Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Computer Science 14 (2012) 189 – 197

Procedia Computer Science

4th International Conference on Software Development for Enhancing Accessibility and Fighting Info-exclusion (DSAI 2012)

User-Centered Healthcare Design

Joana Duarte[a], Arminda Guerra[b*]

[a]*Instituto Politécnico de Castelo Branco, Av.doEmpresário, Castelo Branco, 6000-767, Portugal*
[b]*Instituto Politécnico de Castelo Branco, Av.doEmpresário, Castelo Branco, 6000-767, Portugal*

Abstract

Information technologies in health care and its growing use and impact, is a subject of study and interest. This paper presents the work analysis, in progress, in a health center concerning information systems, technologies, employee's roles and real user needs. This study makes part of a research master's thesis in progress. The main goal is to understand users and employees behaviors, and how they interact using information systems and technologies to supply better patient services and sector efficiencies. The selected methodology to gather and analyze the data was Grounded Theory Method. The methods of data collection were interviews and observations. A case study was considered for data analysis and observation. The data analysis results, at this moment, provided information to start to define a set of principles to design a framework for clinical support to improve healthcare services.

Keywords: Work Analysis; Interaction design; Service Design; Information Systems; Technologies; User-centered design.

1. Introduction

The technology and its exponential growth is a reality in our society. Today, instead of what happened a few decades ago, the overwhelming majority of the population has direct contact with computers, internet, mobile phones, smartphones, PDAs and other technological tools that have been progressively improved. The offer is great and demand is within the desired parameters. The technology is embedded in several commercial areas and in virtually all sectors of provision of existing services. One of the areas over which lies particular interest is the health, an important sector for the population welfare where any error is too serious if happen. People life and well-being demand excellence. However, health care systems encompasses a huge amount of information that, when poorly managed, often proves to be harmful and even fatal. For this reason, and to fill some gaps, there is a need to develop support systems for health professionals, to organize information and to enable an exchange of secure and reliable information among various health professionals.

In this paper some guidelines for designing a clinical tool to support user-centered services is drafted based

* Arminda Guerra, email: aglopes@ipcb.pt.
Contact: 966226370.

1877-0509 © 2012 2012 The Authors. Published by Elsevier B.V. Selection and/or peer-review under responsibility of the Scientific Programme Committee of the 4th International Conference on Software Development for Enhancing Accessibility and Fighting Info-exclusion (DSAI 2012)
Open access under CC BY-NC-ND license. doi:10.1016/j.procs.2012.10.022

on information gathered, personal opinions and case studies. It will be possible to present some ideas and produce some interesting conclusions with a significant degree of accuracy. Conversely, it will be demystify the fact that technology per se is the solution to all the encountered problems. The positive aspects of technology are: it provides the platform for access to timely information by multiple people from multiple locations; it permits to view user center information to suit the needs of individuals and it adds value through decision support tools and work flow functionality to assist in the resolutions of health care situations. The main solution is to analyze problems' context in a conceptual view and then, bringing people, information and technology together to reach a common understanding.

2. Work Analysis and Interaction Design

This section presents some considerations about work analysis and interaction design. Different authors definitions and examples of use are stated. The importance of service design as a planning activity evolving people organization, infrastructures, and communications and material components of a service in order to improve its quality and the interaction between service provider and customers is considered. Finally, a style of working [1] with interaction design, the user-centered design approach will be tackled. The combination of Work analysis and Interaction Design in user interface design for healthcare systems has to adopt itself to diverse delivery media. Technology is changing human life and work contexts in numerous ways. These new ways of working demand for techniques and technologies that address contemporary issues related to communication, collaboration, problem solving and information seeking in large information spaces of great variability. To address this comprehensive problem, the interrelation between Work Analysis and Interaction Design must be understand to entailed in the design of technological support for modern, dynamic and complex work environments [2].

