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Factors Known to Influence Acceptance of Clinical Decision Support Systems

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Abstract. Clinical Decision Support Systems (CDSS) have been shown to improve clinical performance and patient outcomes, but the failure rate of such systems is still over 50 percent. To contribute to a wider understanding of issues surrounding CDDS acceptance, we performed a systematic review of studies that evaluated CDSS implementations in clinical care to determine the factors that are associated with acceptance of CDSS by physicians. The factors that were found were categorized according to the HOT-fit framework. The mapping of factors concerning CDSS acceptance on the HOT-fit framework revealed gaps in each domain of the framework and showed that research has mainly focused on human and technology factors and a lack of research on organizational factors. A potential area of research could thus be studying the organizational factors that may influence CDSS acceptance.

Keywords. Clinical Decision Support System, Physician Acceptance

1. Introduction

Even though the evidence of Clinical Decision Support Systems (CDSSs) improving clinical performance and patient outcomes is convincing, the failure rate in introducing CDSS in clinical practices is still over 50 percent [1]. Introducing a CDSS seems fraught with obstacles among which low ease of system use [2], negative end-user attitudes towards the system and negative impact on clinical workflows [1]. But studies that evaluate CDSS implementation in clinical care continue to provide insight into these and other factors influencing acceptance of CDSSs. By systematically reviewing the status quo on what is known on factors contributing to CDSS acceptance this study aims to contribute to a wider understanding of issues surrounding CDSS implementations in clinical care and in doing so illustrate the gaps in current research on CDSS acceptance.

2. Methods

2.1. Systematic Literature Research

A literature search was conducted to determine the factors that are associated with acceptance of CDSS. Pubmed, Web of Science, The Cochrane Library and IEEE

explore were systematically searched. The combinations of search terms applied can be found at [3].

All abstracts resulting from these search queries were reviewed by the first author. The second and third author each reviewed half of the set of abstracts. Studies were included if they assessed factors contributing to or impeding acceptance of CDSS or physician's attitudes towards CDSS. A second screening of the resulting set of included papers was done on basis of full text review by the first, second and third author. All papers that were finally included were textually analyzed for their description of factors influencing CDSS acceptance among physicians. Each of these factors was categorized according to the HOT-fit framework [4] by the first author.

2.2. The HOT-fit Evaluation Framework

Building on the knowledge base of evaluation studies of Health Information systems (HIS) Yusof et al. proposed a framework to evaluate HIS while incorporating the concept of fit between Human, Organization and Technology (HOT-fit). In the HOT-fit framework these three domains are subdivided into eight interrelated dimensions: 1) System Quality, Information Quality and Service Quality fall under the Technological domain, 2) System Use and User Satisfaction under the Human domain and 3) Structure and Environment under the Organization domain. The eight dimension is Net benefits. While human, organizational and technology are the essential components of Information Systems, factors concerning the impact of HIS are categorized under the Net benefits dimension. In the framework, the concept of fit is concerned with the alignment between and compatibility of the human, technology and organization.

The studies included in this systematic literature review were analyzed for their description and evaluation of factors related to user acceptance of a CDSS. Factors found were subsequently mapped on the HOT-fit framework. This mapping provided an overview of those domains and dimensions in which factors have been evaluated with regard to physicians' acceptance of CDSSs in clinical practice. Factors concerning the domains or dimensions which have not been studied provide insight into the gaps in the literature on CDSS acceptance and provide directions for further research.

3. Results

The literature search generated a total of 321 articles. After removing the duplicates and reviewing the abstracts, 70 articles were selected for full text review. In the end 29 articles were found eligible for inclusion. The factors studied in these publications were mapped on each of the Technology, Human, Organizational and Net benefits factors as proposed by the HOT-fit framework. A total of 240 factors were found, including 116 technological factors, 79 human factors, 37 organizational factors and eight pertaining to the dimension of Net Benefits. References to all included papers and the resulting mapping of the factors can be found in [3].

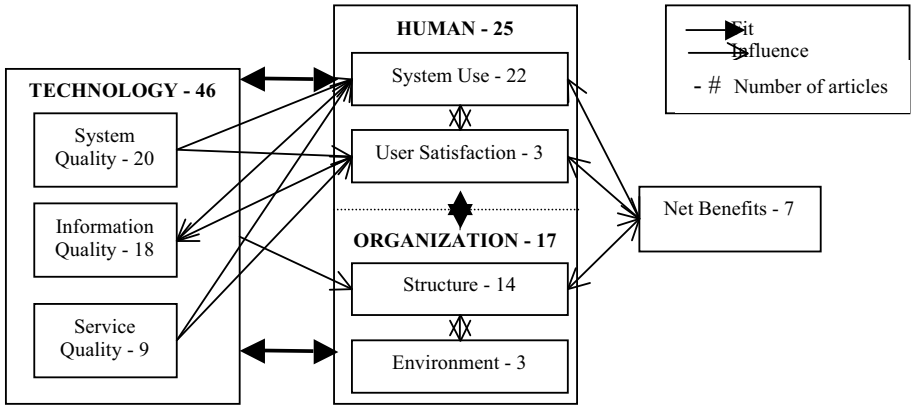

Figure 1 Number of articles on user acceptance of CDSS found per domain

3.1. Overview of Status Quo

Figure 1 presents an overview of the articles that report on factors concerning CDSS acceptance in relation to the specific HOT-fit domains. Factors that have often been studied can be foremost found in the dimensions of System Quality, Information Quality and System Use. Forty-eight factors in 20 articles were found to be associated with System Quality. The most frequently reported factors mapped under System Quality having a positive impact on user acceptance are Ease of system use and System flexibility. Ease of system use and System flexibility were reported on 9 and 10 times, respectively. To increase the ease of system use, screen design should provide clear directions to the user for how to navigate through the system [5]. The system should be flexible so that it lets the physician explore and keep his or her autonomy [6].

