A Framework to Evaluate the Quality in Use of a System from Socio-technical Questions

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ABSTRACT

The definition of quality objectives for business processes of a proposed system and the specification of responsibilities among the stakeholders (professionals, users and organizations) are basic requirements for the success of such system. A framework is being proposed to guide stakeholders to evaluate the defined quality by applying ISO standards. User Experience ISO standards suggested in this framework were obtained from a socio-technical analysis of scenarios related to Digital TV systems. The Framework can be used in any process of socio-technical evaluation of an interactive system. Specifically, evaluators should apply the technical inspection of products or processes using the ISO standards suggested.

Keywords: *Usability Standards, Quality in Use, User Experience, Socio-Technical Evaluation.*

1. INTRODUCTION

Brazilian organizations have struggled to improve its software processes based on quality models, as verified in [1]. They are also interested in the adoption of new interaction design practices in order to improve the quality in use of their products [2]. Several organizations adopt ISO (International Organizational for Standardization) standards aiming at standardizing their products and services so they are easily accepted [3]. A standard is usually made of practices, guidelines or activities that describe what is required (in the case of ISO TR 18529) or suggested (in the case of ISO 9241) to achieve the defined technical objectives.

The choice of an ISO standard is always a challenging process for the professionals involved with the quality of products under development. It requires the clear definition of quality objectives to be achieved, the identification of which category to focus on (such as: on the product, process) and the specification of responsibilities among the stakeholders. Such process is even more complicated when several organizations are responsible for developing and deployment an innovative system – as in the case of a Digital TV system. One could assume that if each stakeholder (such as professional, software development organization, broadcasting organization, etc.) ensured the quality of their responsibilities in isolation, then it would be enough to ensure the quality of the information system. But this is not true for a system with features still unknown. That is, the full technical operation of the system requires the coordinated and successful implementation of the responsibilities of each stakeholder involved with the processes of operation, production, transmission and access to the TV services. In addition, the ownership of the system by users is done according to the construction and social dynamics, which are difficult to be successful if there are any impediments in any process of this chain.

Therefore consider a situation in which an organization involved in the value chain of a Digital TV system is interested in the implementation of a project for the quality in use of such system. We emphasize the need of professionals within this organization to know both their responsibilities and those of other stakeholders involved in several business processes of this system. In this text, a Business Process has repetitive tasks executed in a logic sequence (flows), providing results with business value for the customer and/or user. A task refers to the responsibility of stakeholders involved in the value chain of the system. Examples of processes for a Digital TV system are: production of a TV service and production of content. We also emphasize that a project for quality in use must include the application of ISO standards that affect the user experience with the system being developed (called here UX ISO standards). According to ISO 9241-11, User Experience (also known by the acronym of UX) can be defined as the "person's perceptions and responses that result from the use or anticipated use of a product, system or service".

Particularly, the investigation aspect in this work is: how UX ISO standards must be organized so that stakeholders involved in the integrated processes of an interactive

Digital TV system are able to identify the standard(s) to be applied when evaluating their works (such as product or a process)? In this text, we describe a framework that presents ISO standards associated with quality categories and with stakeholders taking a generic value chain of TV systems as starting point.

To create this framework, the authors followed a methodological approach in which they have defined the responsibilities of the stakeholders for the different and integrated business processes of such system. The results pointed to a set of UX ISO standards suggested to be used in any Digital TV system.

The main contribution of this article refers to the contextualization of standards with quality categories covering a socio-technical viewpoint of a Digital TV system. Such organization helped the authors in the identification of technical, social and environmental questions, which impact the quality in use of this system. It has also helped in conducting the analysis of related works.

This article is organized in the following manner. The next section presents the categories for quality in use. The third section presents the stakeholders of a Digital TV system. In the fourth section, we present the framework and then the methodological approach. Before concluding, the related works and the UX ISO standards are described.

