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## FACTORS OF INFLUENCE OF INTERFACE USE BASED ON MOBILE APPLICATIONS

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*The factors that influence the process of the mobile interface use and the developed graph of relationships between these factors hierarchically ordered by the influence priority on the process (their dependencies), on the user experience of mobile applications interface have been analysed based on the recommendations of the developers and the obtained results of the study; the evaluation has been done and a multi-level factor model has been optimized using the method of pairwise comparisons and Saaty scale of relative importance.*

*From the obtained results, the conclusions can be made that the developers should pay more attention to the functionality of systems and more correctly assign tasks to be solved in certain actions. The studies have shown that it is not necessary to pay attention to brands and their animation capabilities. The developed models enable designers to pay attention when creating the relevant software to the actual factors that contribute to a comfortable and intuitive interface use.*

**Keywords:** *UX, Android, user interface, mobile application, prototype, factors, graphs, links, a binary matrix of dependency.*

**Set of the Problem.** Despite the large number of studies in the field of mobile application development, the rapid development of the industry dictates the need for regular innovations in new versions of Android and iOS.

The functionality and very often the features of interaction through the user interface expand with each new version.

**Recent Research and Publications.** According to the standard ISO 9241-210, a user experience – is «a person's perceptions and responses that result from the use or anticipated use of a product, system or service».

In additional notes the ISO definition states that the user experience includes emotions, beliefs, preferences, feelings, physical and psychological reactions (including behaviour and goal achieving) arising before, during or after the use. Also the notes highlight the factors that affect the user experience: a system, a user and a user context [1].

There are many other definitions of user experience, they are cited at Allaboutux.org. Some of them were examined by Dr. E.L.C.Law and other scientists in 2009 [2].

**Aim of the Article.** To assess the current state of mobile applications development and their user interface, and on the basis of the studies and calculations of the factors of influence, to offer our own information system — a computer software that would allow to make the interface more accessible and intuitive to use.

**Main Material of the Research.** Factors that affect the interface user experience of mobile applications are divided into three main groups: the condition and the previous experience of the user, features of the system and the user context (i.e., situation). The following example, in our opinion, perfectly illustrates the main factors affecting the user experience.

Because of the high competition among websites, the web design demanded the interface openness and greater efficiency of use. Perhaps that is why the first publications on the user experience were connected with the design of websites.

Let us consider the factors of influence of interface use of mobile applications based on this example. Person X is going home by bus. Her husband is on a business trip and she wants to know how he is settled. The bus is full, she has to stand, but despite this, she wants to use her free time to contact her husband by phone. Let us consider the factors that affect her experience of the phone use:

The emotional condition of Person X — her skills, motivation, expectations, mood as well as physical abilities available — to use her telephone she can have only one hand.

The context or the situation in which Person X is:

Physical — the environment, she feels: the moving bus, the view from the windows, the lighting, the noise.

Social — the influence of others on her user experience; the other passengers, the rules of conduct, her husband approachability.

Time limits: the time of a bus trip.

Infrastructure: network coverage, cost of calls and text messages, legal restrictions.

Tasks — basic: to learn how her husband is doing; and other activities; watch around to be able to get off reaching the desired stop, the occasional distraction.

This context makes Person X to use text messages to communicate with her husband. Additionally the context affects the interaction with the phone itself, and hence the user experience.

The system of short message service (currently, a mobile phone and SMS) — is the user interface, functionality (software for messaging and dialing keypad), appearance and brand.

The main advantage of the functionality is, in fact, the communication itself; other functions should contribute to this objective.

After reading SMS from her husband, the emotions of Persons X can range from satisfaction to disappointment, from delight to despair. However, the study of the user experience is focused on those feelings of Person X, associated with using the phone, not with her husband. First of all we are interested in the answers to the following questions. Has the system provided Person X an opportunity to communicate with her husband the way she wanted it in this context? Has the system pleased her exceeding her expectations?

