Application of the FITT framework to evaluate a prototype health information system

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Abstract

We developed a prototype information system with an integrated expert system for headache patients. The FITT (fit between individual, task and technology) framework was used to evaluate the prototype health information system and to determine which deltas to work on in future developments. We positively evaluated the system in all FITT dimensions. The framework provided a proper tool for evaluating the prototype health information system and determining which deltas to work on in future developments.

Key words

FITT; IT adoption; information supply; internet; expert system; meta-search

Introduction

Information technology (IT) found its way into the medical domain decades ago. Since then, practitioners and scientists have researched users' levels of acceptance of IT applications [17]. Two exemplary definition of the adoption of IT systems are the usage and the overall user acceptance [20]. Everett M. Rogers, one of the first researchers who concentrated on diffusion and adoption, developed the diffusion of innovations model (DIM) [18]. This model explains "the process by which an innovation spreads via certain communication channels among members of a social system" [19]. Its analysis, however, "remains firmly rooted at the level of the individual user and hence only tells part of the story of technology adoption and diffusion" [20]. Scientists have designed a variety of models for IT adoption, and have found different key factors that determine the level of acceptance. Kim and Chang [13], for example, employed the Technology Acceptance Model (TAM) by Davis [4] and found that "perceived usefulness" is crucial.

The FITT framework is one of the most recent models. It includes three key factors of information technology adoption: the fit between individual, task and technology. The framework is an enhancement influenced by some existing models like the TAM, the Task-Technology-Fit model (TTF) by Goodhue and Thompson [9] and the Information Success Model by DeLone and McLean [6]. The delta, which represents the deviation between aim and reality, is determined by applying the framework. A low delta represents a high level of acceptance of the system [1].

The framework is based on the idea that adoption of health related IT "depends on the fit between the attributes of the users (e.g. computer anxiety, motivation), the attributes of the technology (e.g. usability, functionality, performance), and the attributes of the clinical tasks and processes (e.g. organization, task complexity)" [1]. The framework is depicted in Figure 1.
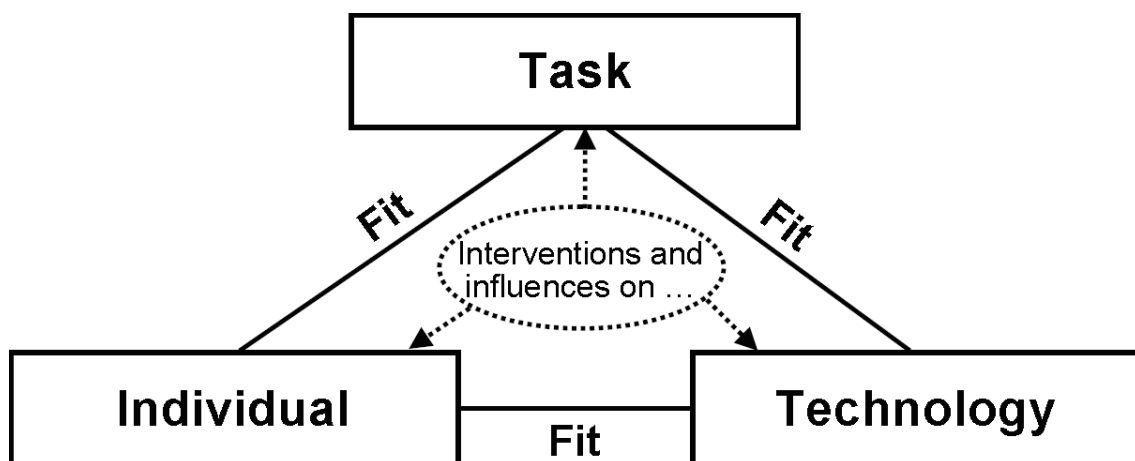

Figure 1: The FITT framework [1]

Consideration of the interaction of user and task is the decisive new element of this approach. This is what all previous models have not considered appropriately [20]. "All of the presented models seem to concentrate rather strongly on individual attribute of the users and of the technology, neglecting attributes of the clinical environment and of the supported clinical tasks that in our opinion are of high importance to understand IT adoption processes" [1]. By applying the framework, one can describe and analyze disruptions of the three fit dimensions, which helps with anticipating or retrospectively analyzing problems. Furthermore, interventions made to improve a system can be analyzed and described in any of the three key factors.

