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Requirements Partially Determine Why Professionals USE IT in Healthcare

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ABSTRACT

Information quality is an important feature for information systems innovation and diffusion. But how important is it? The practice is full with "bad" information systems widely accepted and used and "good" information systems left on the shelf. This paper introduces, defines and empirically tests, requirements as a key determinant of Information Technology diffusion and IT-use in healthcare organizations. The main question is: to what extend do requirements influence the USE of IT in healthcare? A multiple case study amongst 56 general practitioners (GP's) on the influence of requirements on the introduction of an Electronic Prescription System (EPS) demonstrates that the EPS is not used in at least 72% of the cases. Requirements are defined as the degree to which the user needs are satisfied with the product quality of the innovation. Results of the multiple case study show that in the first place the wrong people are asked for their information needs. Only innovators participated in the project team, the "average" GP was not involved. Secondly we found a lack of clarity of goals on macro level. The ministry had a goal to save 150 million euro, the main benefits of the system lie in the quality of the diagnosis and prescription. Finally, on micro level, we concluded that there was an important lack of functionality of the system, that is the communication functionality. On top of that one of the main performance requirement in the perception of the GP's, timeliness, was not met.

INTRODUCTION

The ability to determine how well a system meets the information needs is a critical component of any system (Miller, 1999). He calls it bridging the information transfer gap. This information gap is clearly visible in healthcare. "What features and functions of computer systems are currently acceptable for clinical use, and what improvements are needed to increase the value of these systems?" (Drazen et al., 1995). "In many cases, physician use of clinical functions is voluntary and, unless they conclude that the system is a reasonable tool, they simply will not use it." (Metzger and Teich, 1995).

The adoption of information technology in healthcare has increased which underlines the importance of user requirements (Beuscart-Zephir et al, 97). In later work she links the adoption to the activities of the healthcare professionals (Beuscart-Zephir et al, 2001). From practice point of view, Brender and McNair (2001) describe a case study in which detailed functional requirements are seen as a curse for contract management because too many deviations arise. The use of the system seemed to be a product of customization and standardization. Fleisner and Hofkircher (1998) refer to the same problem when they conclude that relevant information will not be improved unless additional requirements are met.

Saiedian and Dale (2000) typify the situation well when they state: "without a well written requirements specification, developers do not know what to build, users do not know what to expect, and there is no way to validate that the created system actually meets the original needs of the user". It is even more difficult to asses the quality of an integrated system and to derive integration requirements (Toussaint et al, 2001).

Symon (et al, 1992) conducted a requirement study where they encounter cross-departmental problems, the impact of resource shortages, a lack of strategic thinking and an enthusiasm for an integrated information system from hospital staff. Specific hurdles for a computerized patient record are according to van Ginneken (2002), the lack of integration and flexibility.

In this paper we assess the requirements determinant to measure the use of an electronic prescription system for general practitioners in 56 case studies. To explain this we combine the notions of information quality and systems quality of Delone and McLean (1993) and the notion of product quality from Rogers (1983) and use the semantic level from Stamper (1973) and technical level from Shannon (1963) to straighten them out. In the next section we show that requirements is not the only determinant and how it is embedded in other literature.

Background

We can use a wide range of sources that discuss user-perspectives in IT-introduction.

This section gives a short overview of intriguing literature. The aim is to demonstrate that requirements is not *the only* determinant of user-adoption. Rather, it is an important determinant among other factors. One of the ultimate goals of our research project in this field is to propose a model that neatly balances the role of such factors.

First, we present the dimensions of the USE IT-model to predict and evaluate innovation and diffusion of information systems: the innovation-dimension and the domain-dimension, which make four determinants for success: relevance, requirements, resistance and resources.

With the process the innovation process is meant, similar to the process defined by Saarinen and Sääksjärvi (1992) and the innovation process structure of Larsen (1998). The product is the result of this innovation process. This corresponds with the definition of the product by Saarinen and Sääksjärvi and the artifact structure in the framework of Larsen. Also the IT domain is part of the artifact structure; the user domain represents the organizational structure in Larsen's framework. The time horizon structure can be part of the requirements and the knowledge structure can be considered as an element of the resources.