2. NOTION OF QUALITY IN USE

Obtaining ISO certification configures a form of business organization, guiding it in controlling the processes that must be executed in a systematic manner and avoiding that non-conformities happen repeatedly. Organizations are configured to have a greater appreciation for their customers when applying quality models that help in the development of products that lead to customer satisfaction. Several approaches to control software quality in use have ISO standards related to UX with the software as a starting point. However, researches do not present ways to identify these standards from a value chain that governs business processes of one or more organizations. In this work we use the quality categories defined in [4] to identify the standards to be considered in the integrated business processes of an interactive Digital TV system. According to [4], ISO standards are organized in four categories: Operation, Product, Process and Organizational Capability (see Figure 1):
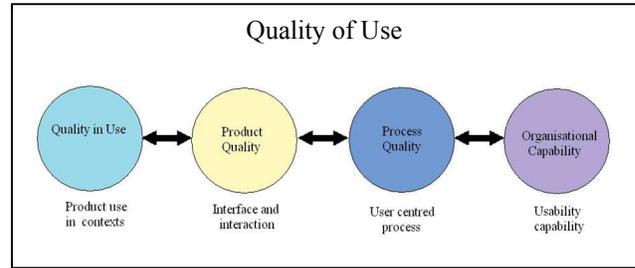

Fig. 1. Categories of Quality in Use

ISO standards for operation define ways to handle products, in the best way possible, aiming to guarantee the UX with a product.

ISO standards for products verify the capability of a product to provide functions that satisfy needs of a user, to maintain the specified level of performance, to be attractive to this user, etc. The quality of product addresses topics that concern the interaction quality [4], such as nature and language of the interaction, user experiences, adaptive systems, intention of use, etc.

ISO standards for process certify a project cycle according to standards established by the ISO. The quality process addresses practices that concern the quality of software processes [4], such as user-centered design (UCD), which describes what must be done to represent and include users in the system design.

ISO standards for organizational capability deal with communications, new work paradigms, such as organizational culture and quality management.

In this text, the notion of quality in use includes the verification of quality in use, quality of product, quality of process as well as the organizational capability (specifically usability maturity) of a set of integrated processes that provide common understanding of a business.

3. DIGITAL TV SYSTEM

3.1 Brazilian Context

Television is an important means of communication in Brazil, considering its scope and social influence in the entire society. According to a survey done in 2007, 98% of the Brazilian population has a TV set in their homes, but only 24% have computers and 17% have access to the Internet [5], therefore to bring interactivity to TV is an

excellent way to promote digital and social inclusion. After some efforts that involved the Federal Government and several research groups to define the Brazilian Digital TV System (SBTVD) [6], the system was released in December 2007 and it is based on the Japanese standard, the Integrated Services Digital Broadcasting Terrestrial (ISDB-T). The established deadline for access to this technology in all Brazilian municipalities is 2016.

Until now there are no scenarios that consider the UX with TV interactive applications in a large scale. Such fact is caused by several issues (such as poor adhesion of the system by users, for lack of extremely interesting applications, limitation of coverage area, lack of definitions for interactivity, etc.). The solutions depend on the infrastructure of the city, the interest of the users and broadcasters, the created content, national congress, among others [7].

Considering this scenario, it is difficult to perform any verification of the quality in use of the SBTVD in Brazil. However there are some results came of the studies performed in Brazil about quality in use of the Digital TV system [8] and [9].

These studies made the authors of this paper to understand and define a generic solution to support the development and deployment of the Digital TV system by focusing on its UX quality.

3.2 A generic scenario to focus on the UX quality

In such solution a system can be composed of a set of applications that enable the creation of multimedia content through the Web and the reuse of contents available on the Web through RSS and visualization and interaction of this content through Digital TV. The combination of applications with contents composes the TV services, which can be used to enhance the education (S-Education), to enhance local information (S-Government), etc.

The stakeholders of this system can be professionals who work in an organization or the organization itself. They assume roles and have responsibilities with the development and deployment of the system. The value chain of the system can be the following: The Application Developer (professionals that work in software development companies) needs HCI professionals in order to make the applications easy to use, pleasant, etc. With the applications ready, Content Producers (such as users who work in local organizations, professionals who work in local broadcasters) are responsible to create the content for the applications. The broadcaster is responsible for the transmission of the integrated system of applications for the viewers through a TV channel. In each house, the Infra-structure Installer (for instance, professionals who work in the local Brazilian Telecom network company) tests the network structure in order to guarantee the return channel. Such return is supported by the Interactivity

provider (such as the Brazilian Telecom Association) and by the service providers (that can be the broadcaster or software companies).

Following, we present the methodology that enabled understanding the responsibilities of the stakeholders involved with the quality of the systems under analysis [8] and [9].

4. METHODOLOGY

4.1 Understanding the responsibilities of stakeholders

In order to have a systemic view of the responsibilities of stakeholders, it was initially necessary to identify the commitment of each stakeholder with quality. The agents (TV set installer, Interactivity Provider, Infra-structure Installer) generally involved with the technical aspects of the projects and with the structure to guarantee the return channel are responsible to guarantee the quality in use.