2.1. Work Analysis

Work Analysis relates to the analysis of work only in a wider perspective. Work Analysis involves looking at several different points of work simultaneously to arrive to detailed findings. The main objective is to identify potential proposals and requirements regarding the reorganization and restructuring. Katre et al. [3] join both activities based on that the analysis of human work combines the study of cognitive, physical, organizational, social and cultural and environmental factors. For them, the goal is the identification of the methods and techniques for human work analysis which will convey the interaction design.

2.2. Interaction Design

Searching literature, we do not find agreement within interaction design definitions and sometimes we find a mixture between it and work analysis. In a human computer interaction perspective and according Moggridge [4] the main problem with interaction design definitions results of its interdisciplinary roots. For him, it is connecting between people through the products they used.

The vast majority of authors believe that interaction design is based on the collection and analysis of experiments. Not only good but also experiences that failed, ideas and stories of success and failure. According to the perspective presented by Shedroff [5], the result of extensive work and analysis, interactivity is the prediction of all experiences. The arguments are the result of direct exchanges of information, without taking into account whether or not this is repetitive. Just in order to get results and to predict adverse situations before they happen. The truth is that every day, every hour, millions of people use technology for fun, to work, to communicate with each other or even to spend time. They all enjoy a good interaction design or a bad

experience in this regard. Interaction design is much more than designs something visually beautiful, pleasant, colorful and exciting. According to Saffer [1], interaction design covers some basic approaches that should be taken into account focusing on users, finding alternatives, using ideation and prototyping, collaborating and addressing constraints, creating appropriate solutions, drawing on a wide range of influences and incorporating emotions. Interaction design is one of the pillars of a good job. People's involvement is so vital and precious, which may prove the turning point of good work.

2.3. Service Design

Service design is all that focuses on making the developing service, usable, effective, desirable and efficient.

Moritz advocates that "Service Design helps to innovate (create new) or improve (existing) services, to make them more useful, usable, desirable for clients and efficient as well as effective for organizations." [6]

Service design can help identify potential problem areas and consequently to generate ideas and ways to improve it. It is also important because it enables the user to adjust the product. Service design is a strategic project that uses not only design techniques, but also research, customer interaction, design ideas, prototyping and testing.

In the development of a health system, it is not enough to do a brief collection of data and return with a functional program. The main goal is to understand the real needs of the healthcare collaborators: doctors, nurses and other services providers. It is crucial to realize their difficulties in relation to information and technology so that we can conceive something intuitive and easy to use within the parameters collected. The design, i.e. the planning and tasks is a key point, since the systems acceptance by health care professionals must fulfill their needs. They need to experience applications and services in a usability way. Conversely, the usefulness and aesthetic must motivate them for its use.

To develop an applications for health is to design a good and coherent project based on an intensive study of the market, considering the best and worst experiences, and considering the user's needs. Hence it is possible to arrive at conclusions with a high level of approval and reliability.

2.4. User-Centered Design

The user-centered design (UCD) point of view is to design the process, through the planning, design and development, based on information about the people who will use the product or service. Abras et al. [7] define it: "is a broad term to describe design processes in which end-users influence how a design takes shape." This approach will permit a deeper understanding of the psychological, organizational, social, and ergonomic factors that affect the use of computer technology in the health care center and it will have the involvement of the users (patients, employees and stakeholders) during the design and evaluation of the intended final framework. The involvement of users assures that the 'product' will be suitable for its intended purpose in the environment in which it will be used. This approach also leads to the development of products that are more effective, efficient, and safe.

Work analyses are a preliminary way to find historical basis for an efficient development. It is directly linked with interaction design. Interaction design is a specific form of work analysis. It permits to know real stories and to learn from them. These approaches led to develop a better service design framework.

