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Mobile device applications usability assessment: The example of an agricultural management application

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A B S T R A C T

This paper examines the issue of mobile application usability assessment and is primarily intended to evaluate a "proposal" concerning the systematic recording of the technical and economic data of an agricultural holding with the aid of a rural management system (agroFarm). This application is an electronic calendar where farmers and breeders can store all the agricultural activities about crops, farms and agricultural machineries. Simultaneously agroFarm calculates the revenues and expenses of every rural activity.
The use of mobile applications requires solving problems in use so that access to information and services can be done without difficulty. This is achieved by assessing the use with methods that can measure the usability of mobile applications.
The application was evaluated with, the Questionnaire for User Interaction Satisfaction questionnaire. Ten users aged 20 to 45, at least high school graduates, holding different farms and different familiarity with digital applications participated in the evaluation process. In addition, a Heuristic evaluation was performed by experts who were asked to evaluate ten "heuristics criteria" and whether they were observed in the evaluated application.
The results of the evaluation showed that the users consider that most important feature of mobile applications is the ease of use and utility.

1. Introduction

The complexity and the large amount of information used or required to solve problems of rural economy coupled with the need for quick decision-making have resulted in the interference of modern and often multifunctional computing units (portable devices computers) and individual devices which take place in different natural environments and can be used in rural economy almost immediately after their introduction.

Agricultural businesses seem to have much to gain from the use of internet technology, given their spatial dispersion and generally their small scale (in terms of employment and turnover), but the available statistics show a lower rate of adoption by small to medium-sized enterprises (Beley et al. 2013).

The adoption of new technologies in agriculture is rarely immediate. Even though much effort is placed into in persuading users to adopt new information and communication technologies (ICT) tools. Adoption ITC is a complex activity and many factors influence these decision-making processes (Pierpaoli et al. 2013).

From various surveys that have taken place at times, it appears that the proportion of the younger Internet-based producers for work purposes is higher than that of the “oldest” producers. Salampasis et al. (2006) report that the penetration of the internet in the Greek rural sector is limited mainly to young ages while it is extremely limited in the middle and older ages, a major obstacle to the use of ICT by Greek farms. In addition, with regard to the reasons why they do not use the Internet, those that come first are the non possession of a computer and the lack of knowledge of its use, as well as the educational

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level, age and marital status which are also key determinants for the use or not of the Internet (Samathrakis et al. 2005). Another factor in the slow adoption of ICT technologies in the agriculture sector is related to the fact that existing market solutions (e.g., farm management information systems, logistics services) have been developed as closed proprietary ones, and their capabilities are directly proportional to their cost (Kaloxylos et al. 2013).

Indeed, there is no better example of smart farming than the mobile application. It has become a change game for on-the-go growers and retailers, allowing them to perform critical tasks whenever and wherever they need it.

The purpose of the paper is to examine whether a portable agricultural management application can be evaluated in terms of its usability and the system efficiency in agricultural holdings.

In addition, to presenting the results of the evaluation, the presentation of the use of each method and the methodological framework used to make the results as reliable and valid as possible is also attempted.

The contribution of this work is that for the first time an agricultural mobile application appraisal is attempted in terms of ease of use and utility. Of importance is the large volume of agricultural applications coupled with exponential growth, which confirms that it is virtually impossible to evaluate every agricultural application available at online stores.

2. The use of mobile applications in agriculture and rural activities

This part presents the literature on portable applications usability assessment studies especially for the agricultural sector. Internet has been recognized as a tool that can be used to improve the efficiency of the agricultural sector (Gloy & Akridge 2000) and multiple factors influence farmers' decisions to adopt agricultural technologies (Birthal et al. 2015, Asif et al. 2017). Farmers obtain information about the technologies and farming practices from different sources such as other farmers, government extension services, information through mobile phones and ITC (Aryal et al. 2018). According to Csótó (2015) the use of smartphone is basically determined by the personal characteristics and previous ICT experience of Hungarian farmers and used as an extension of the current information management system.

