# **Usability And Accessibility In Agricultural Software: A Systematic Review**

**Context:** Accessibility and usability are tools which add quality to a digital service or product. The low level of these attributes encompasses the user demotivation, and in the agricultural field it can result in low use adhesion. Researches have indicated that in Brazil the use of web by farmers has increased between 2009 and 2013. One of the strands in which this technology has been applied in the country is the Environmental Rural Register (ERR), which is mandatory to rural property owners.

**Objective:** Developing bibliographic review in the accessibility and usability field in software, turned to agricultural and web strand. It is sought finding information such as art state, measurement techniques, users difficulties, benefits on the application of these concepts, employed tools, solutions to possible problems found, means to access software, and the most used agricultural software indication.

**Method:** The Systematic Review technique was applied by using 4 (four) databases. As a result 6.577 studies were selected, being those sourced from magazines and conferences, and after the application of the inclusion and exclusion criteria, 28 relevant studies about the research theme were obtained.

**Results:** With the exception of the most used agricultural software data, the other objectives were accomplished. Among the results it is highlighted the limitations of the current tools: necessity of measurement regarding how much one of the attributes had been applied to the system, necessity of performing qualitative tests, and identifying serious problems rather than the trivial.

**Conclusions:** Considered the scarcity of studies in the agriculture area and the difficulties surveyed by users of this environment, it may be inferred the necessity of research about accessibility and usability in the agricultural strand, by emphasizing the necessity of obtaining more knowledge about this user and his/her difficulties. The ERR seems to be a favorable opportunity to perform this survey, because it is being implemented in Brazil, what allows the data survey to comprise the national territory.

**1. Introduction:** Accessibility and usability are terms which add quality to a product or service in the digital scope (CASARE *et al.*, 2016). The usability is considered a decisive factor to the services success (FLÁVIAN *et al.*, 2004) and the low level of this attribute entails time loss, demotivation and frustration to the user (CEAPARU *et al.*, 2004).

# The accessibility is related to the harmony between information and communication in relation to the individual needs and preferences (NEVILE, 2008 *apud* CUSIN, 2010). When it is applied, it becomes a democratizing factor by satisfying the majority of users and giving equal opportunities to everyone (CUSIN,2010).

The usability is identified as an important factor to agriculture (NUTHALL *et al.*, 2005 *apud* NIKKILÄ *et al.*, 2010; HAYMANAD *et al.,* 2012 *apud* NIKKILÄ *et al.*, 2010). The poor presence of this attribute in agricultural software may result in low usage adhesion, the users difficulties are noticed, principally, through non intuitive or complex interfaces, and those interfaces with an amount of resources which are bigger than the amount used by the farmer (PARKER *et al.*,1997 *apud* NIKKILÄ *et al.*, 2010). In relation to Precision Farming, usefulness and facility of use are key aspects considered in the adoption of applications, as long as they do not bring substantial increasing to the production costs (PIERPAOLI *et al.* 2013). The evaluation of the Precision Farming new devices usability is needed in order to meet the requirements of the users (HAAPALA *et al.*, 2006).

Researches have shown that the internet access among farmers has increased. Between 2009 and 2010, 30% of the Brazilian farmers were used to accessing the internet; in the period between 2013 and 2014 this rate rose to 39%. Regarding the access way, 71% occurs through computer, 19% through smartphone, 7% through common cell phone and 4% through tablet (ABMRA, 2013).

Above, it was remarked the usability and accessibility importance to agriculture. The development of this study has been driven by the need of eliciting the technology situation in the rural areas, specifically regarding usability and accessibility.

In forward studies it is aimed to compare the survey data with the result of usability and accessibility tests performed by using the Environmental Rural Register. It is an electronic register, defined by the Brazilian government through the law 12.651/12, being this registering mandatory to every rural property owner. It aims to form a database to control, monitor and fight the Brazilian native vegetation deforestation, and it is also designated to operate as an economical and environmental planning tool of the rural properties. The Environmental Rural Register uses the Environmental Rural Register National System to achieve its goals, that is a system which has the function of receiving, managing and integrating the ERR data.

The systematic review has made possible to analyze, evaluate and interpret relevant studies concerning a research matter (PAZ; POW-SANG, 2016). In this study it is proposed the systematic review application by using a method sourced from guidelines pointed by Brereton *et al.*(2007), Kitchenham (2014) e Pagani *et al.*(2015).