The categories to guarantee the user interaction with the product and guarantee the quality of the system development include the stakeholders responsible for making project artifacts, such as the application developer, the interface designer, and the content producer. The user is the target stakeholder in the quality in use category. If the user has an active role in the development process of a product (as input of requirements for the TV application, producer of content), the user also becomes a stakeholder in the quality of the product category.

In the organizational capability category, there are the stakeholders that guarantee the system sustainability, the interactive services on TV (they are: providers, broadcaster, software company and equipment manufacturers), as well as the legislators to establish regulations that influence the project as a whole.

From this understanding, it was possible to think about the responsibilities of stakeholders for the following business processes: definition of TV services; negotiation of these services; development of applications; design and production of contents; production of services from the integration of the developed applications and contents; transmission and execution of services; evaluation of applications and contents; design of artifacts (such as remote control); production, sales and recycling of artifacts; and consumer assistance. A business process was described from its business and quality objectives and from its operational flow, as previously mentioned.

Aiming to take a systemic view of the responsibilities of the stakeholders, one or more business processes, intended for use in an integrated way, were grouped and described through a scenario [10]. Stakeholders' tasks are associated to socio-technical factors, which positively influence the achievement of the objectives. Overall, 23 integrated scenarios were described [11]. Consider, for instance, the

following integrated scenario of production, transmission and operation of TV services in which technical, social and structural factors were considered: (1) a content producer stakeholder has the business responsibility to feed the system with useful and updated content (social factor); (2) the application developer who presents the content has the responsibility to allow the user to personalize content during interaction since this is a dynamic process (technical factor) and; (3) broadcasters with educational purposes have the right to transmit content (factor related to the necessary structure).

At the end of this step, we have noticed that each scenario may include one or more UX standards associated with the quality objectives of the integrated processes. For instance, if on the first item of the scenario previously described, the quality objective is that it must allow users with special needs to access a multimedia content, then this content must be produced according to an accessibility model (such as the Libras Law Nº 10.436 [12]).

4.2 Elaboration of the Framework

The elaborated framework contains the following components (Figure 2): categories of quality in use, its sub-categories and the main stakeholders of a Digital TV system, which have been previously associated to the categories. The sub-categories correspond to socio-technical factors that influence the interaction (such as: context, structure where the system will be used, the life style of users and the way to take ownership of the technology) or usability practices, which have resulted in laws and/or benefits for customers and/or users. The sub-categories have the following purposes:

- For the quality in use, they aim for the quality in the social world, in the environment and in the physical world, including the infrastructure needed in the city for the installation of a Digital TV system;

- To guarantee the quality of the product, they aim to appropriately describe the context of use of a product, the TV content and the language that will be designed to facilitate interaction with the TV;

- In the quality of process, they aim to guarantee the UCD and understand the context of use of the product that is being developed. The practices of this sub-category include: (i) contextual research to elicit the real needs of the stakeholders, such as: customers, users and providers; and (ii) elicit usability, content

and business requirements, mainly involving the community (such as viewer, application developer) and the market (such as partners and competitors); and

- Related to the organizational capability, it is important to mention that organizations, such as broadcasters and equipment manufacturers, must be qualified in the adoption of practices to ensure the legislative rights of viewers, thus performing their role with social responsibility. They must also develop sustainable projects aiming for the optimization of natural resources. The institutionalization of usability practices is also suggested. In addition, organizations that provide services, such as service and interactivity providers, must have quality in the services for customer assistance.

After the definition of this view of quality in use for Digital TV, there was a need to investigate socio-technical questions that each stakeholder should address.

4.3 Organization of the investigative questions

Table 1 illustrates some questions organized by categories and sub-categories of the framework used to analyze the responsibilities of the stakeholders involved in a business process for the production of an interaction device aiming for the quality of interaction with the Digital TV. Some questions were obtained from [13]. In the quality in use category, questions were raised about the inclusion of the Digital TV in a context of use. In the quality of the product category, questions were raised about the device design. In the quality of the process category, questions were related to the UCD practice. In the last category, questions were compromised with the environmental quality and with customer satisfaction after the use of the product intended to be developed. The questions raised in this table are not exhaustive, but they aim to illustrate the path to select the ISO standards.