We offer to divide the appearance into two sub-headings «style of graphic elements» and «animation effects.» This will take into account the features of interfaces for mobile applications.

Here we present a set of factors considered:

- $k_1$  — habits (H);
- $k_2$  — motivation (M);

- $k_3$  — expectation (O);
- $k_4$  — mood (HAC);
- $k_5$  — functionality (Φ);
- $k_6$  — style of graphic elements (CГE);
- $k_7$  — animation effects (AE);
- $k_8$  — brand (Б);
- $k_9$  — physical (ΦIЗ);
- $k_{10}$  — social (C);
- $k_{11}$  — time limit (OЧ);
- $k_{12}$  — infrastructural (I);
- $k_{13}$  — tasks (З).

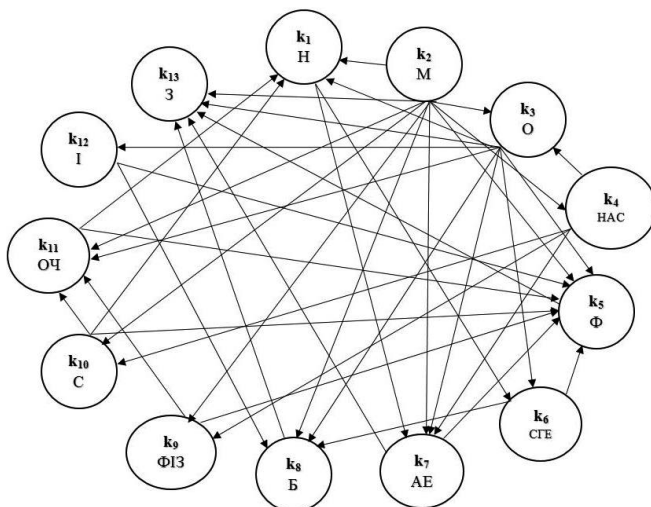


Fig. 1. Graph of relationship between the factors of influence (their dependencies) on the user interface experience of mobile applications

Based on the given graph (Fig. 1) of relationship between the factors, we build a binary matrix of dependency A for a set of vertices K the following way [1, 2]:

$$a_{ij} = \begin{cases} 0, & \text{if Factor } i \text{ does not depend on Factor } j \\ 1, & \text{if Factor } i \text{ depend on Factor } j. \end{cases} \quad (1)$$

A binary matrix of vertices K is presented in Table 1.

Table 1

	1	2	3	4	5	6	7	8	9	10	11	12	13
	H	M	O	HAC	Φ	CГE	AE	Б	Φ	C	OЧ	I	З
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	H	0	0	0	0	1	1	0	0	0	0	0	0
2	M	1	0	1	1	0	1	1	1	1	1	0	1

Cont. of table 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
3	О	1	1	0	1	1	1	1	1	0	0	1	1	1
4	НАС	0	0	1	0	0	0	1	0	1	1	0	0	0
5	Ф	0	0	0	0	0	0	0	0	0	0	0	0	1
6	СГЕ	0	0	0	0	1	0	0	1	0	0	0	0	1
7	АЕ	0	0	0	0	1	0	0	0	0	0	0	0	1
8	Б	0	0	0	0	0	0	0	0	0	0	0	0	1
9	Ф	0	0	0	0	1	0	0	0	0	0	1	0	0
10	С	1	0	0	0	1	0	0	0	0	0	1	0	0
11	ОЧ	1	0	0	0	1	0	0	0	0	0	0	0	0
12	І	0	0	0	0	1	0	0	1	0	0	0	0	0
13	З	0	0	0	0	1	0	0	0	0	0	0	0	0

Based on binary matrix A we design a matrix of reachability according to the rule  $(I + A)$ , (where I — is a single matrix), which is raised to degree n to fulfill the condition [3]:

$$(I + A)^{n-1} \leq (I + A)^n = (I + A)^{n+1} \tag{2}$$

We proceed to fill in the binary matrix with elements in rows (left to right) by the following rule:

$$d_{ij} = \begin{cases} 1, & \text{if you can reach vertex } j \text{ from vertex } i; \\ 0, & \text{in the other case.} \end{cases} \tag{3}$$