3. Methodologies

The selected methodology for this research was Grounded Theory Method. Grounded Theory Method (GTM) was created by Glaser and Strauss [8], in 1965, while analyzing data for their research. Later, other researchers such as Corbin, Bryant and Charmaz [9] did different interpretations of that approach. GTM allows

developing a theoretical account while simultaneously grounding it in observations. Strauss and Corbin [10] proposed three stages in analysis in grounded theory: open coding, axial coding and selective coding. During open coding the researcher reads the text and asks questions to identify codes that are theoretical or analytical. Axial coding is used to relate categories to subcategories. It specifies the properties and dimensions of a category. According to Strauss and Corbin [10] axial coding answers questions such as 'when, where, why, who, how' and with what consequences. Selective coding involves the process of selecting and identifying the core category and systematically relating it to other categories. It involves validating the categories' relationships. The main goal of GTM is a constant comparison. Previously coded text also needs to be checked to see if the new codes created are relevant.

Methods used to collect data were centered in the qualitative study; a combination of research methods was used as a literature review, clinical interviews, observations, discussions with doctors and counselors, and patient interviews. The data was gathered from around 200 people, until de moment. Notes were written from observations, and interviews were video recorded. The conversations were transcribed preserving the context in which things were said and done. Later it is planned to interviews more people before the phase of theory generation either to validate the data or to complement it and arrive to data saturation.

Grounded Theory Method was chosen since it has been used, frequently, in healthcare study domains and conversely, because it gives guidelines and grounding than most approaches.

Another research method, a case study of a health centre was used. A case study serves to introduce the problem as a background place and to define the users. The case will guide to collect and analyse the data and to develop conclusions, recommendations and implications [11].

The data was, firstly, analysed using Zachman Ontology [12]. The goal of this study is to analyse the use and interactions among all the stakeholders involved in the health systems. And, the Zachman framework conducted the data collection framework facilitating to define the specific necessities and the encountered problems of the institution. After the first picture of the institution, data started to be organized and ideas emerged. So, the reason for Zachman [12] model was the necessity to frame and to classify the whole tools and documents in order to sort complex problems in information systems domain.

4. The case

The health center serves about 160 patients daily and employs over 30 employees with different backgrounds and specialties. According observations it was found (fig.1) that all general service centers operate on the basis of interaction between the user and the reception staff.

The patient enters the health center and the first procedure that follows is to remove a ticket. This contains all the information regarding the service order and time. The reception consists of a row of six separate service counters. After removing ticket, patient addresses the waiting room where there are interfaces that allow them to view services, queues, and tickets counter. Thus, it is ensured the attendance of all, as well as the expected time for each activity. The information, queries and other data is given by employees from computers. To know their place of care, patients have to pay attention to the monitors in the waiting room which give information through the corresponding service number and the counter. The call for specific queries is made by employees. There is no indication for time delay. The health center of this case study is relatively recent. The installations are new. It was found a considerable amount of technologies however, its use is not in maximum performance. There are some interfaces that provide useful information for users and computers with software that enables to manage, enter, and find information more quickly and efficiently. Apparently, it seems that the existing computerization and good service are not enough to give the best service. Along this research it will be deeply analyzed and evaluated. The goal is to understand how to improve the health center services and the reasons for users' complains.

In an organization that involves considerable amounts of information and many service sectors, there are several information systems that are integrated by technologies capable to do so. This interoperability between different systems avoids misunderstandings and enables data communication between different departments, which is essential in an area that deals with human beings and where any error is serious and calls into question the integrity of human life. However, it is necessary not only to promote the integration of information systems to facilitate communication, but also manage and monitor these systems.