IT adoption in clinical environments is successfully assessed by the FITT Framework [1, 20]. All documented applications were retrospective despite the fact that the recognition of deltas based on the appropriate application of reconfiguration, redesign, or reorganization is one of the advantages of the framework. Researchers determined the degree of adoption of the described systems. The interventions were not based on the application of the FITT framework, but rather on other experiences [1, 20]. Thus, a case study of a recent health IT system is not available.

According to recent studies, 54% of European grown-ups [14] and 61% of American adults [7] search for health information on the internet. Many view the improvement of the quality of health information provision as the crucial challenge in health information supply [11]. To enable users to cope with the flood of information available to them, it is required that tools and processes be developed [12]. The improved efficiency of tailored health information is already demonstrated while the collection of user-specific information needs through electronic questionnaires and the individual processing of health information are propagated.

Therefore, there is demand for a goal-oriented information service based on a user profile [15]. In this context, the question arises as to whether a better outcome can be achieved by using structured, guided search based on the intention of the user that is less dependent on search terms. Expert systems offer a possible solution. Expert systems whose design is based on the knowledge of experts are capable of categorizing and narrowing down blurred, broad issues. Therefore, they are already in use in the healthcare system to support medical decision making [3]. A combination of expert system and search engine, which selectively guides a user, depending on the patient history, to relevant information has not been designed yet. We have developed a prototype web-based health information system to support users searching for health information online [10]. This system is currently restricted to German language and includes information about headaches. The system is evaluated by applying the FITT framework. Therefore, 3 different processes are used: assessment of 20 beta-testers of the system, evaluation of the 528 websites provided by the system and a study evaluating the surplus of the system.

Objectives

The aim of this paper is to assess the appropriateness of the FITT framework for the purpose of health information system evaluation. Furthermore, it demonstrates the usefulness of the developed prototype health information system. Additionally, the paper shows possible improvements based on the determined fit deltas.

Methods

We developed a prototype information system with an integrated expert system for headache patients. The purpose of this information system is to determine the users' information demand and subsequently supply the user with links to related quality-controlled websites. Headaches were chosen above other ailments because knowledge about this disease is readily available and optimally structured for implementation in an expert system [3, 8, 16].

A patient's information demand is determined using a frame-based expert system. Frames are a way to store knowledge in an intelligent system. A web-interface guides the user through the search process by querying the information demand. This action is carried out by an integrated expert system using a rule based inference to determine an internal diagnosis. An assortment of information (consistent with the classification of the International Headache Society [IHS]) [16] is gathered from portals and other trustworthy sources, depending on the output of the expert system. This action is completed by a meta-search engine with a list of reliable websites that hold the quality seal of Aktionsforum Gesundheitsinformationssystem (afgis) [21] or Health on the Net Foundation (HON) [2]. The set items are then arranged by labeled quality and relevance. Finally, the results are presented to the user.
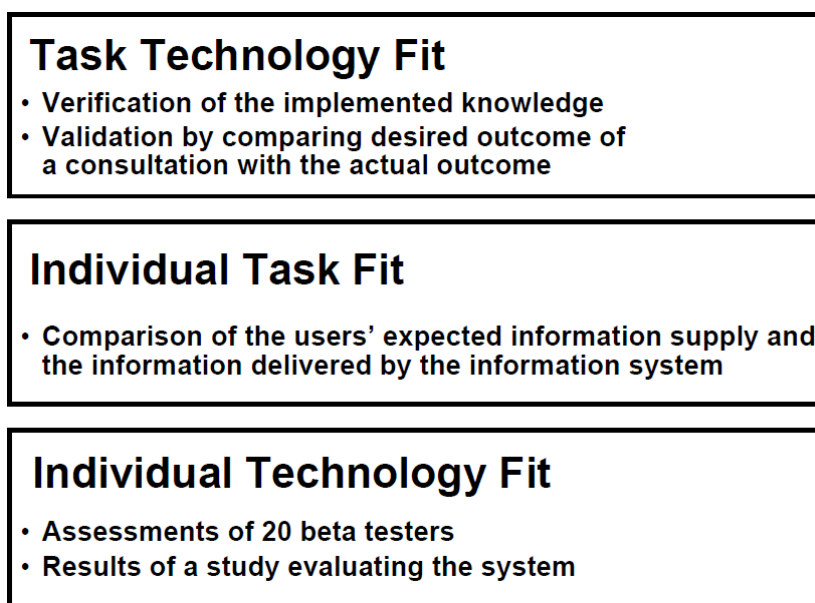

