	1	0,88	0.097363	0,88	0,08568
TOTAL	**-**	**-**	***1***	***8,65***	***AGR = 0.75797***

Value of aggregated indicator is 0.75797.
Increase application quality can be achieved by improving SMSEncrypt on certain segments.
It can be improved by the quality of instruction sequences, so as the number of instructions is completed successfully, the index is higher, so will the application

quality increase. If the quality of instruction increases, so does the user's degree of satisfaction. Also new instructions can be implemented so as to reach the number of instructions that was planned.

Another segment that can increase application quality, without much cost, is to ensure better security at both management and user level, so will the number of vulnerabilities decrease.

Increasing user security can be achieved by using digital signature certificates to encrypt text messages.

7 Conclusions

These features are used to achieve a global model. In [14] it is presented the need for a global model. Further developments, it is necessary to conduct stability analysis aims both at equipment and application-level in terms of growth of degree of homogeneity user. Thus we must build a proper metric for measuring the stability behavior knowing that lead indicators refining processes to reduce complexity metrics, making it operational.

If you want to use a smaller number of features from the 11 characteristics to determine the weights chosen, you will use a simple proportion (the rule of three).

If you want to use only the first five characteristics (quality of instruction sequences, number of written instructions, compliance deadlines, quality testing process, cost of the application developer), their weights will be determined by a simple proportion / rule of three. The data are shown in Table 14.

Table 14. Calculating weights only for the first five characteristics

Characteristic	1	2	3	4	5	Total
Initial	0,047278	0,011785	0,049944	0,073513	0,06229	0,244809
Final	0,193123	0,048138	0,204011	0,300287	0,254441	1
Correlation	1					

Because the correlation between the two series is 1, this means that the new weights are the same with the initial ones. This shows that the method of determining the new weight is correct.

If you want to use the characteristics 1, 3, 5, 7, 9, 11 (quality of instruction sequences, the deadlines, the application developer cost, user satisfaction ratings, risks and vulnerabilities, security users). Results are presented in Table 15.

Table 15. Calculating weights for some characteristics

Characteristic	1	3	5	7	9	11	Total
Initial	0,047278	0,049944	0,06229	0,190937	0,089366	0,122615	0,56243
Final	0,084061	0,0888	0,110751	0,339486	0,158892	0,218009	1
Correlation	1						

For these series, the correlation is also 1. This shows the effectiveness of the method for calculating a limited number of weights from 11.

Taking into account these features which are easily measurable, mobile software applications can be ranked. Such a hierarchy of mobile software is useful for choosing mobile device applications. It is very important that the applications ranking to be made on the categories of the existing applications.

Based on these characteristics one can achieve quality metrics for mobile applications that will be used to determine the quality of certain mobile software applications.

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