Models for the acceptance of tele-care solutions: Intention vs behaviour

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D.G. Bouwhuis, L.M.J. Meesters, A.A.M. Sponselee. Models for the acceptance of tele-care solutions: Intention vs behaviour. Gerontechnology 2012;11(1):45-55; doi:10.4017/gt.2012.11.01.007.00 **Purpose** Tele-care is expected to replace regular home care when an integrated set of health monitoring devices and a communication network enables nursing staff to provide remotely appropriate care. While cost considerations and scarcity of nursing staff are strong motivators for tele-care, the actual effectiveness and acceptance of tele-care systems still falls short of expectations with an attrition rate often higher than 50%. As standard models of technology acceptance are poor predictors of actual adoption of tele-care systems we argue that the theoretical assumptions of models of technology acceptance are inadequate, and that the complexity of tele-care implementation has many facets that are not appropriately factored into those models. The identification of relevant factors will benefit and improve the development and acceptance process of tele-care systems. **Method** The study is based on a broad range of evaluation studies of tele-care systems, under development or installed in the Netherlands, in which many variables could be observed from the earliest stages of conception up to the full operation and (sometimes) demise of the systems. In addition the assumptions behind technology acceptance models (TAM) have been critically analyzed and serious methodological flaws were identified. Also the deployment of tele-care systems was systematically compared with the introduction of application software in industrial settings as described by TAM theories. **Results & Discussion** A main reason for poor acceptance level is that tele-care does not materialize as a stand-alone product with a specific and clear functionality, like a TV set or an espresso machine. Tele-care can have a surprising variety of instantiations and functions that easily obscure the functionality for the individual user. Another reason is that, even on somewhat longer trial periods, it is not evident to what extent it supersedes other and earlier functions and services that were available to the client. While many clients claim that their tele-care system is easy to use, its inherent complexity often seriously reduces its actual effectiveness. Currently there is more evidence on factors that reduce the adoption rate, than on those that increase it. We also show that part of the poor predictive value of the technology acceptance models can be explained by an inadequate interpretation of the attitude and intention concepts. There is, fortunately also more recent evidence that the use of assistive systems like tele-care can be promoted effectively by increasing self-efficacy of users. Both introductory individual guidance and errorless learning appear to affect user-system interaction in rehabilitation and tele-care to a considerable degree.

Keywords: technology adoption, user acceptance, quality of experience

From a technological point of view the state of the art in ICT, sensing and monitoring products is sufficiently advanced that, when integrated in a tele-care system, it can cover a considerable part of the care for older people. From a care organizational point of view the deployment of tele-care becomes a pressing necessity in view of shortage of care staff, the increase in number of older people and the associated higher expenditure.

The growth of the older population has also spurred governmental organizations to support introduction of tele-care in mostly regional projects. In particular the European Commission has been active with programs and established the TIDE program (TIDE: Technology Initiative for the [socio-economic] emancipation of Diabled and Elderly) which ran from 1992-1994, and from that time on a special section for the disabled and elderly was created in the 'Telematics

applications programme' of the Fourth Framework program like 'ICT for Inclusion, ICT Information and Communication Technologies'. The 6th Framework Program, finally, introduced the concept of eInclusion, which gave research and development on the field of health and elderly care a strong impetus[2]. Next to the framework programs there were many cross national programs (ITEA, Interreg I-IV), national and regional endeavours, sometimes also large municipalities, all of them bearing witness of a concern for the growing burden of the supply of care to a growing number of older persons.

At the time of TIDE Internet was just in its infancy and nowhere figured in the discussion concerning tele-care. Since then Information and Communication Technology development has been accelerating, and effected fundamental changes in considerations what a tele-care system should consist of, and how it should operate. With the expanded functionalities, decreased component size, and often a significantly lower price, possibilities for tele-care seemed around the corner.

The battle between functionality and cost

Curiously, the basis for tele-care components and architecture derived from domotics that found its way in houses of the future, and domotic systems were frequently seen as expensive toys for affluent home owners. With the advent of new technology it was realized that similar systems, originally intended to heighten comfort, might also be used for the infirm and mobility challenged people. Early developments in this area comprised functionalities like remotely opening doors and/or windows, opening and closing of curtains and controlling illumination. Gradually new functionalities were introduced, like an alarm pendant, fire alarm and movement detectors that could switch on lights when people were busy in a specific location of the house and switch them off when they left.