Task Technology Fit
- Verification of the implemented knowledge
- Validation by comparing desired outcome of a consultation with the actual outcome

Individual Task Fit
- Comparison of the users' expected information supply and the information delivered by the information system

Individual Technology Fit
- Assessments of 20 beta testers
- Results of a study evaluating the system

Figure 2: Evaluation of the health information system applying the FITT framework

The FITT framework was used to evaluate the prototype health information system and to determine which deltas to work on in future developments. One can describe and analyze disruptions of the three fit dimensions, which helps with anticipating or retrospectively analyzing problems, by applying the framework. Furthermore, one can analyze and describe interventions made to improve a system in any of the three key factors. The entire evaluation is depicted in Figure 2.

Fit between task and technology

We determined the fit between task and technology by two means: verification of the implemented knowledge, and validation. This was achieved by comparing the desired IHS diagnosis of a consultation with the actual internal IHS diagnosis of the system. For verification purposes, we checked all 199 integrated headache diagnoses for correct implementation. Verification was based on the IHS classification [16] by verifying the correct application of the least number of attacks in total (per month and per year), the duration of the attacks, and the associated schemes.

We established a test scheme including symptoms for all implemented diagnoses to validate the information system. The symptoms were then input into the expert system dialogue, and the estimated internal diagnosis was compared with the expected diagnosis. Additionally, 20 beta testers who already had a practitioner's diagnosis of their headaches used the system. The main purpose of the beta testing was to determine whether the prototype information system was fit for its purpose. Thus, we assessed whether the expert system part of the prototype determined the same diagnosis as the practitioners of the beta testers.

Fit between individual and task

To determine the fit between individual and task, we assessed the users' expected information supply and the information delivered by the information system. Therefore, we extracted the most demanded criteria from the literature: "description of the symptoms", "depiction of the diagnosis according to the IHS classification", „advice on which kind of practitioner is to be consulted", „urgency of the consultation", „method of treatment" and „way of prevention" [5, 8, 16]. In this context, we assessed 528 internet pages; each of which could be provided by the information system depending on the result of the expert system's consultation. The scale ranged from "0" for "no information available" through "1" for "incomplete" to "2" for "almost complete".