4.4 Selection and Classification of ISO standards

The applied methodology for selection and classification was the following: Initially, there was the collection of the ISO standards. Most of the ISO standards were collected from articles, books and sites. In this work, we considered the ISO standards related to the categories in the proposed framework [11].
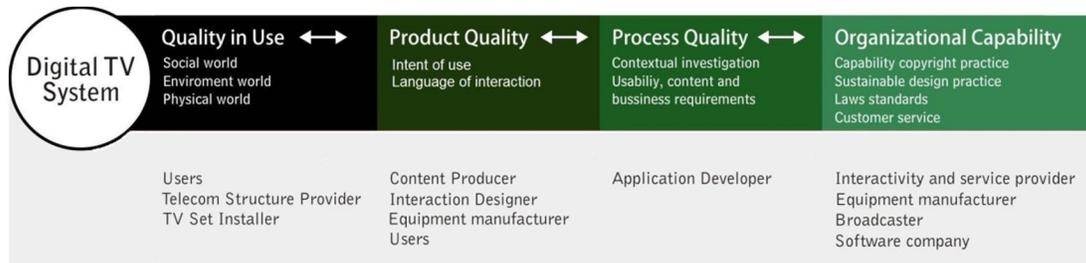
International Journal of Computer Science and Software Engineering (IJCSSE), Volume 2, Issue 1, November 2014
E. S. Furtado and D. B. Guimarães

46

Fig. 2. Framework for the quality of a Digital TV system

This table contains the following components: (i) the categories of quality (in the columns of the table); (ii) definition of the evaluation context (in the rows of the table), as regards the scope of the analysis for a particular value chain. To make this association, we thought like that, Q uality models related to other purposes, not with quality in use, were not considered. This was the case of the ISO 9001:2008 [14] that presents a systemic view of processes and is useful in managing any process in a company. Following, each identified ISO standard was classified according to the questions identified in the business processes. An ISO classified in a category means that it presented evidence that its information conform to the objective of the associated category (be it relative to the product, process or organization). An ISO classified for one or more stakeholders means that it presented evidence that it can reach the quality objective of the business processes with which the stakeholder(s) is(are) associated.

The collected list is not exhaustive because the authors had difficulties in accessing the standards, since in some cases, such as the ISO/AWI 23973, they have not yet been published.

There were also difficulties to make the categorization originated from inconsistency of information, ambiguity, and incompleteness. For space reasons, the ISO standards are not defined in this article and only those whose reference cannot be obtained on the site [4] will be referenced in this text.

5. RESULTS

Table 2 presents the result of the association of the stakeholders analyzed in 4.1 section with the collected ISO standards and classified in the four categories. Blank space in a cell of the table means that none of the studied ISO standards presented evidence to be considered in such a place.

This table contains the following components: (i) the categories of quality (in the columns of the table); (ii) definition of the evaluation context (in the rows of the table), as regards the scope of the analysis for a particular value chain. To make this association, we thought like that, "The evaluator may want to evaluate the quality in use of

the system, considering the responsibilities of some stakeholders, or certain business processes in this chain"; and (iii) the object of evaluation (at the intersection of a row and a column); the evaluator may refer to the expected result, the assessment instrument (in this text, ISO standards, but it could be requirements).

For the quality in use, the following usability standards were suggested: ISO 20282, ISO 9124-11, ISO / IEC 9126 and ISO / TS 16071.

ISO 20282 was suggested to guarantee the operation quality of the products with which users interact. The most important criteria of this ISO for this research refer to the context of use, in which environmental factors (such as time, the fact of being in a public space) can influence the quality of operation.

ISO 9124-11 and ISO / IEC 9126 were suggested aiming to guarantee the quality in use and the product quality, when validating the user satisfaction and verifying the accordance to standards in the created applications and content.

The ISO 9241-11 part includes guidance on how the Usability of a product can be specified and evaluated for office work and other situations.

Usability and UX are different concepts. According (ISO 9241-11:1998; ISO 9241-210), Usability is concerned with the "effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments" while UX is concerned with "all aspects of the user's experience when interacting with the product, service, environment or facility". In other words, Usability constructs can be considered subsets of the UX aspects.

The ISO standard 9241:210 defines User Experience as the "person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service". Complementing this concept is stated that it "includes all the users' emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviors and accomplishments that occur before, during and after use". Finally, this ISO standard affirms that UX "is a consequence of brand image, presentation, functionality, system performance, interactive behavior and assistive capabilities of the interactive system, the user's internal and physical state resulting from prior experiences, attitudes, skills and personality, and the context of use".