One refractory problem has long been, -and still is -, that of interconnectivity, that at the time could only be solved by wired or radio frequency networks and dedicated hubs. As many physical networks were derived from industrial networks their cost was often prohibitively high, but special networks for domotic use were not well standardized, often rather slow and had a narrow bandwidth. This was mainly caused by the presumption that simple switching, as exemplified above, did only involve limited information transfer. Efforts to standardize home bus systems were stimulated in the European Framework programs and involved EHS (European Homebus System) and EIB (European Installation Bus).

One related problem was how wired networks could economically be installed in existing homes where older people wanted to stay. This is one of the reasons why EHS was designed to operate on power line, using the home electricity network as the physical network.

Yet, in hindsight it can be seen that this type of domestic home networks was motivated more by a technology push than a real market pull, considering the limited functionalities that were not properly matched to felt older user needs. Also a wider distribution of these systems ran aground for unwanted reasons. Component cost was quite high as most of those were custom products manufactured in very small numbers. Safety requirements introduced special precautions to be taken. Automatic door openers, for example, should in no circumstance squash unsuspecting passers-by against a wall, which necessitated special safety measures that raised the cost considerably. Strangely enough, at the same time automatic garage door openers, in order to prevent a toddler or pet being crushed, had exactly such features, but at a fraction of the cost. Then, inasmuch as the system as a whole had to be installed in far from uniform homes, installation costs had to be included which initially were as high as the system cost, but quickly grew to double the system cost, or more. Eventually, total cost and uncertainty about which party was footing the bill, made similar systems infeasible for installation in single homes.

In the Netherlands the scale of nursing homes and sheltered housing made it possible to renovate buildings and flats and improve comfort by installing domotic products that were supposed to increase the well-being of the older tenants. Because of the scale, and the renovation that took place anyhow, costs could be mitigated and various comfort-increasing provisions be put into place[3].

Examples

It is illuminating to give two examples of such applications. In the bedroom sensors were installed to detect when one of the sleepers went out of bed to go to the toilet. Low intensity lights then illuminated the floor on the way to the toilet, in order not to wake up the partner and enabling a safe passage to the intended place of service. It appeared, however, that even when sleepers turned around in their beds, the sensors interpreted this as getting up, and so switched on the illumination. In addition, all bedrooms were at the streetside, where new lampposts had been positioned by the city to further improve living conditions, which gave enough light to make additional lighting totally redundant. All tenants asked therefore to remove the sensors.

Another, somewhat bizarre situation arose when the bathroom lighting was made dependent on human movement. As long as movement was detected the lights were on, and switched off when the bathroom was left. This was not only a matter of comfort; it also avoided mounting an electric switch in the mostly humid bathroom. Two problems manifested themselves quickly. First if older persons were sitting on the toilet bowl, sometimes for some minutes, their lack of movement made the lighting switch off. On the other hand, as often the washing machine was located in the bathroom, it was spotted by inquisitive tenants that movement of the washing machine could make the lights switch on without necessity, thereby creating a wasteful loss of energy. To make things worse, several tenants removed the lights physically from the bathroom, and placed a floor light in the bathroom instead, which could be controlled by themselves, but presented a distinct safety hazard.

In some cases surveys were held to enquire whether the tenants were satisfied with the new, comfort increasing provisions[4]. Here a fairly uniform dissociation emerged, which is at the basis of the rationale of this paper. Almost unanimously tenants asserted that the new provisions were very useful, worked well, and constituted a great asset of their renovated housing. Whenever investigators asked the same persons to demonstrate the new functionalities it appeared that only few people could actually control the new devices, or needed extensive perusal of the manual, while in some cases it was discovered that, erroneously, some parts of the system had not been installed at all.