Table 2 shows the determinants with their sub-determinants. Every determinant comprises to levels: the macro-level and the micro-level. The macro-level represents a general perspective e.g., the organizational level. The micro-level refers to the individual user.

The *relevance* determinant is defined by Schuring & Spil (2003) as: *"the degree to which the user expects that the IT-system will solve his problems or help to realize his actually relevant goals"*. The word "expects" expresses that relevance is a factor that is important in the course of the adoption process, not only in evaluation. The word

Table 1: The USE IT-model (Michel-Verkerke et al., 2003)

USE IT-model	*User Domain*	*Information Technology Domain*
Product	Relevance	Requirements
Process	Resistance	Resources

Table 2: The USE IT-determinants based on Michel-Verkerke (et al., 2003).

Determinant	**Sub-determinants**
Relevance	Macro-relevance: • Economic improvements, • Social improvements, • Functional improvements, • Saving time and effort. Micro-relevance: • Solve here-and-now problems • Compatibility with working process
Resistance	Macro-resistance: • Lack of opportunity to change Micro-resistance: • Unability to change, • Bad attitude
Requirements	Macro-requirements: • Strategic general requirements, • Tactical approach. Micro-requirements: • Functional, • Performance requirements.
Resources	Material: • Hardware & Software, • Time, • Money. Immaterial: • Adaptability, • Capabilities, • Reliability.

"actually" is crucial in their view of relevance. Relevance is not to be confused with the degree to which the user considers outcomes as being positive. The set of outcome-dimensions that someone considers "positive" is larger than the set of outcome-dimensions that are relevant. Imagine a physician, who basically considers IT-outcomes of a computer decision support system, such as, assistance in diagnosis, disease prevention, or more appropriate dosing of drugs, as "positive". This does not automatically imply that the IT-adoption is relevant to him; it is only relevant if these dimensions are high on his "goal agenda".

Relevance defined in this way comprises relative advantage (Rogers, 1995), net benefits (DeLone and McLean, 2002), perceived usefulness (Davis, 1989) and job relevance (Chismar and Wiley-Patton, 2003), and results in task support satisfaction, which is a criterion for user satisfaction (Garrity and Sanders, 1998).

In their study on the implementation of an Electronic Prescription System Schuring and Spil found that lack of relevance was the major determinant that explained the failure of the implementation (Schuring and Spil, 2002).

Resistance is the personal attitude of all stakeholder groups towards the introduction of an information system (Spil et al, 2002). The main IS-quality aspect of resistance is the attitude and the willingness to change. Pare and Elam (1999) also focus on the attitude of the professional when they assess clinical information systems. The end users have an important role because their norms and values determine the effectiveness of the information system. Resistance was found to be the cumulative effect of the other three determinants (Spil et al, 2002).

Expectance of reduced quality of work life satisfaction, high complexity and the lack of trialability can result in resistance (Rogers, 1995; Garrity and Sanders, 1998). Observability reduces resistance (Rogers, 1995). Offenbeek & Koopman (1996) connect people with resistance potential because they can feel that the quality of their working life will be decreased. Mumford (1995) observed that user participation contributes to effective organizational change. Wissema (1987) defines resistance as willingness to change and the difference between results and expectations.

Resources are defined as the degree to which material and immaterial goods are available to design, operate and maintain the information system (Spil and Schuring, 2004, Salmela, 1997). The main focus of the determinant resources will be on the people and on the costs these people cause. Next to that the reliability of the information technology and the information systems are considered. Resources defined in this way refer to service and system quality (DeLone and McLean, 2002), management support and mature IS function (Saarinen and Sääksjärvi, 1992). Resources(human, physical and monetary components, Ansoff, 1965) are needed to implement the new information system into the organization. The human resources can both be insufficient in time and in experience (risk of technology). Insufficient material resources (Offenbeek & Koopman, 1996) will have a limiting influence on the other three risk domains.