Fifty-one factors revealed in a total of 17 articles concerned the dimension of Information Quality. The most often factor noted to contribute to CDSS acceptance by physicians is the relevance of data and messages delivered by the system: those should be suited to the particular clinical situation at hand [5]. Seventeen factors studied in a total of 9 articles concerned Service Quality. Easy access to computers and technical support are often named as facilitating factors for CDSS use.

Most of the factors studied in the CDSS acceptance literature concern the dimension System Use, with 76 factors found in 22 articles. Overall, physicians' expectations and believes concerning a particular CDSS are the most often noted factors influencing its acceptance. Physicians are more willing to use a CDSS when they believe they are in control of the system and that using it is worth the effort. Physicians are less willing to use the system when they believe it will harm the physician-patient relationship and when it reduces their decision making power. Physicians' computer skills are also important in their acceptance of a CDSS.

Only three factors in three articles were mentioned that concerned User satisfaction. All these publications reported that perceived usefulness of the system influences acceptance of CDSS.

A total of 34 factors in 14 articles were categorized under the dimension Structure in the domain of Technology. It appears that the structure/organization of the clinical

process is an important factor in physician acceptance of CDSS and that clinician involvement in introducing CDSS has a positive impact on acceptance [1].

Three factors in three studies were found that concerned the dimension of Environment. Two studies noted that social pressure influences acceptance and in one expert panel the need for adequate budgeting was noted [2]. There are eight factors mentioned in six articles concerning the dimension of Net Benefits. Most important here is that the physician sees a direct benefit [1].

3.2. Gaps Analysis

Table 1. Gaps analysis of factors not mentioned/ assessed in CDSS acceptance literature

Domain - dimension	HOT-fit Factors not mentioned in CDSS acceptance literature
Technology	
System Quality	Data currency, database content, security, resource utilization
Information Quality	Importance, legibility, conciseness
Service Quality	Assurance, empathy
Human	
System Use	Amount/duration, use by whom, actual vs. reported use, nature of use, level of use, recurring use, percentage used, voluntaries of use
User Satisfaction	Satisfaction with specific functions, overall satisfaction, enjoyment, software satisfaction, decision making satisfaction
Organization	
Structure	Nature, autonomy, communication, champion, mediator, teamwork
Environment	Government, politics, localization, competition, population served, external communication
Net benefits	Effectiveness, error reduction, communication, clinical outcomes

The literature review and consequent mapping of factors on the HOT-fit framework showed that many factors suggested by the HOT-fit to be of potential influence to successful implementation and acceptance of HIS in clinical practice have not yet been studied in the CDSS acceptance literature and provide means for further research. Table 1 gives an overview of these factors which are not yet researched in the CDSS acceptance literature. Also, many of the factors which are enumerated by the HOT-fit framework are only mentioned in CDSS acceptance literature and not assessed or their impact measured. Three of such factors fall under the domain Organization-Structure. Leadership, management and strategy have been suggested as potentially impacting CDDS acceptance. Most of these factors relate to recommendation or suggestions made in the article such as to include management and administrative staff in planning of CDSS introduction to assist with arising workflow issues [6].

Accuracy of system data, which falls under the domain of Information Quality, was mentioned twice in expert panels and once as an expert opinion to influence CDSS acceptance. Provision of irrelevant or erroneous information might have a negative impact on user acceptance of CDSS [2]. In the domain of Environment, adequate budgeting was also mentioned once in an expert panel [2].

4. Discussion

This systematic literature review revealed that research conducted on acceptance of CDSS systems have mainly focused on factors concerning the Technological and

Human domain, reflected in the high number of factors of 116 and 79 found, respectively. More specifically a high amount of factors revealed concerned System Quality, Information Quality and System Use. While these factors can have an impact on the acceptance of CDSS, conclusive evidence is not yet provided on the effect of these factors on CDSS physician acceptance. For example, it was reported that perceived usefulness of CDSS can have a positive impact on its acceptance, but in other studies this association was not found [7].

The mapping of factors concerning CDSS acceptance in clinical care on the HOT-fit framework mainly showed a lack in research on factors concerning the Organization domain. Experts have suggested that factors like leadership, management and strategy might be of impact on CDSS' acceptance as well. There are other issues, like teamwork and communication, that have never been studied for their impact on CDSS acceptance but that might likewise be of influence. Other organization issues not yet subjected to research concern for example, type, size, hierarchy, politics, culture, and autonomy [2]. These organizational issues are a potential area for further research on CDDS acceptance. The results of this systematic literature review nevertheless revealed that the organizational structure of the clinical process has a great impact on physician acceptance of CDSS. How to fit the CDSS seamlessly into the particular clinical process at hand needs to be the first objective of a CDSS implementation and acceptance study.

The HOT-fit framework has proven to be helpful in categorization of factors revealed by the research literature on CDSS acceptation. The framework was useful for revealing gaps in research of factors of each of its dimensions concerning CDSS acceptance with organizational issues as main underexposed domain of study.

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