Designing Healthcare Information System in Non-urban Area Using Neuroscientific Approach

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Abstract— **We will present at the beginning the situation of the Healthcare System in a non-urban area, and how to design a new conceptual framework in a Healthcare Information System. We will describe all the parameters of a significant good Healthcare System as viewed by a consumer. We will focus our works of what nowadays is known as human behavior or neuroscience. The analyses of information system must take into account much more the neuroscience approach, than limiting this analysis to the system components. We will focus our study to the non-urban people's interaction with an information system in a Healthcare area. We use a new approach especially neuroscience to represent the expected reactions in the human behavior and the impact expected in a medical healthcare information system. This consideration is due because of the wide range of motivators, and rewards that may induce irrational reactions that people show when they face to any new situation, especially those in non-urban area.**

Keywords- *Information System; HCI : Human Computer Interaction; neuroscience; non-urban area; healthcare*

I. INTRODUCTION

The non-urban areas know nowadays a major expansion that conducts cities to expand into rather rural areas for various reasons despite a lull observed during the 90's. Several types of non-urban areas have been identified, they have a lowest socio-economic indicators conjugated to a high demand of care. Geographically, these areas are located between the cities or urban area with highest infrastructure and rural areas devoid of any heavy hospital infrastructure, where the populations have changed their behavior to adapt to this lack of equipment and in which medicine is organized around the local doctor (primary care).

The population of non-urban area is displaced due to the enhancements of the property prices and the limited adaptation of the offer to a big family. The majority of these middle class populations consist of workers or employees. There are also a large community of immigrated from the first and second generation, the majority of these populations can be considered as currently disadvantaged groups, having low access to internet (50% for employees whereas it is more than 80% for urban population). The non-urban area represents only 18% of the Corsica area, but 75% of the Ile de France area [1]. Healthcare offer in these areas is relatively low as compared to urban area, with a density of medical offer below that of Paris or other city centers [1].

Nowadays, the medical situation in the non-urban Ile de France, which seems to be very similar to other cities, is considered as being in crisis [1,3]. The situation, according to the latest report of DREES (Direction de la recherche, des études, de l'évaluation et des statistiques) seems more disturbing especially from 2030 [4]. The same phenomena exist in United States for example, whereas disparities in access to medical care and utilization of services exist between urban and non-urban populations [2]. We observe in our preliminary results the same phenomena inside non-urban area. This result must be deeply investigated due to the fact that the population of non-urban area must be discriminated between well informed user and non educated user. This would be due to different reasons, as ethnicity, cultural effect, and non-connected population.

Our idea is to provide new theoretical approach of an Information System (IS) that will have a role in correcting social inequalities and to permit the access to a Healthcare Information System (HIS), in a context of cost reductions of healthcare system. This IS would be specifically developed for a non-urban people which suffer of a lack of access to existing IS or medical website. The main challenge remains the construction a system that matches user's capabilities. We will try in to open a new way for the construction of friendly and usable HIS.

II. DISCUSSION

It is admitted that the Healthcare Information Systems must be constructed in the perspective of the final users. Nevertheless, it is observed that a large number of HIS are designed without consideration of user-centered requirements. In consequence, when systems are created without further consideration such human behavior, users are dissatisfied and systems are not used, causing a lost of money and the degradation of the level of information of this population [5]. Numerous of health and medical information systems exist on the Internet in the form of aggregations of health data, but most of them are inaccessible to the population in non-urban area due principally to the symptoms described above, specially the low social level of this population. In a general observation, only 61% of Information System projects meet the requirements of the user needs [6]. A precise analysis of end-user permits to profile his characteristics such education, skill level, cultural environment, frequency of use, acceptance, expertise, knowledge, skills, cognitive capacities and limitations,

 ISBN: 978-1-61208-117-5

cultural background, times available for learning and training, and familiarity with IS.

Furthermore, it is admitted that the place and conditions in which the IS is located can play a great role in the interaction with the "patient" [7]. Experts agree that when the patients are more educated, they are more prompt to take their medication and to manage their own care [17].