Fit between individuals and technology

We used two sources of data to evaluate the fit between individuals and technology: first, the assessments of 20 beta testers, who had the opportunity to rate the prototype information system on a five-tier scale from extremely bad to very good, and could also comment on the system, and second, the results of a study conducted to evaluate the prototype information system. The design of the study is illustrated in Figure 3.
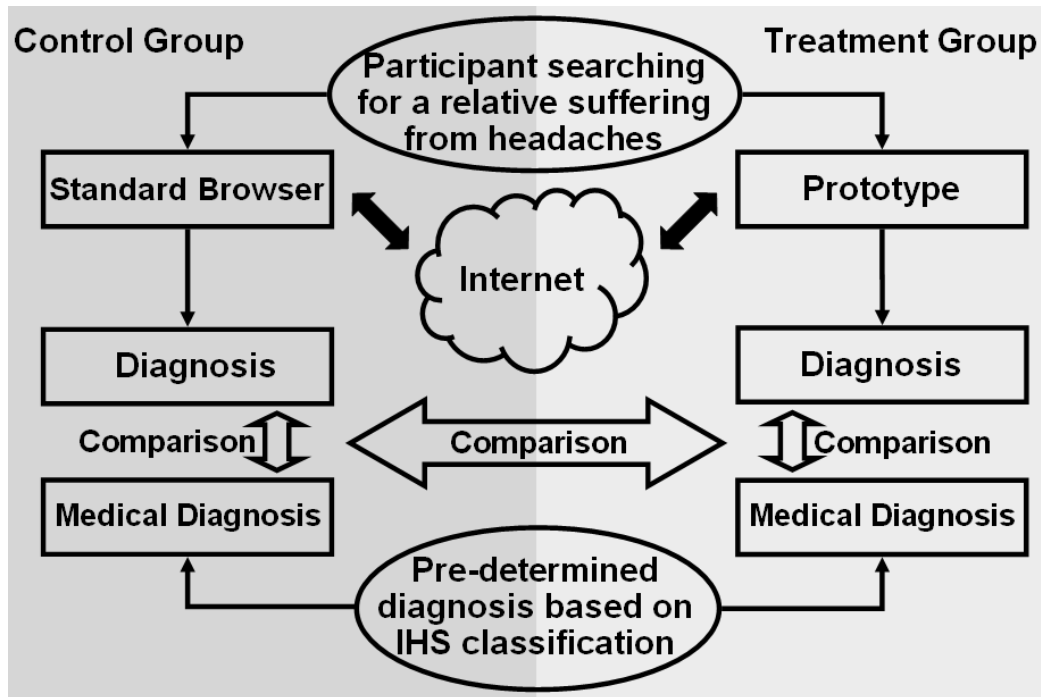
Figure 3: Study design

The study took place at the University of Bamberg in Germany. We approached students and employees and asked them to participate. Participants were randomly allocated to the intervention or control group. They received a pre-filled-in anamnesis form describing a fictitious male close relative who asked them to search the internet for the specific kind of headache that causes him suffering. We derived the content of the form from the IHS classification describing a distinct diagnosis. Two experienced practitioners evaluated the form, and they both confirmed that the content fit the diagnosis. The participants were given an estimated search time of 20 minutes in the study description, but were told that study staff did not limit the actual search time.

The study's control group used common search engines or portals to determine the diagnosis of the fictitious patient. The intervention group used the prototype health information system. After the search, the participants had to input the determined diagnosis according to the IHS classification. The surplus of the prototype was determined by comparing the proportion of diagnoses matching the pre-determined diagnosis in the intervention and control groups. Participants were also asked about their impression of the study. They could rate it as: "a burden", "too complex", "OK", or "good experience". Finally, they could freely comment on the study.

The study group to evaluate the prototype information system was divided into two sections: one dealing with common headaches, or "Episodic tension type headache" (IHS 2.2) and one with infrequent headaches, "Medication-overuse headache" (IHS 8.2) [16]. A total of 140 participants were divided into two study sections. There were 60 in the first section, and 80 in the second. Half of the participants were always in the intervention group. The beta testers were not part of this study.

Seventy-one study participants were female, 63 were male, and 6 did not specify their gender. Ages varied from 19 to 61 with a mean of 23.35 years, a median of 22 years, and a standard deviation of 4.9 years. Eight participants did not provide their age. The median of the highest education level was the German University entrance qualification ("Abitur", 113/133); seven participants did not specify their education level. One hundred eleven participants reported daily internet use, five reported weekly internet use, and 24 did not report internet usage. Approximately 45% seldom (median) read (in books, journals, or newspapers) or watched (on TV) health-related information. The same applied to searches for health information on the internet. The participation time varied from 3 to 38 minutes with a mean of 16 minutes, a median of 15 minutes, and a standard deviation of 7 minutes.

There is a nominal scale independent variable for statistical evaluation which could have two states: "search with prototype" (intervention group) or "search with standard search engines or portals" (control group), and a nominal scale dependant variable indicating whether the diagnosis is correct or not. The appropriate test for these circumstances is Fisher's. Due to the one-sided hypothesis, we used the one-sided version.

Results

The following section presents the results of the evaluation. They are distinguished by the three fits of individual, task and technology.