Arhippainen & Tahti (2003) in order to evaluate the use of a mobile application, factors related to the user and application characteristics as well as the space where it is used must be recorded. The Human-Computer Interaction (Cairns & Cox 2008) is based on the fields of computer science, psychology, cognitive science and organizational and social sciences, to understand how people use and test the interactive technology. Jacob Nielsen (1993) in his book Usability Engineering, devotes a whole chapter to explain the concept of usability. Shneiderman & Pleasant (2009) have extensively argued for the concept of universal usability, which also includes factors related to accessibility of products and systems.

Lockner & Bonnardel (2015) in addition to the traditional approach of usability and efficiency, introduce the concepts of empathy and emotional design for user interfaces. According to Hassenzahl et al. (2011) User Experience (UX) is the emotional effect of human-computer interaction, in other words, how a person feels when using a product or service. Moumane et al. (2016) present an empirical assessment of the framework developed for the use of ISO 9126 software quality standard in mobile telephony environments, in particular as regards the impact of mobile telephony restrictions (limited user interface, frequent disconnection, lower bandwidth, etc.) in accordance with ISO 25062 and ISO 9241. Certain representative applications of the agro-industry on the Internet and certain conclusions have led to the successful adoption of e-commerce in agriculture (Ferentinos 2006). According to Adamides et al. (2013) gender, age and education level of the principle farm owner, the annual income, the farm type (crop or livestock farming), the employment type (full-time or part-time), the participation in a Producers' Organization and the district, are factors that significantly influence the usage of Internet by farmers.

Pongnumkul et al. (2015) conducted a research to examine smartphone applications that are referred to in bibliography and use built-in smartphone sensors to provide agricultural solutions. Jennex et al.

(2004) study the adoption of the Internet in small companies in developing countries. Studies have explored the use of e-commerce in agricultural enterprises (Liu et al. 2013) and small rural businesses (Beley et al. 2013). Stoyanov et al. (2015) developed a mobile application appraisal scale to evaluate the usability of mobile health applications. According to Stenberg et al. (2009) there has been a rapid increase in the use of the Internet and applications in almost all sectors of economy. From 1995 to 2008, worldwide Internet access increased from 16 million to 1.5 billion including internet access at home for the two-thirds of US adults. While other sectors use internet services to a large extent, the agricultural sector is slightly behind its urban counterpart. Porter (2001) argues that business survival without being connected to the Internet will become almost impossible in the future. Bohmer et al. (2011) evaluated the data collected through Appazaar. The authors concluded that the use of news apps dominated in the morning, games were widespread at night, and that communication applications were used throughout the day. While the application created very rich data, it did not collect demographic information; therefore, the conclusions are generally valid.

Hegarty & Wusteman (2011) to determine the usability of the services provided by EBSCO host Mobile, utilized the methodology that includes pre and post-use test questionnaires and "think out-loud" usability tests. Bidit et al. (2011) found that mobile phone use by Bangladesh farmers is hampered by language barriers, lack of literacy, unknown English terminology, incorrect Bengali language translation and financial constraints. The findings suggest that the current understanding of usability should be intertwined with technology appropriation to develop a better understanding of the use and the consequent incorporation of the technology in everyday life. They present an initial conceptual diagram that combines the concept of usability and appropriation.

Hansen & Hansen (2009) approach the theoretical exploration of the application of mobile learning (m-learning) in fields with practical orientation such as agriculture. In the agricultural sector (agriculture, livestock farming, fishing, etc.) during the last decade the applications of mobile learning (m-learning) increase more and more in rural education internationally (Denmark, Iran, USA, South America etc.).