When asking the tenants to actually switch on the functions, like opening or closing the blinds, this rarely led to success. In such cases the usability rating by the tenants was low, or very low, and in no way corresponded to the positive evaluation given before. At this point a likely assumption is that in judging the system as a whole it is seen as a welcome enhancement of the living conditions, and subject to a social desirability effect. However when working with the components and details of the system, which requires specific insight in the associated operations, those parts of the system are exempt from social desirability, and present difficulties that make them user-unfriendly. It is akin to a TVset that is valued highly as a product, but only shows disappointing programs.

There have been, and still are, many instances of similar domotic upgrades to existing living accommodations, and the remarkable thing is that both the shortcomings of the installed technology as the experiences of the users are so similar over different projects[3,4].

Frequently control of the functionalities is hard to understand, or functions are not comformant with the behaviour of the users. All projects have instances of functions that have not been installed, or are inoperative. Sound signals of different devices, e.g. doorbell and phone may be identical, and forgetting to switch the burglar alarm on or off may lead to alarms with embarrassingly loud siren signals. Remote controls feature a far greater number of buttons than there are functions, and do not show unambiguously what the associated functions are. Often incomprehensible icons are employed to identify functions on small control panels. In one case the remote control had to be pointed at a mediabox in a far corner of the living room, while the TV set was in the opposite corner because of the location of the cable connection socket. The natural tendency of the users was to point the remote control in the direction of the TV set, which of course did not work. Several users positioned a mirror such that the line of sight would target the mediabox, only to discover that a conventional mirror does not reflect Infrared. One user painted a section of the wall white with a special paint that eventually worked moderately well.

To the extent that the nature of the domotic systems to be installed is largely determined by the management of housing corporations, where tenants can often express their hesitant preferences, the eventual choices are mainly determined by economic considerations and constructive possibilities. This means that the users of such systems a) do not really choose the functionalities, b) do not have to accept them and c) note that the implemented functionalities do not well match existing needs that elderly people might have. It should therefore not come as a surprise that acceptance decreases after actual system use[5] and that the actual number of users of these systems after some 18 months generally will have been halved from what it was at the start[6].

Tele-care implementation

Persons who are living (quasi-) independently, however, do not nearly all have serious, or even minor medical problems. Yet, care organizations must specifically focus on those older persons who have, and did engage in a medically oriented extension of the domotic system. The emergence of these systems was only gradual and comparatively late.

In the past years four main distinct health areas can be identified on which tele-care solutions focus: (i) cardiovascular problems, (ii) COPD,

(iii) Diabetes, and (iv) Mobility problems, that formed the mainstay of an impressive array of research projects, many of them funded by the EC.

In addition to the four main care topics mentioned, another application, not specifically medically oriented, was often the first to be installed in the homes of older persons, which was video communication. Though early video communication systems suffered from the limited bandwidth of existing networks, and necessarily featured expensive image compression technologies, the fast introduction of ADSL and glass fiber networks enabled high quality image and audio at affordable prices[7,8]. The standard service consists mostly of a secured connection of an older person with a care center, which is used by the operator on duty to make daily checks on the condition of the client. This service may be enhanced by various other applications, like banking, dieting information, or gaming.

It is important to realize that both domotic systems and video communication are not selective with respect to specific health problems. This means that a wide range of the population can employ them without changes to the system, which has a definite price advantage. As soon as specific diseases have to be addressed by assistive systems, this situation changes dramatically. In view of the large variety of diseases and handicaps that may occur in old age, it is not surprising that most tele-care systems have restricted themselves to the four main medical categories. Even then, the assistive or monitoring technology must generally be individually adapted, which not only raises the cost but also runs into the limits of interoperability of devices, which, in turn, reduces reliability and ease of use.

In the attempt to provide optimal care in case of emergencies quite many projects have included hospitals and specialists in the architecture of the tele-care system that basically function as nodes in the communication network, which often gets most attention in a technology-centered context. It is therefore not surprising that running such systems, e.g. for cardiac monitoring, are so expensive that hardly any of these projects outlives the duration of the funded project. One of the basic problems here seems to be that the likelihood of an emergency is highly overrated, whereas it is tried to cover all possible occurrences of those in the shortest possible response time. It is, consequently, particularly rare that beside the technology implementation a business plan is created, and that takes the statistical nature of prevailing diseases and health crises into account.