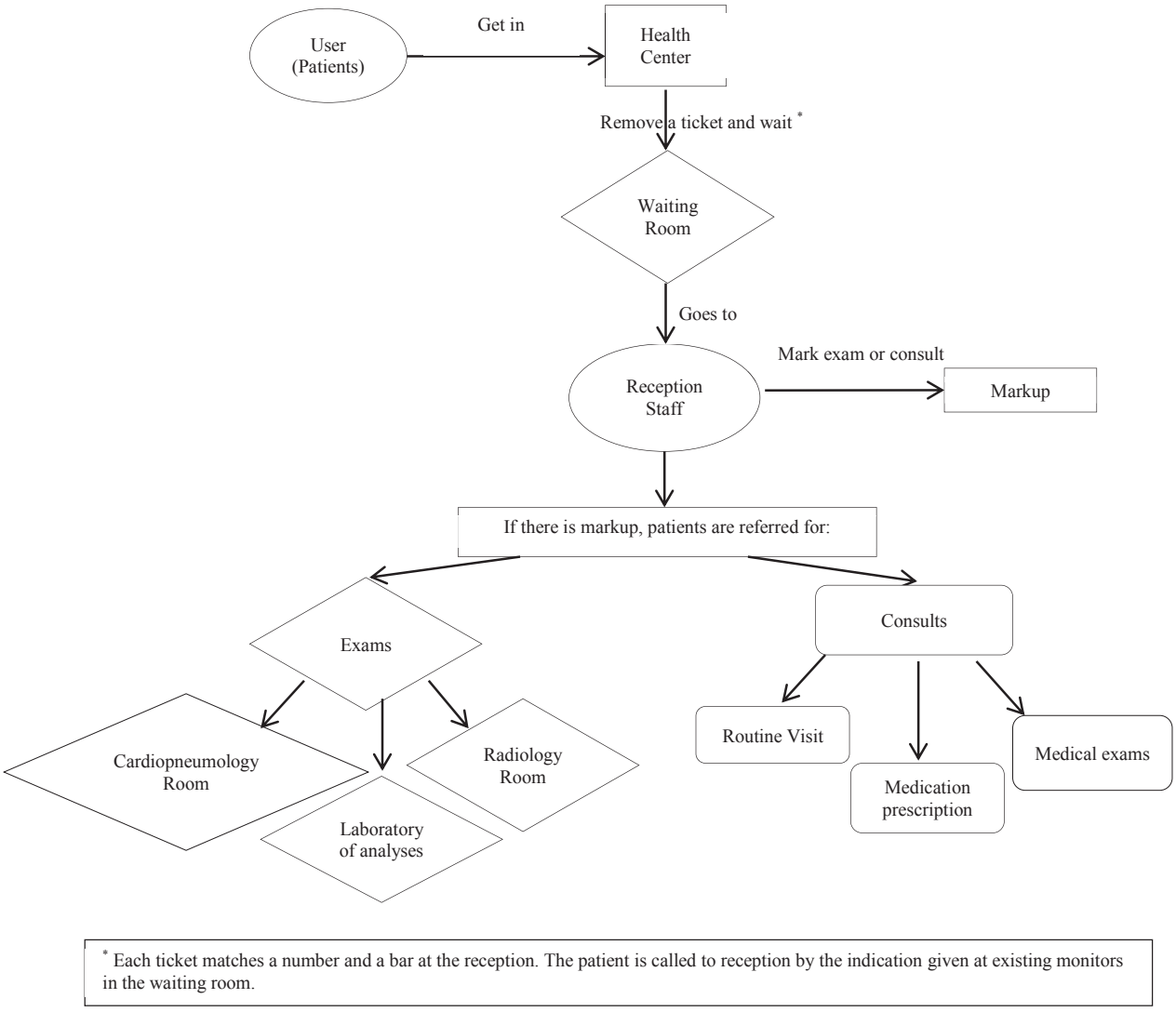

Fig.1: Functioning of the health center

5. Data analysis

In order to organize data, besides GTM, a generic modeling concept, Zachman Framework Professional was used. This Framework is frequently used for enterprise architecture. In this case to organize information it reveals to be appropriate. A classification model in two dimensions, based on questions that address the basic needs of work and communication is used. It works as a guide to answer some questions (fig.2).