**1.1 OBJECTIVES:** The objective of this study is performing a bibliographic review regarding software accessibility and usability, preferably turned to agricultural and web strand. It is sought finding information such as art state, measurement techniques, users difficulties, benefits on the application of these concepts, employed tools, solutions to possible problems found, means to access software, and the most used agricultural softwares indication.

Prospectively it is expected to use this study results to evaluate the Environmental Rural Register National System and verify if the scenario presented by this systematic review is compatible with the scenario presented by rural property owners from Brazil.

This work consists in seven sections. Besides this introductory section, the Section 2 presents accessibility and usability concepts and evaluation means. The Section 3 includes related works. The Section 4 presents the steps, planning and the systematic review execution. The Section 5 exposes the related studies and answers to the research questions. The Section 6 exposes the results. Finally, there is the Section 7 which presents conclusions and further researches.

**2. THEORETICAL FRAMEWORK**

**2.1. USABILITY:** Nielsen (1993 *apud* BARBOSA *et al.*, 2010), defines usability as a set of factors directed to qualify how well a person is able to interact with a system. The author considers as usability factors the learning and recalling facility, efficiency, safety of use and satisfaction.

Preece (1994) refers to usability as a measure of the facility provided by a system regarding its learning or use. Holland *et al.* (2012) defend that usability refers to the facility with which the users are able to use a system to an intended purpose.

According to ISSO/IEC 9126 (1991), the usability consists of a set of attributes related to the demand of effort on the use of an interactive system, and the individual evaluation made by a specific group of users.

The ISO/TR 16982 (2002) cites as usability evaluation methods, questionnaires, interviews, project techniques, participatory evaluation, or methods which involve the final users.

**2.2 ACCESSIBILITY:** The ABNT (Brazilian Technical Standards Association) (2004) defines accessibility as a condition to the use of real estates, services, systems, means of communication and information, with safety and autonomy, complete or assisted, by a person with disability.

The web accessibility has as objective allowing users, with or without disabilities, to have a democratic access to information (W3C, 2008). And, in order to guarantee if a page is accessible, it’s needed the use of automatic validation methods along with the human evaluation, besides being important to identify which users will perform the access and their respective disabilities. Few websites have accessible structure and content to all kinds of users, thus the adaptation of those websites is able to build an egalitarian environment (Carmen *et al.,* 2015).

Besides bringing benefits to disabled people, the web accessibility also assists users who have difficulties to interact with the internet and depend on resources which are able to ease the access to these tools (ROCHA *et al.,* 2012). The elderly, for instance, are a public which is susceptible to the reduction of their abilities over the years (Cusin, 2010).

There are standards to provide accessible design and methods to evaluate the accessibility, directed principally to web content (TANAKA, 2010). According to Baazem, et al. (2015), the accessibility evaluation regarding web is performed through the use of one, or a combination of the methods: automated verification tools, manual evaluation made by specialists, users’ tests, surveys aiming to identify reasons behind inaccessibility problems.

In order to obtain an effective evaluation, methods performed by accessibility expert valuers, website evaluation performed alongside with disabled people, and the use of evaluation tools, are needed (HENRY, 2006 apud ROCHA et al., 2012).

**3. RELATED WORKS:** Paz *et al.*, (2016) applied the systematic review process in order to determine current trends on the use of usability evaluation methods to software development processes. The software categories frequently related in usability tests and the techniques employed by software category were presented. The study was motivated due to the existence of a wide range of techniques used to measure usability, which, on account of its volume, hampers the choice of the most appropriate method to a certain scenario.

It was inferred that the most used techniques according to the literature are the questionnaire, the user’s test, the heuristic evaluations, the interviews and the aloud thinking.

Garcés *et al.* (2017) performed systematic mapping about the art state of models and quality attributes, relevant to the Assisted Life Environment domain, ALE. It was also approached how these attributes were defined, evaluated and used. The study was motivated by the lack of an overarching analysis related to quality guarantee of these systems.

Among the identified quality attributes are present the usability, learning facility, user aesthetic interface, and accessibility. The authors remark that the ALE systems interface is directed to three different kinds of users: The assisted people, medical and maintenance staff. When the elderly are the public to which the system is directed, the learning facility becomes even more important. The accessibility is especially desired in anticipatory interfaces, which are the mandatory kind on ALE systems, and it is destined to provide direct contact with relatives and healthcare professionals in emergency situations.