Acceptance vs adoption

The extremely high cost of many tele-care research projects, that originally were intended to reduce the ever-increasing cost of care, has given rise to considerations on the extent to which the technology is accepted. Acceptance in this case has many receivers. In the first place it is the care organization that has to find a place for it in its daily operations. Relatives of the client may have strong opinions about tele-care, either positively or negatively. If a hospital is involved it also has to integrate the new activities in its scheduling of operations. Further there are categories of nurses that have to cooperate with the care organization, like diabetes nurse, COPD nurses, or nurses who take care of medication adherence by elderly, or food distribution. The most important of all is understandably the end user, the client of the care organization, who should be the central beneficiary of tele-care. Though an analysis of the motives for all of these parties would be relevant and opportune, the current analysis limits itself to the acceptance by the care client. Various surveys and in depth studies make clear that this is not at all a given. Sponselee[6] shows that in a number of different projects the attrition rate is deplorably high, and generally of the order of 50% or more. This actually is an underestimation, as tele-care systems are only installed in cases where the care client agrees with it, and some clients feel that they will not need it, whereas the individual health situation would warrant it.

As suggested above, demand for tele-care systems from the part of the client is lower than the size of the elderly population and its ailments would suggest, while the supply of the needed components of tele-care systems is at an all-time high. It is, therefore, only logical that investigators looked at means to get insight in the acceptance of products and systems, and in particular of tele-care systems. The most influential theory by far is the Technology Acceptance Model (TAM)[9]. Basically, this is an attitude model that attempts to predict in what conditions a product or system will be accepted by the user. The predictions of the TAM model have only been moderately successful, not exceeding 60% of explained variance. The situation is actually somewhat more complex as the concept of 'acceptance' is used in an ambiguous way. Mostly acceptance is observed when a system is installed and operational. However, while tele-care systems may be installed and operational, this does not imply that the clients are using them for their intended purpose, or at all. If they are actually used on a daily basis or in a routine fashion, it is preferable to speak of adoption, the rate of which may be much lower than that of acceptance.

The specific problems encountered to apply TAM to tele-care situations have led to a proliferation of variant models, with ever more components and more intricate connections featuring a number of arrows that, citing L. Henderson[10], look rather like Custer's last stand. An alternative description was coined by Geoffrey Hinton[11], who defined the un-arrow, indicating the lack of connection between two boxes, while all other boxes were connected, and which would make the image considerably simpler.

In fact TAM was not made for tele-care systems at all, but for the acceptance of software applications and computers in an occupational setting. Furthermore, this involved having to choose between two or more types, one of which would actually be purchased and deployed. Consequently, there was no option for either 'nothing' or 'the computer system', which there is in choosing or accepting a tele-care system or not.

Attitudes

The concept of attitudes has been with psychology from its inception, and its basic constituents comprise cognitive, affective and conative processes[12]. Conative stems from the Latin verb conare, meaning 'to attempt, to try'. This distinction in three types of processes, in turn, is still much older and can be traced back to Socrates, Plato and later Aristotle[13]. Brett[15] mentions that Augustine also used this threefold concept that can be translated as 'knowing', 'feeling' and 'willing'. Throughout history the triple of 'thought, feeling and volition' have been considered to be the expressions of the constituent phenomena of the mind. It is so basic that it is sometimes called the ABC model, affect, behaviour and cognition.

The concept of attitude can be defined as: a positive or negative evaluation of people, objects, event, activities, ideas, or just about anything in your environment[15,16]. The affective part of an attitude is the emotional response, the cognitive part represents the knowledge and beliefs, while the behaviour part stands for the behavioral intention of an individual. Both Rosenberg's theory of attitudes[17] and that of Ajzen and Fishbein[18] are based on this tripartite concept. Yet, Jagdish and Park[19] found a low correlation between the predictions of both theories.