These questions are What? (in order to collect the set of methods and processes that are of interest in the profession), How? (set of methods and processes required for the occupation), Where? (places of interest and relevance), Who? (community and interests in a given occupation), When? (temporal obligations and duties, which defines the time schedule and tasks), Why (reasons why the profession performs certain tasks).

The integration of the answers to these questions in an investigation, are the focal point. The Zachman Framework is composed of the intersection of two lines, the first consisting of the questions primitive foundations of communication and the second derives from the transformation of abstract ideas in instances.

This Framework is typically described as a 6x6 matrix, with the questions occupying the columns and rows instances. According John Zachman, Zachman Framework is "a theory of the existence of a structured set of essential components of an object." [12] .

	DATA *What*	FUNCTION *How*	NETWORK *Where*	PEOPLE *Who*	TIME *When*	MOTIVATION *Why*	
SCOPE (CONTEXTUAL)	List of Things Important to the Business	List of Processes the Business Performs	List of Locations in which the Business Operates	List of Organizations Important to the Business	List of Events Significant to the Business	List of Business Goals/Strat	SCOPE (CONTEXTUAL)
Planner	ENTITY = Class of Business Thing	Function = Class of Business Process	Node = Major Business Location	People = Major Organizations	Time = Major Business Event	Ends/Means=Major Bus. Goal/ Critical Success Factor	*Planner*
ENTERPRISE MODEL (CONCEPTUAL)	e.g. Semantic Model	e.g. Business Process Model	e.g. Business Logistics System	e.g. Work Flow Model	e.g. Master Schedule	e.g. Business Plan	ENTERPRISE MODEL (CONCEPTUAL)
Owner	Ent = Business Entity Reln = Business Relationship	Proc = Business Process I/O = Business Resources	Node = Business Location Link = Business Linkage	People = Organization Unit Work = Work Product	Time = Business Event Cycle = Business Cycle	End = Business Objective Means = Business Strategy	*Owner*
SYSTEM MODEL (LOGICAL)	e.g. Logical Data Model	e.g. Application Architecture	e.g. Distributed System Architecture	e.g. Human Interface Architecture	e.g. Processing Structure	e.g., Business Rule Model	SYSTEM MODEL (LOGICAL)
Designer	Ent = Data Entity Reln = Data Relationship	Proc = Application Function I/O = User Views	Node = I/S Function (Processor, Storage, etc) Link = Line Characteristics	People = Role Work = Deliverable	Time = System Event Cycle = Processing Cycle	End = Structural Assertion Means = Action Assertion	*Designer*
TECHNOLOGY MODEL (PHYSICAL)	e.g. Physical Data Model	e.g. System Design	e.g. Technology Architecture	e.g. Presentation Architecture	e.g. Control Structure	e.g. Rule Design	TECHNOLOGY MODEL (PHYSICAL)
Builder	Ent = Segment/Table/etc. Reln = Pointer/Key/etc.	Proc = Computer Function I/O = Data Elements/Sets	Node = Hardware/System Software Link = Line Specifications	People = User Work = Screen Format	Time = Execute Cycle = Component Cycle	End = Condition Means = Action	*Builder*
DETAILED REPRESEN-TATIONS (OUT-OF-CONTEXT)	e.g. Data Definition	e.g. Program	e.g. Network Architecture	e.g. Security Architecture	e.g. Timing Definition	e.g. Rule Specification	DETAILED REPRESEN-TATIONS (OUT-OF CONTEXT)
Sub-Contractor	Ent = Field Reln = Address	Proc = Language Stmt I/O = Control Block	Node = Addresses Link = Protocols	People = Identity Work = Job	Time = Interrupt Cycle = Machine Cycle	End = Sub-condition Means = Step	*Sub-Contractor*
FUNCTIONING ENTERPRISE	e.g. DATA	e.g. FUNCTION	e.g. NETWORK	e.g. ORGANIZATION	e.g. SCHEDULE	e.g. STRATEGY	FUNCTIONING ENTERPRISE