The study inferred that there is a necessity of major engagement from the interested parts in the ALE systems development. It is approached the importance of developing a model able to define quality attributes, considerate its variability according to the assisted life environment domain, analyze the dependence among the attributes, offer indicators and measures to perform measurement, and offer means to evaluate and predict the quality of ALE systems.

Fernandez *et al.*, (2011), developed systematic mapping for surveying the usability evaluation methods used by researchers on the evaluation of web applications in the last 14 years. The motive of the research arose due to the fact that the applications developed not always fulfill the usability expectations of the customers, despite the existence of methods to survey the usability.

Approximately 39% of the analyzed studies used specific evaluation methods designated to web. The User’s Test is the most used method, applied to 59% of the studies. Among the subtypes of the user’s tests which were identified, it is highlighted the Aloud Thinking Protocol, Interviews, Performance Measurement, Log Analysis, and Remote Test.

The inspection methods were applied to 43% of the analyzed studies, and it is highlighted among them the Heuristic Evaluation, Cognitive Course, Inspection Based on Perspective, and Guidelines Review. Inquiry Methods were present in 35% of the articles, and the Analytical Modeling, in 21%.

About 90% of the studies applied evaluations during the implementation phase of web development, and since it is the most expensive phase to perform changes, the evaluations were usually performed in a unique step of the application development. It was also noticed that the usability evaluation methods are based on different concepts, therefore they might not evaluate the same aspects, and this characteristic turns the comparison among them into a complex task.

The majority of the methods were projected to generate a list of usability problems, however this list does not include guidance about how they may be fixed. The studies with a broader scope are scarce, most of them analyze a specific study, and therefore there were no results which were able to be generalized for a vertical domain of the web.

There is a scarcity of methods specifically created to the web domain and which may be applied on the initial stage of the development, thus the automated methods are emphasized. The automation may reduce efforts and resources, however it does not consider the perceptions and condition of the user and this is a disadvantage. The authors suggest the methods to be applied in a combined form in order to provide better results and consider as many usability dimensions as possible.

**4. USABILITY AND ACCESSIBILITY IN AGRICULTURAL SOFTWARE: A SYSTEMATIC REVIEW:** Systematic approaches of literature review have appeared due to the necessity of locating, evaluating and adding results from a number of empirical studies related to a specific topic of interest. This necessity has been approached in many areas, including: clinical medicine, social policy, education and information (SACKETT *et al.*, 2000).

It may be defined as a research method used to identify, evaluate and synthetize substantial studies about a specific subject. As a result, it is aimed finding evidences about specific questions of a research or gaps which need definition (DYBA *et al.*, 2005).

**4.1 ADOPTED SYSTEMATIC REVIEW METHOD:** The systematic review method approached in this work is based on Brereton *et al.*(2007), Kitchenham (2014) and Pagani *et al.*(2015) studies, being the biggest part of the process based on Pagani *et al.*(2015).

The contributions of Brereton *et al.*(2007) and Kitchenham (2014) are related to the process documentation which has occurred with the elaboration of the Review Protocol document. The application of the Kitchenham (2014) study takes place, specifically, on the Review Protocol content making. The Figure 1 identifies in a sequential arrangement the review process steps applied to this research, as well as the study from which the step was harvested.

In the first step are specified the research questions and defined the data to be extracted (BRERETON *et al.*, 2007). The second step consists of the exploration of databases by using key-words, and its main goal is evaluating and testing the terms adhesion to the available filters (PAGANI *et al*., 2015). In the third step are defined the combination of keywords with substantial databases (PAGANI *et al.*, 2015).

The fourth step has a documental aspect, and by means of the Review Protocol creation is defined how the process will occur, as well as the conditions required to its execution. This document has to be constantly reviewed, just as the changes have to be controlled through versioning (BRERETON *et al.*, 2007). In the fifth step the protocol has to be approved by an external member of the development team (BRERETON *et al.*, 2007); doctoral students, for instance, must present the protocol to their supervisors (KITCHENHAM, 2004).

The review is executed in the sixth step, in which the data have to be exported to a reference manager (PAGANI *et al.*, 2015). The seventh step performs the studies filtering procedure, by eliminating duplicated data or articles which do not belong to the designated area; to this end the title, the abstract and the keywords are examined (PAGANI *et al.*, 2015). Subsequently, in the eighth step, it is calculated the relevance of each study through the application of the InOrdinatio method, proposed by Pagani *et al.* (2015). The ninth step generates a ranking of the most relevant works (PAGANI *et al.*, 2015).