Ballantyne et al. (2009) examined some trends and opportunities related to the use of ICT in agricultural science and development. Through investments in infrastructure and collaboration between e-sciences and rapid developments in digital devices and the interconnection in rural areas, the ways in which scientists, academics and development workers create, share and apply agricultural knowledge are transformed through the use of Information and Communication Technologies (ICT). Chang & Just (2009) used a multi-stage econometric analysis to assess the impact of internet access by farm households in Taiwan. A study by Sarban et al. (2015) discussed that people who have higher computer skills their use of ICT services in rural area has been in more rates. Kjeldskov & Graham (2003) conducting an extensive review of studies involving mobile applications from real users which were published from 2000 to 2002, conclude that 71% of these studies were performed in laboratory conditions and only 19% in the real environment for which applications were intended.

According to Beck et al. 2003 there is also reference to cases in which studies take place in laboratories designed in such a way as to simulate the characteristics of the area in which the tested application is to be used. Zhang & Adipat (2005) present an innovative framework that incorporates four major perspectives. That is, the presentation of information, the data input methods, the user and the mobile interface. Thomas (2012) recognizes the capabilities of smart phones as a tool for libraries, both public and academic.

3. Research methodology

This study presents a combination of evaluation methods. The methodology includes two basic methods. (a) the analytical method in the laboratory (without user participation) of the Heuristic Evaluation; and (b) the non-laboratory inquiry method (involving users) and the use of a questionnaire.

Initially, agroFarm (available at goggle play) was evaluated using the heuristic evaluation method. In the assessment process involved three experts, who have experience not only in designing software but in the application of the method and generally in the usability assessment of applications. The review

was conducted at the laboratory of the School of Electrical and Computer Engineering of the Aristotle University of Thessaloniki and the experts used a simulation of the application in a desktop environment. The simulation environment was developed to meet the needs of the assessment experiment. Experts were asked to evaluate the 10-heuristics criterion of Nielsen (1993) based on a numerical scale to indicate the degree of acceptance or rejection of the application's usability in the data being considered. Based on commonly accepted and well-established authorities, they examine whether they are implemented, the design rules and principles are respected. A Likert type scale ranging from 1 to 7 is chosen which is the simplest to create and the most widespread.

For the evaluation of the application usability, a questionnaire for User Interaction Satisfaction (QUIS) questionnaire was used.

Ten (10) users (9 men and 1 woman), aged 20 to 45, with different agricultural holdings, having different familiarity with digital applications and were at least high school graduates, participated in the usability evaluation process.

These users have been using agroFarm for six (6) months in their farm. Given this, they were asked to evaluate their usefulness by responding to a user interface questionnaire.

The QUIS questionnaire consists of 26 questions, divided into five parts, and the answers are given on a Likert type scale of one (1) to seven (7) which corresponds to the extent to which they disagree or agree with each of the questionnaire proposals. The graded answers start with one (1 = Absolutely disagree) and end up in seven (7 = Absolutely agree). Do not know / do not answer = NA.

The five parts of the QUIS questionnaire are; 1) General impression of the user, 2) Screen 3) Terminology and communication with the system, 4) Learning of use 5) System capabilities.

4. Results

The experts who participated in the heuristic evaluation were asked to evaluate the application using the 10 heuristics criteria of Nielsen (Nielsen, 1993) based on a numerical scale to indicate the degree of acceptance or rejection of the application usability on the data being considered. For the process, a Likert type scale from 1 to 7 was chosen which is the simples to create and most widespread. The results are shown in Table 1.