Fig.2: The Zachman Enterprise Framework [12]

The answers to the questions what, how, where, who, when and why, within the profession and needs, establish the communication link between the researcher/programmer, and in this particular case, we will have the answers from health professionals and all stakeholders in a clinical setting. It was essential to find partners with health centers to perform a direct data collection. Within the work that is being developed direct contact with patients and health professionals from a health center was established in order to understand the center functioning and to understand how care is seen by people seeking the service. Stories and experiences will contribute to data analysis. At this stage an exhaustive search for existing clinical support tools is being made. However, we find some difficulties since most of the users are reticent with change and with the use of information technology.

Based on Zachman framework a diagram (Table1) was designed to analyze the data already gathered. It is relevant to emphasize that this structure gave an organized overview of the health center processes and it permitted to have more information about the players in each process and the technologies to consider.

Table 1 - Health Information Architecture

	What	How	Where	Who	When	Why
Scope	Description of important health services and information systems.	Data collection, research and contact with users.	Medical center, with all stakeholders, from health care providers to patients.	Employees, health professionals and patients.	Whenever possible and in situations or important dates.	Impact and importance of health in society and the benefits of technology.
Business (conceptual)	Using technology to promote the health, increase well-being of patients and promoting good practices minimizing failures or errors.	Finding patterns of operation to define the methodology and actively work with users.	Layout pattern of operation of the center and all activities.	All direct or indirect participants in clinical functioning: medical, laboratory technicians, radiologists, cardiologists, staff, reception staff, patients.	Regular visits to the center in order to establish direct contact.	Evaluate the functioning of the organization as a whole; contribute to improve the operation, communication and medical care.
Health information system (logical design)	Vocabulary and terminology, attributes detailed, description of the operation of information systems	Data flow diagrams use case models, mythology, architecture s, security models, and models of data transmission and communication flow.	Controlled environment models, Test area Models,	Assigning responsibilities to each employee of the center and their access to specific components of the health care information systems.	Cycles for clinical study (every week data collection is done, and status)	Purpose of organization, procedures used, function and size of information systems.
Technology (Physical design)	Communicatio n protocols, syntax, programming language, description of health care information	Systems design, accepted protocols, user manuals, practice guidelines, and authorized activities.	Technical Architecture, network architectures (routers, WANs, LANs), laboratory, medical facilities.	Physical health care organization.	Cycles for study of technology and all surroundings.	Understand details of regulations, defining business strategy and operation of the organization. Bridging found grace.

5.1. Usability

As stated, this research is in progress. Presently, we did not start to make the usability tests, since we are making observations and collecting data which, as Grounded Theory Method concerns, this data is collected, and through a constant comparative method is analyzed until saturation and theory emerged. Nevertheless, we must reflect that there are several systems, applications and projects at clinics and hospitals that need to consider usability, and the user's needs, which will contribute to reveal why failures happen. In software development, usability is a crucial point, because it focuses on applications, tools, interfaces or system simplicity. It also refers to the efficiency of design and design for a particular purpose. A system design whose usability is considered will give better reasons for its acceptance. This will be our goal. Table 2 presents the usability goals based on Nielsen [13] arguments.

Our intention is to answer the proposed questions and to make tests during and after the development phase of the interface proposal if it was the case. The goal will be to design attractive, intuitive, beautiful and easy to use interfaces to ensure functionality and to support all the stakeholders involved in the healthcare system. However, it was already found that the health center employees and other health care providers have some problems using software since they do not have the necessary computer skills. So, they will be called to participate in training sessions during the use and development of applications in order to produce something intuitive, with easy navigation, and with task self-explanatory guides. The absence of experience and learning methodologies increases the under-utilization of applications. People require faster applications that can optimize time and reduce waste. Thus, it is important to realize that "lengthy workflows, cumbersome functions, key tasks with jargons are typically what render the execution of tasks slow. Processes and workflows that have optimal turnaround times, quick page load time, and have simple interfaces that facilitate faster information processing make an efficient EHR application." [14]