Table 2

		1	2	3	4	5	6	7	8	9	10	11	12	13
		Н	М	О	НАС	Ф	СГЕ	АЕ	Б	Ф	С	ОЧ	І	З
1	Н	1	0	0	0	1	1	1	1	0	0	0	0	1
2	М	1	1	1	1	1	1	1	1	1	1	1	1	1
3	О	1	1	1	1	1	1	1	1	1	1	1	1	1
4	НАС	1	1	1	1	1	1	1	1	1	1	1	1	1
5	Ф	0	0	0	0	1	0	0	0	0	0	0	0	1
6	СГЕ	0	0	0	0	1	1	0	1	0	0	0	0	1
7	АЕ	0	0	0	0	1	0	1	0	0	0	0	0	1
8	Б	0	0	0	0	1	0	0	1	0	0	0	0	1
9	Ф	1	0	0	0	1	1	1	1	1	0	1	0	1
10	С	1	0	0	0	1	1	1	1	0	1	1	0	1
11	ОЧ	1	0	0	0	1	1	1	1	0	0	1	0	1
12	І	0	0	0	0	1	0	0	1	0	0	0	1	1
13	З	0	0	0	0	1	0	0	0	0	0	0	0	1

The presence of the matrix of reachability can divide the set of vertices  $K$  into the subset of levels. To do this, all the vertices are divided into vertices of its predecessor and reached ones. Vertex  $k_i$  is called reached from vertex  $k_j$ , if there is a path from  $k_j$  to  $k_i$  in the directed graph. Let us mark this subset of reached vertices as  $R(k_i)$ . Vertex  $k_j$  is called a predecessor of vertex  $k_i$ , if it is possible to reach  $k_i$  from  $k_j$ . [4, 5] Let us mark this subset of vertices of predecessors as  $B(k_i)$ . The intersection of these subsets is a subset

$$B(k_i) = R(k_i) \cap B(k_i). \quad (4)$$

A set of these vertices  $A(k_i) = R(k_i) \cap A(k_i)$ , for which we fulfill the condition of unreachability from any vertex that is left in set  $K$ , can be defined as a level of hierarchy [4, 5].

We form Table 3. Subset  $R(k_i)$  contains the elements of  $i$ -row of the matrix of reachability which have one. Subset  $B(k_i)$  contains the elements of  $i$ -row of the matrix of reachability which have one. Subset  $R(k_i) \cap B(k_i)$  is formed as a logical intersection of elements of subsets  $R(k_i)$  and  $B(k_i)$ .

Table 3

$k_i$	$R(k_i)$	$B(k_i)$	$R(k_i) \cap B(k_i)$
1	1, 5, 6, 7, 8, 13	1, 2, 3, 4, 9, 10, 11	1
2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	2, 3, 4	2, 3, 4 ←
3	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	2, 3, 4	2, 3, 4 ←
4	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	2, 3, 4	2, 3, 4 ←
5	5, 13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	5, 13
6	5, 6, 8, 13	1, 2, 3, 4, 6, 9, 10, 11	6
7	5, 7, 13	1, 2, 3, 4, 7, 9, 10, 11	7
8	5, 8, 13	1, 2, 3, 4, 6, 8, 9, 10, 11, 12	8
9	1, 5, 6, 7, 8, 9, 11, 13	2, 3, 4, 9	9
10	1, 5, 6, 7, 8, 10, 11, 13	2, 3, 4, 10	10
11	1, 5, 6, 7, 8, 11, 13	2, 3, 4, 9, 10, 11	11
12	5, 8, 12, 13	2, 3, 4, 12	12
13	5, 13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	13

In Table 3 the equation  $B(k_i) = R(k_i) \cap B(k_i)$  is fulfilled for elements 2, 3 and 4. These elements correspond to factors of motivation, expectation and mood of the user. These are the elements of the first level of the hierarchy, which are the elements of the lowest level of influence priority on the user experience of mobile applications.