The influential attitude theory of Fishbein and Ajzen[20] is known as the Theory of Reasoned Action (TRA). In an era in which emotion and affect were not fashionable concepts, the affective part was phased out at the time, to give way to Subjective Norms (SN). The cognitive part was represented as 'attitudes' defined as: 'The sum of beliefs about a particular behavior, weighted by the evaluations of these beliefs'. In conjunction with beliefs this part was called Attitude Beliefs, or AB. The behavioral part was termed 'Behavioral Intention' (BI) that is supposed to be the precursor of behavior, -or action (B). The basic model entails that AB and SN jointly determine BI, but with a different weighting factor.

The Extended Fishbein Model is:

$$w_1 AB_b + w_2 SN = BI -> B, \quad [1]$$

where
B stands for actual behavior

In this formula w_1 and w_2 represent weighting factors. Despite the conciseness of this formula, it should be noted that all three variables are covert variables and thus cannot be observed directly. Another, and probably the most important issue of all is that the arrow between BI and B is unspecified. In the absence of directly observable variables, the values of the weighting factors are correspondingly harder to establish. It can also be seen that this simple additive model lends itself easily to extensions whereby, e.g. AB can be predicted by two or more variables, etc. or by adding additional variables in the main equation. This was proposed by Ajzen[21] in the Theory of Planned Behavior (TPB). Here Ajzen[21] introduced another concept, called Behavioral Control (BC), which, in turn, was derived from Bandura's concept of self-efficacy[22]. Self-efficacy refers to the belief that the person has in his own competences, being able to execute requisite activities. Ajzen[23] observed that general attitudes failed to predict specific behaviors, which is why he developed a model in which the three variables AB, SN and BC predict BI, but are also interconnected and so influence each other.

Each of the variables AB, SN and BC, further, are specified as linear combinations of a set of n beliefs associated with a strength b_i that combine in a multiplicative fashion with the subjective evaluation e_j of the attribute of that belief.

It should be clear that whereas none of these belief strengths or attribute evaluations are directly observable, and the compound variables AB, SN and BC that result from those are strongly interconnected, that any meaningful parameter estimation of such a model is out of the question. Though it is suggested that some parameters can be estimated by means of regression, it is obvious that regression coefficients will be very unstable in view of the many parameters and the dependency between the basic components[24,25]. Similar concerns hold for Latent Structure Analysis, that in contexts like these produces unstable regression coefficients.

Finally it also leaves untouched the issue of how well actual behavior is predicted.

TAM is a special version of the two attitudinal models discussed above, in which the Behavioral Intention is predicted by Perceived Usefulness (PU) and Perceived Ease of Use (PEU). PU may be equated with beliefs and evaluation (AB) of the system to be acquired and PEU is linked to behavioral control (BC). Note that Subjective Norm is not included as the choices take place in an occupational setting in which Subjective Norm is not applicable. Yet, it may be noted at this point that the social environment may strongly influence subjective norms, which is related to the persuasive influence that relatives of the clients may have on the acquisition of tele-care. In this respect classical TAM has little to offer.

One issue that is relevant in connection with the Technology Acceptance Model is that of measurement scales. In trying to gain insight in the numerical values of the many parameters subjects are usually requested to rate objects, properties and beliefs on a categorical scale, say a 7-point Likert scale, varying from negative over neutral to positive. Other scales may ask for the level of a property, from 'not at all', to 'extremely'.

The psychometric status of these scales is doubtful to say the least. While Thurstone already presented a clear measurement methodology[25], this is in practice never heeded. Rating scale data are at most lying on an ordinal level, yet they are routinely treated as ratio scale data, which in general will produce unreliable and unstable parameter estimates. If now Behavioral Intention cannot be predicted in a reliable way, assuming that it actually exists, then the link to actual Behavior becomes very tenuous. In that sense the predictive value of TAM may seem even better than expected for methodological reasons.

Focusing on the basic constituents of TAM the Perceived Usefulness is of doubtful relevance in a tele-care setting as seen for the viewpoint of the client. The problem is that in many cases the client is unable to have a clear image of the benefits of a tele-care system. There are at least three reasons for this. First a tele-care system definitely does not belong to the technology generation of the client[26-28]. Similar functionality did simply not exist during the formative period of the older client.