<u>Fit between task and technology</u>

For verification purposes, we checked all integrated headache diagnoses for correct implementation. We also checked the 349 schemes and 698 symptoms in detail. After the correction of some typing errors, all entries were correct.

We established a test scheme including symptoms for all implemented diagnoses to validate the information system. All 199 kinds of headache were determined correctly. In all cases, the system confirmed the predetermined medical diagnosis of the beta testers. Overall, there was no delta determined concerning the fit between task and technology.

<u>Fit between individual and task</u>

In total, we assessed 528 internet pages, which could be provided by the information system depending on the result of the expert system's consultation. The summarized results (in modal scores) of the assessment are depicted in Table 1. Although the table shows the average number of pages available to give to the reader an impression of the supply, the quantity does not indicate quality because the number of listed results depends on both the number of sites available, and on the specificity of the internal

search term. An ideal search term, for instance, might lead to one single hit where all required information is available.

IHS	Headache group	Mean quantity	Symptoms	Diagnosis	Kind of practitioner	Urgency	Treatment	Prevention
1	Migraine	7	1	2	1	1	2	2
2	Tension-type headache	6	2	2	1	1	2	2
3	Trigeminal autonomic cephalalgias	9	2	2	1	1	2	1
4	Other primary headache	4	2	2	1	1	1	1
5	Headache attributed to Head and/or neck trauma	7	2	1	1	1	2	0
6	Headache attributed to cranial or cervical vascular disorder	9	2	2	2	1	2	1
7	Headache attributed to non-vascular intracranial disorder	9	2	2	0	0	0	0
8	Headache attributed to a substance or its withdrawal	9	2	2	0	0	2	2
9	Headache attributed to infection	9	2	2	1	2	2	0
10	Headache attributed to disorder of homoeostasis	8	2	2	0	0	1	0
11	Headache or facial pain attributed to disorder of cranium, neck, eyes, ears, nose, sinuses, teeth, mouth or other facial or cranial structures	9	1	1	0	0	0	0
12	Headache attributed to psychiatric disorder	10	2	2	1	1	2	0
Key: 0…no info, 1…incomplete, 2…almost complete								

Table I: Information supply for different headaches groups

There were web pages available regarding primary headaches (IHS 1-4) for all diagnoses. However, sometimes exact symptom descriptions were missing. Thus, a user supplied with only the symptoms could not determine a correct diagnosis (in specific: IHS 1.4, 1.6 & 3.4). Additionally, one can observe that hardly any quality controlled information regarding treatment is available for the group of "other primary headaches" (IHS 4). Information on which kind of physician is to be consulted and the urgency of finding a consultation is also hard to find.

We found that in some areas there are many (e.g. IHS 6 & 12), and in others only few quality controlled web pages available for assessing secondary headaches (for IHS 11.8 there were only 3 sites). There are three possible explanations which are not mutually exclusive. First, some secondary headaches are very rare (prevalence below 0.001 %), and consequently there is no information demand on the internet, yet. Second, there is

information on rare diseases available, but this information is not quality controlled in every case and, therefore, not listed in the information system. Third, we assume that the design of the search terms could be optimized to obtain better results. In sum, this leads to a three dimensional delta concerning the fit between individual and task: 1. optimized search terms, 2. more quality control for existing information and 3. more information on infrequent diseases.

Fit between individuals and technology

Two sources of data were used to evaluate the fit between individuals and technology: first, the assessments of the 20 beta testers, and second, the results of a study conducted to evaluate the prototype information system. All assessments of the beta testers were good or better. The testers only positively commented on the system. One representative statement was:

„Very well programmed site (very fast, even with ISDN) and concentrated on the essential. The questions are very detailed. I hope there are enough people keeping a headache diary. I can only advice to".

In the first study section, there was no statistically significant difference (Fisher's, one-sided: P=0.381) between the control and the intervention group. Both did almost equally well: 24 (80%) diagnoses were correct in the intervention group, while 22 (73%) were correct in the control group. In the second section, the intervention group did significantly better (Fisher's one-sided: P=0.031) than the control group: 19 (41%) diagnoses were correct in the intervention group, as compared to 10 (25%) in the control group.