Table 1. Heuristic evaluation of the "agroFarm" application

Questions	Exrert 1	Expert 2	Expert 3	Results
[1] Is the user aware of the changes that occur in the system constantly through his feedback?	5	6	5	Positive result: Data storage and deletion information is provided to the user.
[2] Do simple and understandable language be used and are the conventions of the real world followed?	4	5	5	Positive result: the user is given the content in a clear design
[3] Is the user able to cancel actions and revoke or repeat operations?	6	5	6	Positive result: User can navigate and control with device keys.
[4] There is consistency in the use of terminology, symbol semantics, etc. throughout the range of use?	7	5	4	Positive result: consistency in the use of terminology is sufficient and the system follows common contracts with similar systems
[5] Does the system protect the user from possible errors?	3	1	2	Negative result: no restrictions

[6] An attempt is made to minimize the user's memory load, is it possible to list information from previous screens?	3	4	3	Negative result: usage and execution information is not sufficient to navigate the user
[7] Is it possible to distinguish between experienced and inexperienced users?	1	2	2	Negative result: Does not provide navigation shortcuts
[8] From a design point of view, the system is characterized by elegance and proper flow of information to avoid confusion of the user.	5	3	5	Positive result: the same design is provided on all screens, but any additional information is burdened by the user.
[9] Are error messages clear and understandable and suggest a way out of the error?	2	1	2	Negative result: there are no error messages.
[10] Is the help provided and user manuals adequate and comprehensive and focused on user work	7	7	6	Positive result: There is user guidance at points defined as necessary.

The ten (10) users- owners of agricultural holdings evaluated the features for five individual dimensions of the application. They evaluated the 1) General impression of the user, 2) Screen 3) Terminology and communication with the System, 4) Learning of use, 5) System capabilities.

Table 2. General impression of the user

	N	Min	Max	Mean	Std. Deviation
The overall reaction of the system was great	10	4.00	6.00	5.100	.567
The general reaction of the system satisfies	10	2.00	5.00	4.000	.942
The overall reaction of the system was pleasant	10	4.00	6.00	5.600	.699
The general reaction of the system was easy	10	2.00	6.00	3.900	1.100
The general reaction of the system was flexible	10	3.00	6.00	4.300	.948

By examining the user responses one can conclude that the users of the application were partially satisfied with the general impression of the application. The users felt that the application is quite pleasant and flexible, but less easy and with the general reaction of the system being confusing.

Table 3. Screen content

	N	Min	Max	Mean	Std. Deviation
Screen design has always helped	10	3.00	6.00	5.000	.942
The amount of information displayed on the screen was sufficient	10	5.00	7.00	6.000	.816
The structure of information on the screen was organized	10	2.00	6.00	4.500	1.433
The sequence of screens was clear	10	3.00	6.00	4.600	.966

Next screen in the series was predictable	10	4.00	6.00	5.200	.918
Back to the previous screen was easy	10	3.00	7.00	5.800	1.135

The user responses showed satisfaction with elements such as 'screen design', 'the amount of on-screen information', 'return to the previous screen', and 'next screen in the predictable order', while they showed that they expected more from the 'building information' and 'the sequence of screens'.

Table 4. Terminology and communication with the System

	N	Min	Max	Mean	Std. Deviation
Messages appear consistently on the screen	10	5.00	6.00	5.600	.516
Messages that appear on the screen are clear	10	3.00	7.00	5.100	1.286
Your computer tells you what it's always doing	10	1.00	7.00	3.700	2.110
Performing a move leads to a predictable result	10	4.00	7.00	5.400	1.074
Delays were admissible	10	4.00	7.00	5.700	1.159
The error messages were very helpful	10	3.00	5.00	3.700	.675

Generally, the users liked the way the app communicated and scored high in questions about the messages that appeared on the screen. High scores were also given to questions like 'if we conduct a move, we are led to a predictable outcome' and users were pleased with the possible 'delays' in the application response.

Table 5. Learning of use

	N	Min	Max	Mean	Std. Deviation
Learning to use the system is easy	10	2.00	7.00	4.200	1.549
User learning time is a few	10	2.00	7.00	3.900	1.595
Work is done in a logical sequence always	10	3.00	6.00	4.300	.948
The steps to complete always follow a logical sequence	10	4.00	600	5.100	.875
Feedback when the job is completed is clear	10	4.00	7.00	5.400	.966

The users argued that 'learning how to use the system' was not easy and the 'time to learn' was enough. Positive were their judgments about whether 'steps to complete the job follow a logical sequence' and about 'feedback' when a job is completed, while they were negative about whether 'work is done in a logical sequence'.