Second, there has been no prior exposure to the tele-care technology after the formative period, which might have helpful in understanding its operation[29]. This is probably also the reason why older persons can be relatively easily persuaded to use a mobile phone, as that is an application they have grown accustomed to and is easier to take along than a wired phone. Third, to the extent that tele-care systems are in continuous development and also are generally heavily interconnected with other applications and parties, it is quite hard to explain exactly what benefits tele-care will produce.

There is one other reason why older people are hesitant to accept a tele-care system, which is that they express that they do not need it yet[30]. Though they may appreciate the value and usefulness of tele-care highly, they feel that it is for older people than they are themselves. Only when their health is deteriorating they would graciously adopt the system. In the first place, this goes against the inherent value of prevention for which most tele-care systems are excellently suited. But on the other hand, the same persons are not willing to be confronted with potential ailments that may beset them in the future. Tele-care invariably is associated with frailty and disease, and this is exactly what they try to avoid. This is similar to a situation when in a neighbourhood police surveillance is intensified. Though objectively this should reduce criminality, the inhabitants are constantly reminded of criminality by encountering police, and feel the situation has worsened.

Partly similar arguments hold for the other concept, that of perceived ease of use. Not having had any previous experience with tele-care it is quite hard to assess the ease of use. Whenever the tele-care system has been installed, it is not always easy to make it operate successfully. Also there are various reasons for this. One persistent problem is the design of the interface. In actual practice the code for the interface program is made by relatively young programmers, who are unfazed by software and system errors, and often are immigrants who do not speak and write the older people's language well. With the background of strictly technical training, there is usually little understanding of what makes an interface easy to use for older people.

Secondly, most tele-care systems are assemblies of many different components. For diabetes, for example, they would consist of a weighing scale with digital readout, a glucose meter that is accompanied by a set of lancets or samplers for blood absorption and a computer that combines the information, stores it and sends it to a diabetes nurse. There are numerous things that can go wrong, and indeed go wrong, which is why, again, more than half of the participants will abstain from further participation. An interesting

observation is that often the care organization cannot believe that some clients experience the components, like the glucose meter, as particularly user-unfriendly. It usually suffices to show them video recordings of clients struggling with the equipment and showing the affective reactions that are so conspicuously absent in recent attitude theories[31].

Nevertheless it should be noted that some older people have had an adequate exposure to the use of computers and are having no problems whatsoever in running the system. Still, the connectivity and compatibility of the components, comprehensively brought together under the term interoperability, is usually far from optimal, which can produce service interruptions that sometimes may go unnoticed by the clients.

A final point, related to perceived usefulness, is that when the system operates to satisfaction, and the particular disease can be well controlled, nothing much is happening in the daily life for considerable periods of time. This may give the impression that the tele-care system has a limited usefulness that still requires regular operation by the client. As a consequence the perceived benefit of the system will diminish over time. Also the presence of boxes of equipment with dangling wires is frequently mentioned as an eyesore that should be put out of the way. Many tele-care systems also make use of existing products in the home, like a TVset that is used as well for watching TV shows. This often creates interference between types of usage, where the entertainment is frequently preferred. Sometimes the video communication that takes at a prominent place in the living room is seen as being privacy-intruded, where other persons present can follow the exchange of information.

This, however, is the case when the client is relatively free from chronic diseases and not mobility restricted. It has been found that the appreciation of the benefits of tele-care is rising after a serious health incident has taken place, like a cardiovascular incident[6].

Introduction and exposure

Considering the poor predictability of not only acceptance of tele-care, and even more, adoption of it in daily life activities, the question is what can be done to improve the diffusion of tele-care systems in the elderly population. It is useful to look at the current ways in which older clients are made familiar with tele-care to be installed.

Mostly there are a couple of public sessions where the aspiring users are being informed concerning the type of tele-care, the functionality, the scheduling and the cost, whoever this may bear. It appears that these never cover all of the potential clients, and that the information value of the meeting is often denied. The meetings, being public, offer less opportunity to inform the participants on an individual basis.