In the end of the process, there are the tenth and eleventh steps, which are responsible for performing the search for the complete version of the documents, and the final reading by obeying the InOrdinatio order (PAGANI *et al.*, 2015), respectively.

**4.2. SYSTEMATIC REVIEW PLANNING:** The systematic review planning starts in the first and it ends in the fourth step of the Systematic Review Process, which has been exposed in the Figure 1. As the final product, it is generated the Systematic Review Protocol document.

This document has to include the justification, research questions, studies search strategy, selection criteria definition, quality criteria definition, extraction strategy, data synthesis, and timeline elaboration (KITCHENHAM, 2004). Subsequently it will be shown the way each one of these requirements has been developed in this work.

**4.1.1. JUSTIFICATION AND RESEARCH QUESTIONS:** The systematic review has been developed to perform survey about usability and accessibility, emphasizing the web and agricultural domain. The Table 3 presents the defined research questions, and this activity corresponds to the first step of the systematic review process. The development of these questions has taken place by basing itself on the observation of other studies regarding Systematic Review, some of them being Fernandez (2008), Fernandez et al.(2011) and Ribas et al. (2015).

**4.1.2. SEARCH STRATEGY:** In order to select databases, it has been considered notes in systematic review studies; more specifically Dyba *et al.* (2005), Brereton *et al.* (2009), Kitcheman *et al.* (2009), Pagani *et al.* (2015) and Ribas *et al.*(2015). It has been conducted exploratory research about 15 databases which were indicated in those studies cited above, which corresponds to the second step of the review process. As the result, 4 databases have been selected to the execution of the Systematic Review, all of which are in Table 2. This activity corresponds to the third step of the review process.

As well as the databases, it has been also conducted explanatory research in order to select the keywords. After the procedure execution, the defined keywords are: “Usability”, “Accessibility”, “Agriculture”, “Software”, “Farming”, and “Tillage”.

The searches have occurred after the combination of two or more keywords by using the logical operator “AND”; its details are shown in Table 3.

**4.1.3. SELECTION CRITERIA:** In order to take part of the review, the study, besides being returned by the search in the database, has to possess all the characteristics defined in Table 4.

**4.1.4. QUALITY CRITERIA:** It has been opted to use the MethodiOrdinatio, which was defined by Pagani *et al.* (2015), as a form of measuring quality. By calculating the InOrdinatio index, this method defines the scientific relevance of a publication. So that it is been used three criteria: impact factor, year of publication, and quotation amount. The variables present in the calculation may be extracted from a number of indexes, among which are JCR (*Journal Citation Reports*) and SJR (*Scientific Journal Rankings*). It was opted by the use of SJR because it analyzes both magazines and conferences publications.

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| The InOrdinatio calculation is done by using the formula (1):  *InOrdinatio* = (FI/1000) + FP \* [10- (Year of research – Year of publication)] + (∑ Quotation amount) | (1) |

Where: FI is the impact factor, FP is the weighting factor which varies from 1 to 10 and has to be provided by the researcher. Year of research is the year in which the research was developed, Year of publication is the year in which the research was published, and ∑Quotation amount is how many times the article was quoted. The needed values to fill the calculation variables have been extracted from the SJR index. The Figure 2 presents an example of the InOrdinatio index calculation.

**4.1.5. EXTRACTION AND DATA SYNTHESIS:** In order to perform the selection of primary studies, it has been read the title, abstract, keywords and conclusion, and after the selected studies has been thoroughly read. It has not been applied any specific technique to synthetize the data.

**4.1.6. TIMELINE:** The development timeline of the systematic review is detailed in Table 5.

After surveying the results from the steps 4.1.1 to 4.1.6 it has been made the Review Protocol, and such activity corresponds to the fourth step of the adopted review process. Its validation, fifth step of the adopted review process, has been executed by an external member.

**4.2. SYSTEMATIC REVIEW EXECUTION:** The studies collection, sixth step of the adopted review process, has occurred by using the Zotero reference manager (HARDING, 2014.). It has been obtained a total of 6.577 studies as a result.

Subsequently, the seventh step of the adopted review process, it has been performed the results filtering by eliminating duplicated studies as well as those which are not related to the research topic. The outcome has been 28 out of 4.975 studies, which have been selected to be completely read.

