

## A new approach to assess e-health applications

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### Abstract

*ICT (Information and Communication Technologies) and its applications are increasingly looked upon as a potential answer for the requirements of a modern society, with demands for a better healthcare, improvements in medical outcomes, and maintenance of a relatively high quality of life, especially with the onset of chronic health conditions coming to the fore as a key issue.*

*However, understanding the relatively low uptake of ICT systems in healthcare is important so as to design more effective and successful e-health applications.*

*In order to assess a system in a holistic manner, both validation and evaluation need to be considered. Validation assesses the concept of the system, the need of such a system. Evaluation, on the contrary, analyses the system once implemented. It takes into account aspects such as functionality, appropriateness of scenarios, language, etc. Subjective and objective measures ensure that the evaluation is properly carried out. Besides there is a need for assessment by all the relevant stakeholders in order to understand the requirements from all the different points of view.*

*This paper presents an evaluation and validation methodology valid for a broad assessment of e-health applications.*

### 1. Introduction

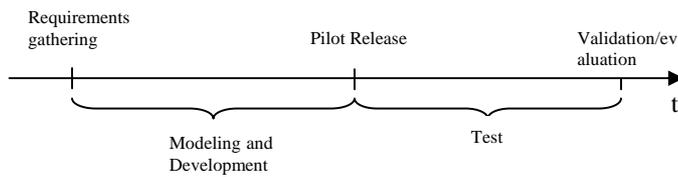
PIPS is an IP project in the e-health IST priority, the aim of this project is to develop an intelligent environment that enables ubiquitous management of citizen's health status and to assist health professionals in coping with some major challenges, risk management and the integration into clinical practice of advances in health knowledge. Our methodology focuses on developing a new model to understand why individuals would use new ICT, to perform changes in

their lifestyle, a multifold issue that can be addressed by analysing their willingness to change health behaviours and to do so by using an e-health application. In order to test this project different pilots have been developed. The goal of the PIPS pilots is to demonstrate the applicability of the PIPS system to a real business and process environment.

The PIPS pilots (in Italy and in Spain) will be implemented incrementally in several steps (deployments) including each time new services related to the same field, pathology (i.e. diabetes, cardiology, etc) or healthcare habit (i.e. nutrition) or the same set of services (personalized feedback, interactive shopping list, etc) but related to a new pathology.

In order to effectively appraise the system it is pertinent to use a prototype-pilot methodology in an iterative way in order to better implement market needs and to offer up to date added-value services that have been chosen during the analysis, according to Business Model process. These pilots will get more and more complete and, at the end, fully operational with the incorporation of all relevant feedback. In particular, the innovative concepts and tools developed in the project will be applied in order to guarantee the continuity of care throughout the patient's daily life (both for the improvement of healthcare and quality of life habits).

Once the pilot has been implemented, a validation is needed to iterative check the status of the deployment and correct eventual errors or inconsistencies. The validation is the process settled up in order to determine the degree of validity of a system.



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## 2. Material and methods

The evaluation model is currently being evaluated and validated with three different target groups (experts, healthcare professionals and citizens) and hence, with different versions of questionnaires tailored to these audiences. Professionals are enquired in order to provide expertise and guidance for the design of the system, and the implementation. On the other hand, healthcare professionals (Doctors, Nutritionists ...), are asked for their advice about the real need and impact in the healthcare process and, finally users/citizens provide their opinion with regard to the need of such systems.

With this set of questionnaires the concept and the impact of the model is evaluated, finding out how e-health applications could be more effective and successful. Each question is meant to analyze a different parameter of the model.

Moreover, the model is currently being tested in several clinical trials and it is being validated and evaluated at different levels and by different stakeholders: experts (in the different fields, including at political and management levels, technical, etc), professionals and users. Consistent feedback is expected from them all. With their suggestions a refinement of the model will be proposed.

The questionnaires currently available to make a project or system assessment/evaluation are fully necessary. However, in order to obtain meaningful responses, our experience tells that the evaluator experience is a decisive factor, since every project or system has a number of characteristics that make it unique and therefore, none of the existing tools in the field fits perfectly in the evaluation of the mentioned project or system.

Different approaches of evaluation methodologies have been approached. The first one, consists of designing the evaluation focusing on its own evaluation [1], that

evaluation [1], that is, taking into account what we want to extract by means of an evaluation process, and who should use the data and reports obtained as a result of the evaluation. The strong point of this kind of evaluations is that they identify the weaknesses and the strengths of the projects so that it is possible to establish new aims to reinforce the strengths and remove the weaknesses. These evaluations are more used in the development phase of the project, among the different systems prototypes and pilots. This way, it is possible to redefine those points of the initial design that are not admitted by the users and identify the diverging aspects from the initial conceptions. Steps to follow in this approach are:

- Step 1: Define who and how the evaluation will be used.
- Step 2: Identify the final stakeholders of the data obtained from the evaluation process.
- Step 3: Define the questions of the evaluation
- Step 4: Define the indicators to be followed.