Next, the installation process is frequently beset with difficulties, causing many more than a single visit to get the system operational. Though this may not be a reason of overriding concern for technicians, it is considered to be particularly annoying by older clients. Bouwhuis, Meesters and Berentsen[4] mentioned that in 10% of all installations more than 10 visits by technicians were needed to make the systems operational, while in 89% repair was necessary. In a number of cases this has been the reason why clients end participation and request removal of the equipment that was already installed.

In all cases we have encountered, one or more user manuals were distributed to individual homes. While this must be seen as obligatory, from a strictly principled ergonomic point of view a manual should not be necessary, as user control should be intuitive, or not needed because of automatic procedures.

In actual practice manuals are present in clients' homes, but being mislaid they are often unfindable, and if they are found require careful reading that has apparently not taken place before.

Finally, there is a persistent occurrence of inoperative components of tele-care systems, which, apparently cannot be solved during a project's lifetime. This may be caused by erroneously omitting to install them, but often connection problems cannot be fixed, even after repeated visits by a technician. It also is mentioned as annoying by older clients that at every visit a different technician is looking after the equipment, which is damaging for their trust in the reliability of the system.

One of the most productive findings in studying a number of tele-care projects is that the acceptance and adoption of tele-care can to a large extent be predicted by the amount of individual guidance and training that the clients receive. This training procedure has to satisfy a number of requirements that have found wide support in many other studies.

First, the perceived self-efficacy[22] should be increased. Self-efficacy has been found to have a very powerful effect on both performance in computer tasks as well as in rehabilitation and coping with many types of chronic diseases[32-40].

In a series of studies Nap[41,42] investigated the effect of induced task performance, i.e. the suggestion given to older persons what level of performance was expected of them in computer tasks. If this was positive it significantly reduced stress. Moreover, a high expected task performance, which is a measure of self-efficacy, produced high efficiency and high effectiveness in the same computer tasks. It also appeared that negative feedback, and negative feed forward, significantly reduced task performance and increased stress. In the words of Gallagher et al.[43]: "As self-efficacy is the only predictor known to be amenable to intervention, self-efficacy enhancing support should be promoted".

The importance of such a statement can hardly be overrated: apparently older clients can and will much more successfully perform computer tasks and work on their increased well-being if the level of self-efficacy can be increased. Another positive message of this statement is that self-efficacy can indeed successfully be heightened in a relatively simple way with relatively little effort.

There is one other procedure that can be applied successfully to train older persons in computer and product control tasks. It is called errorless learning, which was originated by Terrace[44] in the framework of training pigeons to discriminate between two alternatives. The basic idea is that at first the wrong stimulus is presented in such a way that it will not evoke a response, for instance by a short presentation, and a low luminance. While the correct response, displayed prominently, is being learned in regular trials, the alternative stimulus is gradually made more similar to the correct one, except in one clearly discernable feature. In situation like these it could be observed that no wrong answers, - errors- were given at all. In recent years the procedure of errorless learning has been extensively used in rehabilitation[45,46] after a stroke. More recently, errorless learning was also applied in memory training of older people, which turned out to be particularly successful[47]. This learning procedure does not eliminate errors altogether, but tries to limit the production of error responses as much as possible. The theoretical background of this is that repeated exposure to error responses may cause a higher activation level of these responses in memory, which is unwanted. This, in turn goes back to the exemplar theory[48,49] holding that every presentation of a stimulus reinforces the activation state of that stimulus in memory. Avoiding error responses will thus contribute to a lower activation state of those responses. It has been shown that e.g. spelling errors accumulate by repeated exposure to wrongly spelled words[50,51], which is one of the instantiations of how errors to some extent will also generate further errors.

Prediction of acceptance

It has been tried to show in the foregoing analysis that the application of the TAM model from a business software domain to a tele-care domain is not straightforward and even misguided. One of the main reasons is that the concepts of Perceived Usefulness and Perceived Ease of Use have a very different interpretation in the tele-care domain than in an occupational setting. One might even state that in the tele-care domain they hardly have an interpretation. A study by Agarwal and Prasad[52] shows, taking into account the limitations of the TAM model, that there are some important individual differences that have to be taken into account. First, in line with what was mentioned above about tele-care application programmers, those persons who are technology providers, rather than end-users rate the Perceived Ease of Use much higher than the end-users. A second finding relates in a broad sense to technology generational effects. Persons with a high level of education, or those who had previous exposure rated Perceived Ease of Use higher than those without. This corresponds exactly with the findings of Langdon, Lewis and Clarkson[29].