The requirements determinant evaluates the meaning of the information system. Requirements are defined as the degree to which the user needs are satisfied with the product quality of the innovation (Spil and Schuring, 2003). This includes such aspects as the functional capability, the ease of start-up and the ease of use.

Meeting the end-user's requirements results in high information quality, system quality (DeLone and McLean, 2002), high interface satisfaction (Garrity and Sanders, 1998), and high compatibility (Rogers, 1995). The requirements determinant will be elaborated in this paper.

To measure the determinants the USE IT-tool consists of structured interviews. In this way a more precise insight can be obtained in the nature and relevance of problems and solutions, before implementation and this insight can be tested with the same tool during the evaluation of the implementation.

In this paper we only show the results of the requirements determinant.

REQUIREMENTS: DEFINITION AND FRAMEWORK

At the semantic level (Shannon & Weaver, 49, Stamper,73, DeLone & McLean, 93) we are concerned with how pattern-types relate to what happens in the world. On this level we deal with the meaning of the system but this term brings along a lot of different meanings about its definition (Cohen, 62). The meaning of a sign relates to the response the sign elicits in a given social setting (Liu, 93). It is situational of nature since we have a range of pattern-types that signify a certain meaning and a user (group) that interprets the expression (Spil, 93). Therefore it is necessary to establish requirements as thorough as possible. Wieringa (1996) defines requirements as *desired properties needed to achieve the desired composite system properties*. Pressman (1982) makes a distinction between normal requirements, expected requirements and exiting requirements. Before defining requirements ourselves we want to study the problem at a deeper level.

'Many system designers do not appear to realize that with their present approach they are designing only partial systems' (Mumford, 95). She argues that all needs of the end users should be identified. The notion of variance emerged from some early socio-technical work design experiments in Norway (Mumford, 95). A variance is defined as *a tendency for a system or subsystem to deviate from some desired or expected norm or standard.* Key variances are the deviations on goals and functions, operational variances stem from the organizational problems. Together they get close to the main problem that we are addressing, the information gap between designer and user.

The functional uncertainty is often described in information systems literature. It occurs in the task domain of Leavitt. In each situation, the interpretation and the meaning can be different. Therefore, it is necessary to establish a functional specification with user and providers of the information systems. Henry & Stone (1999) state this to be information quality. Larsen (1998,p.413) notes however "the

quality of the IS/IT product is a necessary but not sufficient prerequisite for IS innovation success. The *people* within the organizations determine the outcome." Within the healthcare sector, Walley & Davies (2001) conducted a study to the internal barriers to technological IT-advancement in the healthcare sector. The involvement of stakeholders is arguably one of the most distinctive characteristics of IT projects. There are instruments to identify user-needs, but they question whether they are actually used.

Iivari and Koskela (1987) include three quality constructs on semantic level which they call the input/output requirements: informativeness, accessibility and adaptability. Informativeness describes the potentiality of the information systems, accessibility the quality of the user-IS interaction and adaptability points to the ability of the systems to change.

DeLone and McLean (1992) enumerate the criteria from nine earlier studies. They declare themselves that there is not "one" measure of IS success but there are many dependent variables. They call their taxonomy on semantic level information quality. Usefulness or relevance is mentioned eight times in the nine studies. Schuring and Spil (2002) have studied the importance of relevance and made it a separate determinant on the pragmatic level. Timeliness is empirically used five times and adopted in our model. We keep using the term accessibility as a broader term including convenience of access. Accuracy is studied four times and adopted under informativeness. We do not understand why there is no notion of adaptibility or ability to integrate in the DeLone & McLean study. We adopt ability to integrate as the degree that the new system is imbedded in the organization.

Brender and McNair (2001) use the ISO 900x structure and use the strategic, tactical and operational level to perform their user requirements specification. Larsen (1999) also makes this distinction. The strategic level is concerned with the problem definition, including objectives and global task description. The tactical level is interpreted as a preferred approach and the operational level includes a set of functional, performance and capacity criteria.