Table 1: Socio-technical questions related to the production of a new interaction device

Category/SubCategory	Investigative questions	Stakeholders Involved
Quality in use: Social World	What are the social impacts of a new interaction device?	Interaction Designer, Service and Interactivity Provider , Equipment Manufacturer , TV Set Installer
Environmental World	What are the implications for the environment with the production of new equipments?	
Physical World	How would the design of a new interaction physical device be for Digital TV?	
Product Quality: Intenções de uso	How could the user express his/her intention of use of the Digital TV through the design and/or interaction language?	User and Interaction Designer
Interaction Language	How would the interaction language be in a new device?	Interaction Designer
Quality of Process: Contextual Investigation	Will there be interest from the TV manufacturers in producing another device?	Equipment Manufacturer
Content Requirements	How the TV content can be manipulated with a new interaction device?	Content Producer, Application Developer, Interaction Designer
Usability Requirements	Which are the design principles of a new interaction device?	Equipment Manufacturer, Interaction Designer
Business Requirements	Is the development subject to regulation – existing standard? Can it create new needs for standardization?	Interaction Designer, Equipment Manufacturer
Organization Capability: Práticas de *Copyright*	Is there any legislation to control the quality of products produced by an organization?	Equipment Manufacturer
Self-sustainable design practice	Is it possible to construct and/or use a new technology maximizing the already existing resources? What are the implications for the environment to produce new devices?	Equipment Manufacturer, Telecom Structure Provider/ Installer
Customer Service	Is there a set of activities designed to enhance the level of customer (as the user) satisfaction?	Broadcaster, Equipment Manufacturer , Telecom Structure Provider/ Installer

In summary usability is more task-oriented, pragmatic, error-freeing paradigm and UX is more hedonic, self-oriented, emotional and holistic concept [21].

ISO/IEC 9126, parts 2 and 3, besides having the usability as a characteristic of the product quality, it also includes functionality, reliability, efficiency, maintainability and portability of the product. Therefore, this ISO was suggested to the interaction designer, application developer, content producer, service and interactivity provider and infrastructure installer stakeholders. Part 4 in this ISO defines a model for quality in use, which is useful for the Usability Evaluator stakeholder, who focuses on the user satisfaction and for the providers and TV installer stakeholders who are concerned with security and efficacy of the system.

ISO/TS 16071 was suggested to guarantee accessibility to disabled users in the Digital TV system. Such fact must be verified during the definition of the product interaction, which has direct implication on the quality in use. When the structure is not totally available, or it is not adapted to the user, the system becomes inaccessible.

Related to the quality of products, the suggested standards were: ISO 11581, ISO 15910, ISO 9126 and ISO / TS 16071. ISO 11581 and ISO 15910 were suggested aiming to facilitate the user interaction with the product.

Table 2: ISO associated to the Quality in Use categories

	Quality in Use	Product Quality	Process Quality	Organizational Caoability
Equipment Manufacturer	ISO 20282	ISO/TS 16071 ISO 15910	ISO 25062	ISO 1400 ISO 12119 ISO 18019
Application Developer	-	ISO/IEC 9126-2 ISO/IEC 9126-3	ISO 14598 ISO 25000	ISO 18529
Interaction Designer/ Usability Evaluator	ISO 9241-11 ISO/IEC 9126-4	ISO/IEC 9126-3 ISO/TS 16071 ISO 11581 ISO 15910	ISO 13407 ISO 25062 ISO 25000	-
Content Producer	-	ISO 9126-3	-	-
Service and Interactivity Provider	ISO/IEC 9126-4	ISO/IEC 9126-2 ISO/IEC 9126-3	ISO 25062	-
Telecom Structure Provider/ Installer	ISO/IEC 9126-4 ISO/TS 16071	ISO/IEC 9126-2 ISO/IEC 9126-3	ISO 25062	
TV Set Installer	ISO/IEC 9126-4 ISO/TS 16071	-	ISO 25062	-
Broadcaster	ISO/TS 16071	ISO/IEC 9126-3	ISO 25062	-

ISO 11581 facilitates the interaction between computer-aided applications, thus guaranteeing the coherence in the presentation and operation of icons. ISO 15910 specifies the process to create any kind of user documentation for software with user interfaces. This is useful for designers and equipment producers.