Based on Queirós *et al.* (2015), the resulting studies have been grouped by subject, being the first group related to Review and Surveys in the Accessibility and Usability area, the second being related to Tools which provide Usability and Accessibility, and the third group being related to Accessibility and Usability Initiatives in Agriculture. More details about the source of the articles may be observed on Figure 3.

The MethodiOrdinatio calculation needed data were surveyed by using the SJR index, which corresponds to the eighth step of the adopted review process. It has been applied the InOrdinatio significance calculation and it has been generated the ranking of the studies reading order as a product, corresponding to the ninth step of the adopted review process.

It has been performed the acquisition and complete reading of the 28 selected studies to end the process, corresponding to the tenth and eleventh steps of the adopted systematic review process.

# **5. SELECTED STUDIES AND ANSWERS TO THE RESEARCH QUESTIONS:** The Table 6 brings the description of the 28 selected studies, which are organized by group. Primarily, 9 studies belonging to group 3, Accessibility and Usability Initiatives in Agriculture, are presented, followed by the 11 studies belonging to group 2, Tools to provide Usability and Accessibility, and finally are presented the 8 studies belonging to group 1, Reviews and Surveys in the Accessibility and Usability Area.

**QUESTION 1 – Is there any indication of the problems caused by the lack of usability and accessibility? Are there problems specifically cited to the agricultural domain? Is the device used to access the software portrayed?**

The most substantial indications related to problems are listed in the Table 7. The pointed problems to the agricultural domain are specified in the problem description.

Table 7 – Problems related to usability and accessibility

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| **Study: KrishiPustak: a social network system directed to low-literate farmers (MEDHI THIES *et al.* - 2015)** |
| **Problems:** |
| - Internet high cost and the bandwidth hamper the online participation.  - Audio output applied to graphic and Touch Screen systems do not foster relevant impact to low-literate farmers.  - Information which is not consolidated in the same screen foster less use facility to the farmers.  - Photographs or abstract icons are less well understood than images including hand drawing representations.  - Illiterate publics have difficulty to read and comprehend numerical digits. However, these characters are well accepted by the low-literate public.  - Numerical passwords might cause difficulties to low-literate users.  - There is a necessity of using non-textual resources to users who are unable to read texts.  - Nonlinear navigation structures reduce the user performance. |
| **Study: Cross-platform of user interface applied to agricultural sector (ŠIMEK; VANĚK; PAVLÍK, 2014)** |
| **Problems:** |
| - Unconsolidated information annoys the users. |
| **Study: Usability of UX Methods in the Agricultural Sector – Verification (ŠIMEK; VANĚK; PAVLÍK, 2015)** |
| **Problems:** |
| - Traditional graphics may be commented by final users. Nevertheless it is a common and expected practice among the majority of final users. |
| **Study: A Hindi language recognizer directed to search of agricultural video (BALI *et al.*, 2013)** |
| **Problems:** |
| - Aplicativo para reconhecimento de voz apresentaram níveis mais baixos de precisão e aceitação por parte das agricultoras do que dos agricultores.  - The application used to language recognition presented lower level of accuracy and acceptance to women farmers than men farmers. |
| **Study: Relation among Input Gadgets Usability of Computing Technology and the Rural development in India (GUPTA, 2012)** |
| **Problems:** |
| - The data input through keyboard was considered a hindrance to farmers.  - It is necessary to reduce the use effort of input devices in order to increase the life standard of rural areas residents.  - Farmers reported difficulty in finding the web portal homepage when the link was placed in the system logo.  - Difficulty in distinguishing the interface elements.  - By proposing that the farmers performed an action and subsequently undid the same action, it was noticed that they wanted the undo button to be in the same position as the button which executed the action.  - Any input device in rural area demands bigger effort to be used, which results in less usability.  - The Touch Screen use provides more use facility to unskilled people.  - The most common reasons to failure are occasioned by visibility problems. |
| **Study: Introduction to PEGI: A usability process for practical evaluation of Geographical Information (BROWN; SHARPLES; HARDING, 2013)** |
| **Problems:** |
| - Traditional usability heuristics are not appropriated to evaluate Geographical Information.  - Application presenting translation failure.  - Lack of information about the last data update.  - Lack of clarification about abbreviations used in the documentation.  - Inconsistent technical terms, the same technical term has received more than one related technical term.  - Difficulties to represent geographical information when the available layers granularity is fewer than 4.  - Product presenting complex appearance.  - Inappropriate description to cartographic physical characteristics.  - Non-intuitive symbology.  - Differences between the terminology used on the product and the user guide.  - Difficulty to download files which refer to certain geographic region.  - Use of abbreviation in the names of files entailed the users to consult the user guide constantly.  - Traditionally, usability concentrates just on interface, disregarding the data usability. Among the unwanted results coming from this scenario, well projected data presented in a low usability interface, or appropriate interface with low usability data, are examples.  - The Geographical Information designers have minimum control about the interface matters because the various Geographical Information Systems which will present and manipulate these information have different interfaces.  - The wide range of kinds of users is a challenge to the Geographical Information conception. |