We build Table 4 deleting rows 2, 3 and 4 from Table 3 and in the second row we delete the numbers 2, 3 and 4. It will look this way:

Table 4

$k_i$	$R(k_i)$	$B(k_i)$	$R(k_i) \cap B(k_i)$
1	1, 5, 6, 7, 8, 13	1, 9, 10, 11	1
5	5, 13	1, 5, 6, 7, 8, 9, 10, 11, 12, 13	5, 13
6	5, 6, 8, 13	1, 6, 9, 10, 11	6
7	5, 7, 13	1, 7, 9, 10, 11	7
8	5, 8, 13	1, 6, 8, 9, 10, 11, 12	8
9	1, 5, 6, 7, 8, 9, 11, 13	9	9 ←
10	1, 5, 6, 7, 8, 10, 11, 13	10	10 ←
11	1, 5, 6, 7, 8, 11, 13	9, 10, 11	11
12	5, 8, 12, 13	12	12 ←
13	5, 13	1, 5, 6, 7, 8, 9, 10, 11, 12, 13	13

In Table 4 the equation  $B(k_i) = R(k_i) \cap B(k_i)$  is fulfilled for elements with numbers 9, 10 and 12. They correspond to physical, social and infrastructural factors. These elements form the second level of hierarchy [8].

Similarly to Table 4 we define the third level of the hierarchy of factors of influence on the user experience of mobile applications. We form Table 5, which will look like:

Table 5

$k_i$	$R(k_i)$	$B(k_i)$	$R(k_i) \cap B(k_i)$
1	1, 5, 6, 7, 8, 13	1, 11	1
5	5, 13	1, 5, 6, 7, 8, 11, 13	5, 13
6	5, 6, 8, 13	1, 6, 11	6
7	5, 7, 13	1, 7, 11	7
8	5, 8, 13	1, 6, 8, 11	8
11	1, 5, 6, 7, 8, 11, 13	11	11 ←
13	5, 13	1, 5, 6, 7, 8, 11, 13	13

In Table 5 the equation  $B(k_i) = R(k_i) \cap B(k_i)$  is fulfilled for the element with number 11. This factor is a time limit. Similarly to Table 5 we define the next levels of the hierarchy of factors of influence on the user experience of mobile applications. We form Table 6, 7 and 8:

Table 6

$k_i$	$R(k_i)$	$B(k_i)$	$R(k_i) \cap B(k_i)$
1	1, 5, 6, 7, 8, 13	1	1 ←
5	5, 13	1, 5, 6, 7, 8, 13	5, 13
6	5, 6, 8, 13	1, 6	6
7	5, 7, 13	1, 7	7
8	5, 8, 13	1, 6, 8	8
13	5, 13	1, 5, 6, 7, 8, 13	13

Table 7

$k_i$	$R(k_j)$	$B(k_j)$	$R(k_j) \cap B(k_j)$
5	5, 13	5, 6, 7, 8, 13	5, 13
6	5, 6, 8, 13	6	6 ←
7	5, 7, 13	7	7 ←
8	5, 8, 13	6, 8	8
13	5, 13	5, 6, 7, 8, 13	13

Table 8

$k_i$	$R(k_j)$	$B(k_j)$	$R(k_j) \cap B(k_j)$
5	5, 13	5, 8, 13	5, 13
8	5, 8, 13	8	8 ←
13	5, 13	5, 8, 13	13

Based on the received results we present the model of factors of priority influence (their dependencies) on the convenience of use of mobile applications interface.