Usability standards that cover the activities of a software development process are: ISO 14598, ISO 25000, ISO 25062 and ISO 13407. ISO 14598 and ISO 25000 were suggested aiming to guarantee the quality of the evaluation process of applications under development. ISO 25062 [15] provides a standard method to communicate results from quality tests and particularly usability tests. It was suggested for the quality process and for all stakeholders involved in this type of test, aiming to support decision-making professionals in the delivery of software products, for instance, using data to help decision-making, such as: the description of a product, objectives of the test, numerical results. ISO 13407 supports UCD.

Related to the last category, the ISO standards suggested were: ISO 14000, ISO 12119, ISO 18019 and ISO 18529. ISO 14000 [15] was suggested aiming to guarantee the project sustainability, whose product must optimize the resources of the environment where it is inserted. This is the case, for instance, of the current analogical TV sets that will not be compatible with the current Digital TV system. This standard addresses the impacts caused by organizations in the environment.

ISO 12119 [14] and ISO 18019 were suggested to aid organizations in preparing standard documentation for their products. ISO 12119 establishes quality requirements, for instance, description of the product and instructions for software packages. ISO 18019 provides guidelines to elaborate documentation for software applications. ISO 18529 is responsible for the definition of activities that must compose an organizational maturity model in usability.

6. RELATED WORK

There are works in the literature aiming to guarantee the quality of TV services/products offered to users. Such works present specific focus. The work described in [17] presents the architecture components of a TV system and focuses on monitoring the quality of information that go through a data network (QoS). In [18], the authors analyze the quality in terms of the usefulness of the service and of the offered price. In [19], the focus is on the evaluation of usability of interfaces for TV considering user errors to access the information in the screen using remote control. [20] defends the quality of interfaces of TV applications using interface patterns. Despite several initiatives, they do not present the notion of quality in a holistic way. The work described in [22] presents stakeholders of a value chain for a Digital TV system using the Organizational Semiotics Artifact, called semiotic onion. The artifact is used to depict the relationship among stakeholders. However, there is no specification of where a stakeholder influences the quality of the other one.

These theoretical findings were also observed when analyzing the deployment of a recently inaugurated Digital TV system. The authors of this article have visited a broadcaster, the largest subsidiary in the country. This investigated broadcaster covers the entire chain of content production, editing and transmission, including assistance to the viewer. It was also learned that even though this broadcaster focuses in some aspects of quality, the work is done in an isolated manner, not considering the different stakeholders. The aspects identified related to the guarantee of the system in operation were: there are two systems for digital transmission (one only for backup) and the image, supposed to be received by the user, is previously monitored in several TV screens, including different sizes and manufacturers, with set-top boxes embedded and external to the TV. Concerning the quality of the content, there is a thorough work of synchronized integration of commercials and local information to the programming guide sent by the headquarters. The accessibility processing of the contents has not been made in the subsidiary broadcaster since the headquarters already covers the minimum necessary and required by the Libras Law. Concerning the organizational capability of the company, we have found that there was concern with the sustainable design of the system. The cooling of the transmission system is done using recycled water pumps, instead of traditional systems. However, the technicians reported that they receive daily several complaint messages from users about the new system and that they do not have a way to address them. When investigating

International Journal of Computer Science and Software Engineering (IJCSSE), Volume 2, Issue 1, November 2014
E. S. Furtado and D. B. Guimarães

49

about ISO standards of the processes, they reported that there is still no implementation of quality programs. It was also found that the headquarters is arranging to have its own team of software developers to explore interactivity resources. This presented situation deserves further research in the national context about the role of the broadcasters, the integration of responsibilities with those of other stakeholders and the importance given to users.

7. CONCLUSION

In this article, we have shown a methodological approach to aid in the identification of UX standards to be applied aiming for the quality in use of a Digital TV system. We believe in the generality of the presented results since the UX standards were classified according to the roles of the stakeholders, who are generally the same for any value chain of this system. However, following such approach for a specific system can give greater assurance of this statement.

The analysis of the existing works on the deployment of Digital TV leads the authors to make the following question: does the fact that the stakeholders know the ISO standards motivate them to apply these standards? A motivating factor is that applying quality models allows its followers to present to their customers evidences of the commitment with the quality of the offered services and/or products. A deeper study about the real intentions of use of stakeholders still deserves to be done. This work will also be extended to consider other laws and ABNT standards for the TV.

ACKNOWLEDGEMENTS

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