Requirements are defined as *the degree to which the user needs are satisfied with the product quality of the innovation.* We divide the requirements into macro and micro requirements:

- Strategic general requirements and tactical approach is the degree in which the users agree with the objectives and methods used.
- Functional requirements and performance requirements specify what the content of the innovation should be. In this study we chose timeliness (accessibility), accurateness (informativenes), ability to integrate and content as main quality criteria but we acknowledge that this is more a framework than a complete list.

Box 1: Framework for the requirements determinant

Requirements
Definition: the degree to which the user needs are satisfied with the product quality of the innovation.

→ (Co)determines: IT-diffusion

Macro

Strategic general requirements and **tactical approach** is the degree in which the users agree with the objectives and methods used.

\+ Clear objectives, iterative approach, users involved.

\- Unclear communication, no participation, education

Micro

Functional requirements and **performance requirements** specify what the content of the innovation should be.

\+ Timeliness, Accuracy, Ability to integrate, Content

\- Fuzziness, non contract

MULTIPLE CASE STUDY RESULTS

Case Study Method

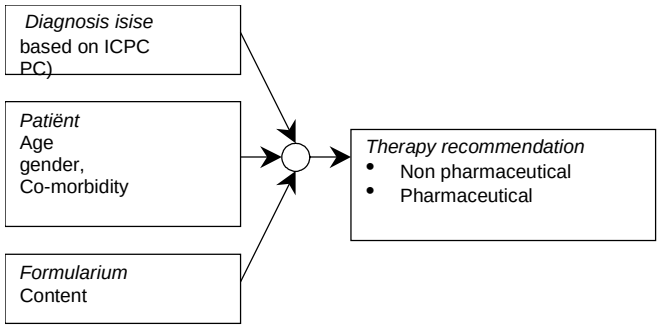
Nykänen (2000) distinguishes four major evaluation perspectives: goal-oriented, standardised, effectiveness-based and stakeholder-based perspective. In goal-oriented evaluation the emphasis is on rationality: measurement criteria and means to achieve the goal can be derived from the goal itself. This is possible if there the criteria are clear and there are no conflicts of interests among the stakeholders. The downside of goal-oriented perspective is the inability to see other than the anticipated consequences of actions. In standardised (or normative) evaluation, causes and consequences are not in the scope of interest, but compliance with rules, agreements, budgets and principles is monitored (e.g. quality systems). In effectiveness-based view the input/output ratio of actions is economically evaluated. The problem with this perspective is in expressing intangibles (e.g. health) in monetary terms. According to the stakeholder-based perspective, all actions are not always rational, aiming at one mutual goal, and therefore the criteria should be collected from several stakeholders' view. The perspective has a lot of qualitative characteristics and it can be a quite laborious framework for a study design (Hakkinen et al, 2003).

This study used the stakeholder-based perspective and was set up to both assess the situation regarding the electronic prescription system "EVS" in the Netherlands and the theory that is described above, that was set up to provide an instrument that could be used to unravel the diffusion-situation of the prescription system. This resulted in a case-study protocol that covers all the topics that are mentioned in the framework in open-ended questions. In line with the case-study approach by Yin (1984) we discerned different case-situations on the basis of our theoretical framework. Particularly, the network-situation (individual, group practice, health-care centre) of general practitioners and the degree of adoption of previous ideas (laggard (no computer) to innovator (using ICPC codes and electronic patient record)) served as a basis to make categories of general practitioners. A total of 56 case-studies were conducted. Each general practitioner was visited in his/her own working situation and interviewed for over an hour. We agree with Brender (1999) that the kernel point of assessment is that of understanding the process. We had data available on the size of each category, which enabled us to quantify the qualitative data that we gathered.