This lack of these considerations make that many HIS are abandoned. This is not because misfit of technology, it is mainly due to the lack of systematic considerations of human being and behavior during the design and the implementation processes [8]. In designing of the most HIS, the importance of informing and actively engaging health care seekers in the planning and execution of their own treatment cannot be overstated. Efforts to achieve these goals must be based on integration of findings in studies from a wide range of disciplines bearing on motivation and decision making. To start this study, we must analyze in details the health's user behavior trends which make them acting more as consumers than traditional patient, by describing the best medical ontology and whereas the IS can be located in a secure place for such user as a result of neuroscience trends, , in order to determine the most appropriate information system that can be deployed.

A. Theory of choice: From rational choice to neuroeconomic choice

In the rational model, the user is viewed as assigning utilitarian values to a range of presented options, both for information gathering and decision making. The preference based on utility function is the primary notion of economic rationality: the decision theory, game theory and the theory of general equilibrium model are based on this concept. This model of rational decisions making, based on VNM utility (von Neumann Morgenstern) [9], persists in contemporary decision theory and game theory. The rational agent is one who selects optimal decisions or strategies from his point of view or his self-interest. This last point seems important in this model, because it consider that agent have merely stable preferences and likelihood that all agents reason in the same manner. Nevertheless in neuroeconomic theory, the choice of human may be noted as puzzling in regard to rational model. The neuroeconomic theory gives a new sight of human choices.

Most of these choices are guided by psychological aspect, sometimes related to learning process. Indeed, in a recent report on the strategic development of health care system, Thaler *et al*. [10] show clearly these new trends of development of healthcare behavior. In this way the IS must be developed in preventive strategies that should not be intended only to inform but also encourage people to have new behavior in order to access to the IS. It was clearly identified that the difference between urban and non-urban people in use of services can be seen as differences in attitudes and behaviors toward seeking medical care [18].

B. The process of webdesign

Classical Human Computer Interaction (HCI) approaches remain indispensable to develop an information system, despite the fact that they are unable to answer to the complexity of healthcare information system. For this purpose, this study cannot be conducted without talking about HCI. Indeed, the HCI field is precisely positioned at the intersection of social sciences, behavioral sciences, computer sciences and information technology, in other words between psychology and informatics. Aiming in design a successful Information System depends on many elements as described above and they must be included during their implementation and evaluation, in order to satisfy the final users. Several models have been proposed in HCI, one of them that define the best information offer is described by The DeLone and McLean model [11,12].

Indeed this model contains six factor and some of them are interconnected: System quality, information quality, system use, user satisfaction, individual impacts and organizational impacts. In this way, an efficient system can be considered as an ineffective one if users don't adopt it [19]. Moreover and until now, the HCI model gives a large place to the human characteristic, especially by the side of cognitive psychology and the social science. In support of this point of view, it has been shown that the social environment of the users affects also the information system process. From this analysis two parameters have been extracted [20]:

(1) Must share the same information by the users.
(2) Which resources are available to assist the users.

In this work, we choose to focus to the two main effects, structure effect and neuroeconomic approach, bridged to a classical approach used in HCI analysis as psychological and sociological approach, with implementing the healthcare information system in a secure place, and by building an ontology that correspond to level of the end-user and their aversion to the risk.

The main challenge in our innovative approach is to bring the patient to the information point access. Indeed the individual characteristics include attitude towards innovation and level of the user. In that way, the neuroscientific approach seems fundamental because it tends to study the factors which govern this acceptance. We recall briefly that the Technology Acceptance Model (TAM) has as a purpose to predict, and explain the user's attitude toward an information system, by studying the factors which may influence him to accept or reject an IS [21].

Moreover, the style of the website is very important. Some websites use high or low medical jargon whilst some others are more or less formal. In both case, they seems inaccessible for a people with a low educational level, for this purpose the role of paramedical staff present in this place is to help them and to guide such user in their information research. They will play a role of assistance.