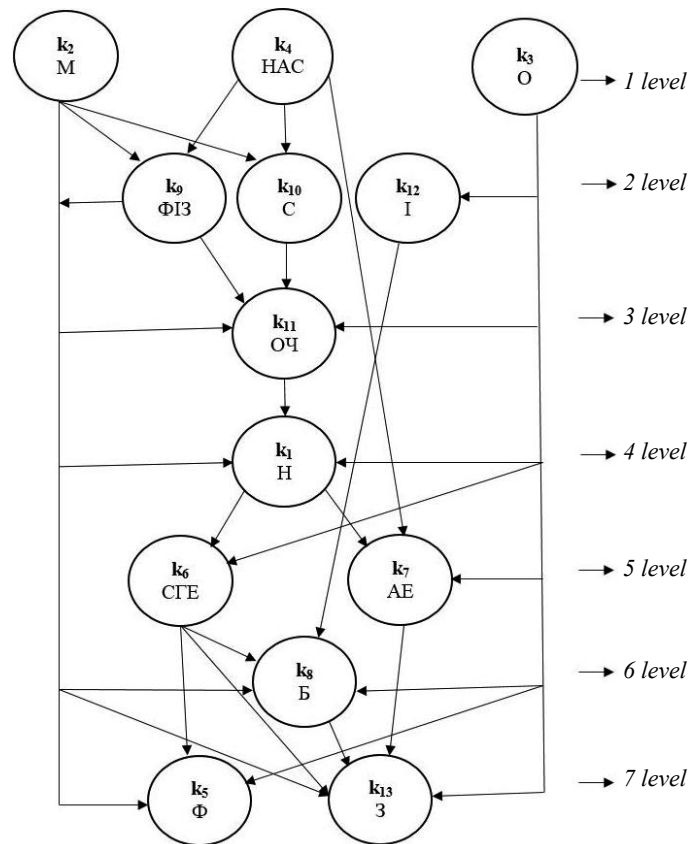


Fig. 2. Model of factors of priority influence (their dependencies) on the experience of mobile applications use

**Conclusions.** Based on the conducted research of evaluation of influence priority of factors on the use of mobile applications, we have developed an optimized model that shows the influence of factors (their dependency) on the experience and intuitiveness of the latter. This model makes it easy to prioritize factors in the development of mobile interfaces. Since the study shows that developers should pay more attention to the functionality of systems and more correctly assign tasks to be solved in certain actions. The studies have shown that it is not necessary to pay attention to brands and their animation capabilities. With the help of such studies it is easier for designers and developers to put priorities in the development of mobile application interfaces. These studies are new and relevant, and the subject has not been highlighted enough, particularly in printed works. The developed models enable designers to pay attention when creating the relevant software to the actual factors that contribute to a comfortable and intuitive use of interfaces. These studies will be used to develop mobile application interfaces with different versions of Android and iOS.

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## **ФАКТОРИ ВПЛИВУ КОРИСТУВАННЯ ІНТЕРФЕЙСОМ НА ОСНОВІ МОБІЛЬНИХ ДОДАТКІВ**

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*На основі рекомендацій розробникам і попередньо отриманих результатів дослідження проаналізовано фактори, що впливають на користування інтерфейсом мобільних пристроїв, та розроблено граф взаємозв'язків між цими факторами, які ієрархічно впорядковані за пріоритетністю впливу на процес (їх залежностей) та досвід користування інтерфейсом мобільних додатків. Проведено оцінку й оптимізовано багаторівневу модель факторів із використанням методу попарних порівнянь і шкали відносної важливості Сааті. З отриманих результатів можна зробити висновки, що розробники повинні більше уваги надавати функціональності систем і коректніше формулювати завдання, які треба розв'язати під час виконання певних дій. Як показали дослідження, не варто надавати вагомого значення брендам та їхнім анімаційним можливостям. Розроблені моделі дають можливість звернути увагу дизайнерів під час створення відповідних програмних засобів на актуальні фактори, які сприяють зручнішому та інтуїтивному використанню інтерфейсів.*

**Ключові слова:** UX, Android, користувацький інтерфейс, мобільний додаток, прототип, фактори, графи, зв'язки, бінарна матриця залежності.

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