Table 2: Usability Goals

Goals	Issues
Ease of learning	What degree of ease and how long it takes the user to understand and correctly use the key tasks of the system?
Efficiency / Effectiveness	After learning to use the system, the user can be productive in their jobs?
Easy to memorize	The system provides assistance to use? It supports that assist in the tasks?
Errors	The system prevents the development of errors? When you are committed, provides support for your resolution?
Motivation	The interface motivates you? It's enjoyable and encourages the integration?
Utility	The system enables you to perform tasks that are really necessary? Fills gaps and produces satisfactory results?
Integration	The system easily integrates all the necessary data and actors?

6. Conclusion

This study, started to show that there are a considerable interest in health services improvement to give the best service for society. Besides the opportunity for change and amelioration it is not always easy to introduce adjustments, involving a large number of employees, patients, and other stakeholders.

To circumvent this difficulty we are defining strategies and establishing partnerships with the staff management. They were open to collaborate with academia to help them to identify and suggest solutions to sort encountered problems. This is not an easy task since work analysis in a health center is not just to make a brief collection of data and return a functional program. The main goal is to understand the real needs of doctors, nurses and other service providers and then to return a really useful, complete and desirable solution. It is also crucial to realize that there are several difficulties that most of the stakeholders have in relation to information technology. This means that we must conceive something intuitive and easy to use within the parameters collected, if it will be the case. The guarantee we presently have is that from the data collection and beginning of its analysis, some problems were identified and the end of this study we will have an emerged grounded theory which will contribute to improve the health center and user's satisfaction.

References

[1] Saffer Dan, "Designing for Interaction, Second Edition: Creating Innovative Applications and Devices", New Riders (2010).
[2] Orngreen, R., Pejtersen, A. M., & Clemmensen, T. Themes in Human Work Interaction Design. Paper presented at the Cultural Usability and Human Work Interaction Design – techniques that connects: NordiCHI 2008 Workshop Sunday October 19, 2008, Lund, Sweden (2009).
[3] Katre, D., Clemmens, T., "Human Work Interaction Design for e-governement and public information systems" in International Journal of Public Information Systems, vol 2011:3 (2011).
[4] Moggridge, Bill, *Designing Interactions,* The MIT Press, (2007)
[5] Shedroff, Nathan, "Information Interaction Design: A Unified Field Theory of Design", Vivid Studios (1994)
[6] Moritz Stefan, Service Design Practical access to an evolving field, London (2005)
[7] Abras, C., Maloney-Krichmar, D., & Preece, J. (2003, June 22-27). Evaluating an online academic community: 'Purpose' is the key. Paper presented at the HCI International 2003, Crete, Greece.
[8] Glaser BG, Strauss AL., The discovery of grounded theory: Strategies for qualitative research, New York: Aldine de Gruyter (1967)
[9] Charmaz K, Constructing Grounded Theory: A Practical Guide through Qualitative Analysis, London, Sage Publications (2006)
[10] Strauss A, Corbin J., Basics of qualitative research Grounded theory procedures and techniques, Newbury Oark; Sage Publications . (1990)
[11] Yin, A Case study research: Design and methods (1st ed.). Beverly Hills, CA: Sage Publishing, (1984).
[12] The Zachman Framework™: The Official Concise Definition, http://test.zachmaninternational.com/index.php/the-zachman-framework
[13] Nielsen, Jakob, Finding usability problems through heuristic evaluation. Proceedings of the SIGCHI conference on human factors in computing systems. Monterey, CA, USA, 1992. 373-380, (1992).
[14] Goodman Elizabeth, Stolterman Erik, Wakkary Ron: ACM Human Factors in Computing Systems: Understanding interaction Design Practices (2011).