The adapted ontology must fit the behavioral attitude of these populations, otherwise it can put off someone who's new to the information center disease and can be entirely appropriate by knowledgeable patients who belong generally to a high educated urban population. Describing purely formal ontologies or semiotic one, requires explicit and

 ISBN: 978-1-61208-117-5

shared conceptualization, which are not be necessarily shared by these population having a low education level. In the configuration where the ontology is well adapted, the patient will be in a situation that may be considered as a very low risk for him and finally it will push him to act in favor to use the IS as a pre-diagnosis system or on self-medicament effect for example, which causes in France more than 10 000 death/year. From this point of view, the presence of forum in the website can plays a great role in avoiding this risky behavior specially addressed to these populations. Indeed, moderating forum embedded on the website could be critical to avoid potentially dramatic auto-medication.

Based on this approach describe above, the main contribution of this work, is to define a new way to create and validate an ontology in the field of medical IS, especially for the population situated in a low level area density of medical offer. For this reason, we try to extend the neuroscientific approach to the development of new IS and new ontology mainly related to a neuroscience using for example positive words that mimic reward, which is no longer a purely formal [13] or semiotic [14] which derives from Semantic Web or a "Socio-Semantic Web" and can be adopted only by a high educated people. Indeed, Zhang scheme gives a functional analysis that product an ontology of a given work domain. These considerations match with formal ontology. It includes (a) objects and their attributes, (b) resources and their types, (c) relations among entities and constraints on relations, (d) operations on single or multiple objects, transformations, relations, and constraints, and (e) workflow structures [8].

C. Information Point Access

The implementation of an information system must be made in a secure place like a city hall or a nursery office, or whatever paramedical office. It will create a confidence for the patient-user and this is the major opportunity to use a neuroeconomic approach in addition to a specific ontology derived from this theory. This can be considered as the reward by the end-user. Effectively, the reward in the case of healthcare system can be regarded as the result of the consultation in doctor's office and the main goal of this action: to get the information on therapy or to cure from disease. Indeed the presence of paramedical staff in a secure place, linked to a hospital network, with agreed information system, will make the patient more confident in such new medical approach. It has been proven that most frequently used quality criteria include accuracy, completeness and readability [15].

This can be obtained by a trustmarks website or when the IS is delivered by official organization. A recent experiment in an information systems shows, for those suffering from diabetes type II, one of the fastest growing health problems around the world, that such tools are more effective when it is designed to inform patients and integrate them as an actors into multiple-actor treatment teams including paramedical and social service personnel, along with nurses and doctors [16]. Within the Ile de France area, as in many similar communities elsewhere, this approach is particularly promising because it empowers patients to take an active role in their own treatment, and also because the distribution of nurses, social service and paramedical personnel is uniform throughout the non-urban areas.

III. CONCLUSION

This work is an exploratory work and still in progress; the observation made here about the difference between urban and non-urban populations is also observed elsewhere. The approach presented in this article indicates that efficiency dictates the patient choice and the user defines the quality of care as the primary utility function. The information tools for patients, is essential to improve the quality of care in non-urban areas. The IS must interact with local city hall or a paramedical staff, as it will involve the hospital network, to share data with the doctor offices and allow local hospital to act as a sentinel for access to these databases and to respond to outbreaks. The interface of Information System should be accessible, well designed and must correspond to the population's sociology, it is the main factor during the building of the ontologies. The importance of data will be crucial to regaining the trust of patients by ensuring the security of personal private data. The most important point of our approach focuses on the development of technologies needed to build and maintain public confidence in computer systems. This will help the e-health Information System to become ubiquitous for public whatever his education level or cultural belonging and especially for people socially and territorially isolated

These considerations invite us to plead for a new approach to build user-machine interfaces and to create neuroeconomic ontologies that user can use and which supports the reasoning of patients especially in decision making, rather than forcing them into a mode of thought which may be natural for machines or for well informed urban people, but not very useful for these populations, which are for the majority of them, socially excluded for a different reasons. In fact, the information system can't be considered as efficient if it is poorly adapted to their users, especially in their ways to use and to practice information.

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