Table 6. System capabilities

	N	Min	Max	Mean	Std. Deviation
The speed of the system is satisfactory	10	1.00	7.00	4.500	2.415
The system is always stable	10	3.00	7.00	5.300	1.494
Operations-functions are reliable	10	4.00	7.00	5.900	.875
The ease of handling depends on the user experience	10	5.00	7.00	6.400	.843

Finally, the users believe that the 'speed of the system' is satisfactory and the application 'stable' and that 'operations-functions' take place quite reliably. The user responses to whether 'user-friendliness depends on user experience' reached almost Maximum with an average of 6.4.

Generally according to the users' replies and their comments, they consider usability being the most important feature of mobile applications. The users want to get the information they are looking for following simple steps, and in the case of agroFarm, the relatively low rating on the question of organizing information on the screen clearly shows that almost everybody's attention was focused on this point. In general, the second and third sections, which were concerned with the presentation of the data on the screen and the communication with the System, had the lowest score from all other sections. This indicates that users require of such an application (or generally a mobile app) to give more importance to presentation and usability rather than anything else.

5. Conclusions

Electronic applications are an easy, economical and dynamic way of organizing and managing farm and livestock units, whereby producers can monitor the operation of their farms or their businesses and the development of their economics.

Nowadays, a Smartphone or a tablet coupled with a data 'packet' is a valuable tool for the new farmer who saves time and money for the development of his farm.

The farm management application named "agroFarm" is an innovative proposal to Greek farmer as well as to the agronomist researcher, a simple system of keeping records and accounts that allows producers to monitor the smooth operation of their holdings or businesses, and indeed online. It can offer a different approach to accurate keeping of farm records and accounts, and to be a helper in the difficult journey of future agriculture.

With regard to the purpose set in the introductory chapter, it has been found that the use of portable computers can contribute to the integration of the two information spaces (physical and digital), creating a new type of experience. It was also found that for this purpose the main factors influencing the acceptance and intent to use the new technology are the users' predisposition to mobile devices, the perceived performance improvement expectation, the perceived ease of use and utility, the expected personal benefits (e.g. less effort) and the suitability of the specific technology for the purpose for which it is used.

The analysis of the evaluation data revealed the primacy of expert judgment and their ability to identify problems related to system consistency and navigation so that they can be corrected at early stages of application development in general. However, in the future extension of the methodology, the integration of evaluation methods taking place in laboratories that simulate genuine conditions of use could be explored.

The overall conclusion that results from the use, study, and appraisal of the application at this stage is the creator's apparent effort for an application that is user friendly through simple, comprehensive language, symbolism, images and certain choices. In addition, the user is adequately updated to perform

his / her actions (storage, creation / deletion). As far as errors are concerned, they are possible to be corrected by the user himself. Yet, the correction is absent from the system itself, which is usually the main form of correction.

A desirable outcome of the usability evaluation is to identify the low usability and draw conclusions that will produce solutions for redesigning the application.

Nevertheless, further study is necessary to provide a wider understanding of the evaluation usability of mobile rural management applications.

The available applications are a good raw material for creating and developing more user-friendly, responsive and customized to the existing needs and requirements.

The results of this assessment case confirm that the application of different methods can give different type of conclusions of complementary character. Therefore all the methods used seem to be equally useful.

Finally, the assessment of rural management applications seems at present to be a difficult task. Initially, too many available apps in e-shops make it impossible to evaluate them, in combination with the rapid growth rate of new applications and the fact that evaluating a single application - according to the existing rating models - requires at least a few weeks to a few months to be carried out adequately, an important time constraint is introduced which contributes to the failure to evaluate all the Agricultural Management Applications available at webs hops.

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