As a last point Agarwal and Prasad[52] found that participation in training increased very much the Perceived Usefulness, which is understandable as this will make users familiar with the functionalities of the system. The model of Agarwal and Prasad explained 57% of the variance in perceived usefulness and 18% of Perceived Ease of Use and was also applied to information technology innovation in a company. More recently Huang[53] modified the TAM for tele-care and, in addition, did not employ Structural Equation Modelling but a neural network with back-propagation. This allows the inclusion of non-linear effects in the model. This produced 75% of explained variance for Perceived Usefulness, and 30% of that of Perceived Ease of Use and is clearly superior to the classical TAM approach. The results showed that Perceived Usefulness should be raised significantly to increase acceptance, and that education and training appeared especially important. The absence of individual differences in the original TAM has also given rise to an adaptation of it, which was called UTAUT[54]. In this model the concepts of Perceived Usefulness and Perceived Ease of Use have been scrapped to give way to four variables concerning internal and external expectancies, moderated by four individual variables that, in principle, give rise to 16 effects that impinge on Behavioural Intention. One individual variable is of special interest as it is termed 'vol-

untariness of use', which is essentially what the model intends to predict. Inasmuch as practically always the ratings of descriptions are positively correlated, the impression of circularity here cannot be avoided. While no one will try to understate the importance of any of these variables, their high correlations beg the question of how many there are, and which are actually the basic ones. Yet the most important issue is that the model does not have an observable and objective dependent variable, which is the frequency of actual and routine use of a tele-care system.

A final word concerns the investment that one has to make in order to promote a successful uptake of tele-care systems. It is obvious that individual training will be more expensive than organizing meetings and printing manuals. In addition, it requires specially schooled supervisors and trainers to realize the intended degree of self-efficacy and to make clear what the benefits of tele-care are. This means that some critical factors for widespread adoption of tele-care solutions may not be technical but psychological. In the unrelenting quest to cut cost of care it will not be easy to maintain a sufficiently effective training schedule that will permit, or rather enable successful participation in the functional operation of tele-care solutions.

Dependence and locus of control

Three main motivations were presented in the introduction for the development of tele-care systems, one from technology, on from the care organization, and one from governmental agencies. To the extent that older persons formed no part of this, these motivations can be said to be normative. Indeed, from a perspective of any non-elderly party, tele-care seems to be beneficial, to increase safety, and to increase well-being.

One reason why older persons, however, refuse to make use of tele-care was mentioned above, implying that continuous exposure to health and physical status confronts the client with morbidity associations he would like to avoid. This feeling can perhaps be well expressed by the concept of locus of control[55]. Locus of Control reflects the tendency to attribute events in the interaction of the person with the environment to external forces (external) or to oneself (internal). These two concepts appear not to be bipolar, but rather more orthogonal, though a low score on both does not occur. External locus of control is high in early youth, but generally declines in adulthood, and remains low until relatively high ages, after 75. At the same time internal locus of control that was high during adulthood, shows a highly variable decline, unchanged in some persons, but lowered in others. A position on each of these two variables reflects the level of independence of a person. This creates the interesting situation that the normative approach of introducing tele-care is confronting the dependence or independence of the older person. From the viewpoint of locus of control, this does not have to be conflicting. An independent person can accept tele-care, making him dependent, probably only to a limited degree, but given the ease of use and perceived effectiveness it does not necessarily affect his level of internal control. A person with high external control, in contrast, might be tempted to try tele-care, as it consolidates his worldview. Alternatively, both external and internal control could have the opposite effect. A high level of external control might lead to consider tele-care as something that in vain tries to change the situation; a high level of internal control could cause any intrusion on private life to be excluded. Fortunately, the literature, referred to above in the framework of self-efficacy, indicates that not only can self-efficacy be increased by proper training methods, but that an increased level of internal control stimulates the usage of rehabilitation and tele-care systems.

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