ELECTRONIC PRESCRIPTION SYSTEM

The Electronic Prescription System that we studied are IT-systems that give general practitioners recommendations on the therapy that can be given to patients on the basis of the diagnosis of the practitioner. This diagnosis is coded by use of the International Code for Primary Care (ICPC). The value of of the system, as compared to the traditional situation, lies in the fact that the system takes characteristics of the patient into account. The recommended therapy is customized on the basis of the age and gender of the patient, existing pharmaceutical therapy for other diseases and is based on the formulary, which is a list of drug-preferences that is set up by professional associations. Figure 4 shows the working principle of the EVS.

Figure 1: Working principle of the EVS electronic prescription system



EMPIRICAL RESULTS GP ELECTRONIC PRESCRIPTION SYSTEM

Strategic General Requirements

The objectives for this innovation were mainly money driven. The system should decrease prescription costs with 150 million euro yearly. To the GP's we interviewed, the goals were not clear. The qualitative benefits were not communicated.

One GP said: "This is one economy measure of many". Another one said: "I don't want to be patronized by government".

The general requirements were not derived from a broad group of practitioners but from a group of innovators. This means that the average GP was not asked for his requirements. The final product is therefore too sophisticated. Please note that these findings are perceived by the GP's.

Tactical Approach

From the document study it is not clear whether a formal approach was used. The development seems to be based upon an existing information system (ETAS) which was enhanced with prescription features and tested on a group of 1100 users of a specific system (PROMEDICO). In that sense we can conclude that a prototyping approach was used.

For the GP's, the development method was invisible. Voluntary training was given but more support was needed in the practice itself. The training was decentralized toward the district GP organizations that were still far from the GP practice.

Functional Requirements

Content

The functionality of the system can be divided into administrative functionality and medical functionality. We observed that the administrative use of the system has the overhand. Only 15 GP's(27,3 %) made use of the SOAP (subjective, objective, assessment, plan) module in the systems which is a prerequisite for the use of the electronic prescription system.

Communication with other GP's, hospitals and pharmacists is a requirement that is high on the agenda of the GP (55%). Still, the new EPS does not support the communication at all.

Performance Requirements

Timeliness (Accessibility)

The time pressure is one of the most important problems of the GP today. Timeliness of the system is therefore an important performance criterion. Due to a bad user interface the GP's are not able to work several records parallel and therefore loose time in opening and closing the patient's record.

Accuracy

The accurateness of the system is good and might be too good. The system was rigidly designed to avoid failures and therefore has many signal functions. For instance, when prescribing medicines for influenza, the GP gets a lot of alternatives and warnings where he or she already exactly knows what to prescribe.

Also the accurateness of input is a problem because 30 percent of the GP's think it is unnecessary and sometimes difficult to generate a code for all "vague" diseases like stomach ache, headache and so forth.

Ability to Integrate

The electronic prescription system is delivered on CD-ROM as a stand alone system. This means that it is not integrated in the GP information system and also not in the communication configuration of the GP. The GP therefore has to start the program for each patient and cannot work parallel even more because the system is not window based.

CONCLUSIONS

At this point we revert to the main question: was the information gap bridged in these 56 cases? We can answer with a clear no. The causes for this failure could be found in the requirements determinant.

1. General requirements: Main cause is the lack of clarity of goals.
2. Functional requirements; Main cause is the omission of commu nication functionality.
3. Performance requirements: Main cause is the timeliness of the system that is very important in the general practitioners office.

Although in many studies the social criteria of success are mentioned as more important than the technical criteria we cannot confirm this for these 56 cases. The requirements of the users were not sufficiently met by the system. Still we think that the omission of for instance the communication requirement can be overcome if the rest of the system has enough relevance for the working process.

We like to draw the following recommendation to healthcare organizations to make a contract containing functional and performance requirements both agreed upon by a broad (laggards and innovators alike) group of end users and the responsible designers of the system. This should not be a static contract but dynamically evolve over time.

It was difficult to apply the macro requirements in the interviews with the GP's. We were only able to register their perception on these macro items and could not directly observe them. We think this is a disadvantage of our chosen user perspective.

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