There was also evidence that using the prototype health information system in the intervention group was in both study sections, on average, more time consuming than the free search in the control group. The rating of the study was slightly worse in the intervention group (Ø =3.28) than in the control group (Ø =2.96), although the median in both groups was "OK".

The assessment of the participants' free comments revealed that for some in the intervention group, the expert system dialogue of the prototype health information system had too many medical terms that were not explained in lay terms. They also mentioned that some questions were asked twice and that there was no overview of all answers at the end of the dialogue. The participants in the control group mainly complained about the information overflow, the questionable quality of the information found and the helplessness they experienced while searching.

To recapitulate, the fit between individual and technology is deemed suitable to gather health information online, more time consuming than free online search, and it has some technical problems concerning the expert system dialogue

Discussion

The evaluation of the prototype health information system employing the FITT framework revealed no delta in the fit between task and technology, three deltas (search terms, quality control and missing information) concerning the fit between individual and task and two deltas (time consumption and technical deficits) in the fit between individual and technology.

More intensive research in the field of specific headache information online can serve to address the problem of search terms. Only providers (practitioners, organisations or portals) responsible for supplying this information and having it quality controlled can address the missing quality control as well as the missing information. Former research has already revealed the problem of the propensity of an expert system to be time consuming [5]. This is, in all likelihood, the reason why the participants in the intervention group (who had to spend, on average, more time with the expert system), rated the study slightly worse. The dilemma is that expert systems provide a generic approach, and thus, in some cases, also ask questions which are not relevant to a specific problem. To overcome this shortfall, it is necessary to optimize the inference and the sequence of questions.

This also applies to the technical deficits of the prototype information system. The prototype character of the health information system explains the fact that some questions were asked twice, and some of the medical terms were not substituted with lay terms. It obviously was not exclusively optimized. During the development phase, we did not consider giving the users a final overview of their provided answers. This recommendation is very good advice.

As a limitation, we chose only two types of headaches for the study. The ways in which the information system would perform for other types of headaches can only be assumed. The recording of time spent on the study by the participant was another limitation. It would have been better to additionally record the time spent on the expert system dialogue (for the intervention group only) and on the explicit search. The conclusion that the dialogue lasts, on average, more than 15 minutes can only be concluded from the experiences of the 20 beta testers. This leads to the assumption that the actual search time for the intervention group was much shorter than for the control group. According to Rogers, university students and employees are more likely to be early adopters because they are on average more educated, literate, have a greater ability to deal with abstraction, and have greater rationality and greater intelligence [18]. Thus, the participants do not represent the entire population.

The advantage of the FITT framework can be determined through a comparison with other models. An application of the TAM [4] for instance, with the crucial factor of "perceived usefulness" [13] certainly would have revealed the deltas in fit between individual and technology. Yet, the TAM has no means to determine the deltas in fit between individual and task. [1, 20] The same applies [1, 20] to the employment of the

TTF [9]. If the information success model [6] had been used in this evaluation, we could assume that this would have led to similar results in both study sections as it concentrates on interactions of factors like system quality, information quality and user satisfaction. The advantage of the FITT framework is that it can explain "why the same IT system can be adopted in a different way, and have rather different effects, in various settings". [1] This paper shows that the prototype information system did better in a more complex setting.

Conclusions

As proposed [1] the FITT framework provided a proper tool to evaluate the prototype health information system and to determine which deltas to work on in future developments. It was useful to utilize the framework for an "a priori assessment of the goodness of fit of the three fit dimensions, prior to the initiation of a deployment effort" [20]. In sum, the evaluation revealed that a health information system based on an expert system and a meta-search of quality-controlled websites is suitable for supplying the users' health information demand. When transferring the successfully evaluated prototype health information system to a system in use, it has to be enhanced by working on the shortfalls. Specifically, the inference and the sequence of questions, as well as the search terms need to be optimized. Furthermore, medical terms have to be replaced by lay terms. Additionally, we should consider providing the users with a final overview of their given answers. Finally, all providers of high value health information are encouraged to have their websites quality-controlled so that they can by found by systems like the prototype evaluated in this paper.

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