Source: Own authorship.

As access devices were pointed the tablets, mobile phones and mobile devices. There were studies which do not specified the device, however they indicated that the access was made through web system.

**QUESTION 2 – What are the initiatives, evaluation methods or indicated products to provide usability and accessibility to software? What are the limitations? Are they specific to the agricultural domain? Who is conducting these initiatives?**

The initiatives, as well as their respective controllers, are in Table 8.

Table 8 – Existent initiatives in usability and accessibility areas and their controllers.

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| **Existent initiatives in usability and accessibility areas and their controllers** |
| **Initiative: Web Content Accessibility Guidelines, WCAG**  **Controller: W3C.** |
| They approach the web content and are used by developers, authoring tools, and accessibility evaluation tools (W3C, 2016).  They were developed in order to create a unique shared pattern to web content accessibility. The guidelines are organized around 4 characteristics, which determine that the interface elements have to be noticeable, operable, comprehensible and robust. Supposing that any of these characteristics is not present, disabled users will be prevented to use the web. The guidelines are written in the form of testable declarations and they do not rely on a specific technology (W3C, 2014). |
| **Initiative: Nielsen Heuristics.**  **Controller: Nielsen Norman.** |
| There are countless lists of heuristic evaluation which may be used, nonetheless it is constant the quotation of the Nielsen Heuristics (1195). They are ten usability general rules: system status visibility, compatibility with the real world, user control and freedom, consistence and patterns, errors prevention, recognition instead of recalling, flexibility and use efficiency, minimalist design aesthetic, support to recognition and errors fixing, documentation and user help system (NIELSEN, 1995). |
| **Initiative: User Agents Accessibility Guidelines, UAAG.**  **Controller: W3C** |
| They show how to make the user agents accessible to disables people. The agent users include browsers, browser extensions, media players, readers, and other applications which process web content (W3C, 2016). |
| **Process of Practical Evaluation of Geographical Information, PEGI.**  **Controller: Study of BROWN; SHARPLES; HARDING (2012).** |
| The Process of Practical Evaluation of Geographical Information, PEGI, consist of usability evaluation methods, which were modified to the use with Geographical Information. Its development occurred because the nature of these information, includes characteristics which make usability evaluation traditional methods to become inefficient or inappropriate (PEGI / BROWN; SHARPLES; HARDING, 2013). |

Source: Own authorship.

The accessibility and usability evaluation methods are listed in the Table 9. In the studies, it was noticed that usability and accessibility were measured collectively, and it was not specified from which strand the results derived.

It was indicated as the most used web accessibility tests, the automated ones, user’s tests, tests of specialists, or a combination of them (BAAZEEM; AL-KHALIFA, 2015). In the usability strand are indicated as the most used tests: questionnaire, user test, heuristic evaluation, interview, and aloud thinking protocol (PAZ *et al.*, 2016).

Some studies approached the development of new methods and products to evaluate accessibility and usability, which have been described in Table 10.

By examining the number of problems indicated in each evaluation method, it was realized the importance of examining a scenario with more than one method. It was verified that by performing more than one test in a specific scenario, the usability tests reliability is increased. Experiments verified that scenarios in which only one usability test was applied, would have as a product the reduction from 19% to 25% in the amount of identified usability problems (BROWN; SHARPLES; HARDING, 2013).

In order to finish the answers in the Question 3, the tools limitations are presented in the Table 11.

**QUESTION 3 - Are there registers about the benefits of accessibility and usability application? Are indicated measurement means to these attributes?**

There are registers indicating improvements in software, although they are not specified, however, studies directed to specific problems were presented, for instance the reading difficulty due to low literacy level.

In relation to the means of measuring usability and accessibility, two studies, Camenar *et al.* (2015) and Dias *et al.* (2014), indicate means of measuring how much the usability and accessibility attributes are applied to a system, nevertheless none of them are specific on agricultural domain. Camenar *et al.*(2015) generates ranking of accessibility problems by basing on benefits that the correction of them would bring to the system. Dias et. al., (2014) develops a questionnaire to evaluate the usability and accessibility in web systems in order to support the measurement of needed effort to the improvement of a system.

**6. RESULTS:** Among the resulting studies 62% of them were sourced from conferences (Figure 4). The total of selected studies was 28, being 8 of them from agricultural area, remarking the necessity of more researches. These 8 researches diverge in relation to the approached kinds of users, for instance, farmers, students from rural areas, rural tourists, among others, were cited.

The systematic review allowed the survey about some of the difficulties of users. It was inferred that the most common reasons behind the failures, occur because of interface visibility problems. Among the generalized difficulties in systems, it is taken by example the interfaces with complex appearance, lack of usability on the data composing the interface, information presented in a unconsolidated manner, nonlinear navigation structures, translation failures and inadequacy, and inconsistence among the terms used in the software and documentation.

Tests performed specifically with farmers have shown that they have found problems to return to the system homepage when the link was placed in a logo, moreover the farmers desired that the do and undo button to be found in the same place in the system. In the agricultural strand, any input device demands more effort to be used, the keyboard, for instance, is considered a hindrance, what makes the touch screens an alternative to the problem. Regarding the infrastructure, it is approached the internet cost and the bandwidth. As access devices were pointed mobile devices and it was mentioned the web systems use.

Among the initiatives, which aim providing usability and accessibility, were indicated the WCAG recommendations, the Nielsen Heuristics, the User Agent Accessibility Guidelines, and the Process of Practical Evaluation of Geographic Information. The most cited accessibility tests are the automated ones, user’s tests, and specialists’ tests. In relation to usability it is indicated the questionnaires, user’s tests, heuristic evaluation, interview, and aloud thinking protocol. It is recommended allying the use of manual and automatic tests.

In order to measure the accessibility and usability there were initiatives directed to generate a ranking of the problems, based on the benefit which the correction of them would bring to the system, and it was also approached the correction effort. Among the limitations of the tools, it is remarked the qualitative nature of the tests, the measurement of how much the usability and accessibility attributes are applied to systems, the impossibility of identifying serious problems rather than the trivial, and the fact that the heuristic evaluations are not appropriate to evaluate geographical information.

**6.1. THREATS TO THE REVIEW VALIDATION:** The main identified threats to the validation of this systematic review study are specified below:

- *Publication results:* it refers to the fact that positive aspects are more likely to be published than the negative ones. The negative results take more time to be published, or are quoted in less extensive publications (KEELE, 2007). In order to alleviate the problem, the research questions have been defined based on other studies of the area, however the present research might be affected by the fact that only the studies published in magazines and conferences have been considered.

*- Absence of important previous studies:* despite the planned measures used to obtain the most relevant studies, it is possible that primary studies have been lost. In order to alleviate threats, the studies search has been applied to the studies indicated in the Reference Section of the 28 studies resulting from the systematic review.

*- Selection of primary studies:* aiming to guarantee the effectiveness in the studies selection, it has been made the Review Protocol document which allowed the guidelines to the execution of the systematic review to be determined; in spite of that, failures in the first phase might have occurred, due to the lack of information in the title, abstract or keywords of the studies.

*- Inaccuracy in data extraction and improper classification:* it refers to the form which the data have been extracted to answer the questions. There might have occurred failures in this step because not all the information fit precisely on the matter.

**7. CONCLUSIONS AND PROSPECTIVE WORKS:** By considering the systematic review results, it has been identified the necessity of creating application and evaluation methods directed to accessibility and usability in agricultural software, due to the scarcity both of the studies in the area, and the identification of difficulties of these users.

Furthermore, it has been noticed that the studies, regardless of the fact that they have been developed to the agricultural area, cited problems, however they rarely indicated solutions, qualitative measurement means, and the impact that such corrections could bring to the system. From these notes, it is proposed as a prospective work the accessibility and usability analyses of the Environmental Rural Register National System application, in order to verify whether the scenario produced by Brazilian rural property owners is the same of the one presented by the current systematic review.