The second approach considers the system or project to evaluate as the main part of the evaluation process [2]. However, this approach not only verifies whether the targets have been or not reached and how, since this assessment may lack of rigour to certain kind of projects. Steps to follow in this approach are:

- Step 1: Explain the object of evaluation (system, project...), who intends to use the evaluation and what its objectives are.
- Step 2: Explain the motivation of the project.
- Step 3: Explain who the users of the system will be.
- Step 4: Decide the features to be evaluated (apart of the main objectives of the project).
- Step 5: Compare cost with validity/effectiveness

The third approach is the reasons why individuals would use a new ICT to perform a change in their lifestyle. To do that we have took into account the different theories we used to create the new model that explains the different stages the user is at both in terms of the perception of healthcare and of the use of technology to perform any desired or recommended change. These theories are (see figure 1):

- On one hand (upper path of the model: health behaviour change) we have focused on an adaptation from an integrative model proposed by Fishbein [3]. There are quite a number of models that explain health behaviour, as there are many similarities across the different theories, the model proposed by this author intends to take into account and synthesize the

different key variables of these models into a comprehensive one [4].

- On the other hand (the lower path of the model) we have focused on the Technology Acceptance Model (TAM) proposed by Davis [5], [6]. This theory models how users come to accept and use a technology. The model suggests that when users are presented with a new ICT package, a number of factors influence their decision about how and when they will use it, such as [5]:

- **Perceived usefulness** Defined as "the degree to which a person believes that using a particular system would enhance his or her job performance".
- **Perceived ease-of-use:** Defined as "the degree to which a person believes that using a particular system would be free from effort".

### 3. Results

According to the different approaches explained, three different versions of questionnaires, tailored to different audiences, have been developed. One for the professionals who have provided their expertise and guidance for the design of the system, one for the healthcare professionals and the last one for the citizens.

With this set of questionnaires we want to evaluate our system both its concept and its practical implementation and find out how an e-health system could be more effective and successful. Each question is meant to analyse a different parameter of the model.

If we take into account, the two first approaches of the evaluation methodology the following indicators have been identified (corresponding to the different questions of the questionnaire) to evaluate PIPS system.

		Indicators	Questions
Utility of the system	What	System concept/approach	2, 3, 4, 6, 11, 12, 13, 39, 41, 42, 43, 44, 35
		Carrying out of the tasks	7, 8, 9, 10
		Raising Awareness	31
		Empowering Self-control	5, 40, 42
		Enhance people knowledge	45, 51, 52, 61, 62
		Services offered	21, 22, 23
	For whom	Enhancing people's quality of life	3, 4, 12
		Patients and citizen	2, 3, 4, 6, 7, 10, 12, 52
		Professionals	43-44
		Health system	39-41, 42, 43-44
User motivation	All stakeholders	5, 8, 9, 11, 13, 21, 22, 23, 31, 40, 45, 51, 61, 62	
	Extrinsic (incentives or rewards for using the system)	53	
Complexity	Intrinsic to a person (i.e. particular worries)	49, 50, 48	
	About the concept	1, 24	
	About the use of the system	25, 26, 27, 37, 36	
Appropriateness of the solutions developed	Personalised information	About obtaining the performance of the system	7, 8, 9, 10, 11, 36
		Need of such a system	54, 60, 63, 35
		General	14, 15, 16, 18, 19, 20, 47, 48
		Tone	17, 49
		Content	16, 18, 14, 15
	Enhance Self-efficacy	55, 56, 57	
High quality information	46		
		Reliability of the system	38
		Real use intention	33, 34
		Subjective perception of the possible use of PIPS (real use)	28, 29, 30, 32

If we take into account, just the third approach mentioned above (behaviour change-ITC model), each question in the questionnaire relate to each one of the stages, in order to evaluate how PIPS matches the behaviour change and ICT model. For example, in the figure below, there are some dots in the stages (coloured) boxes. Each dot corresponds to a specific question, of the experts' questionnaire, meaning what specific state is evaluated.

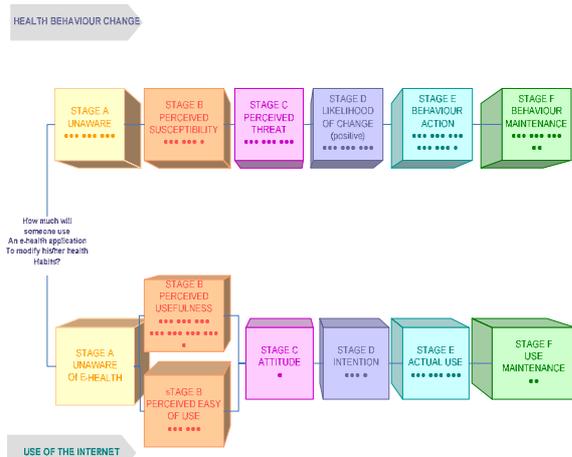


Figure 1: Developed model and its relation to the evaluation and validation methodology (E3OG questionnaire).

In the tables below we have specified which specific question corresponds to each stage both in health behavior change and in use of internet.

Health behaviour change	
Stage	Questions
STAGE A UNAWARE *****	14, 15, 16, 45, 46, 47, 58, 59, 62 <b>TOTAL: 9 questions</b>
STAGE B PERCEIVED SUSCEPTIBILITY *****	3, 46, 47, 48, 49, 62, 63. <b>TOTAL: 7 questions</b>
STAGE C PERCEIVED THREAT *****	46, 47, 48, 49, 55, 56, 57, 62, 63 <b>TOTAL: 9 questions</b>
STAGE D LIKELIHOOD OF CHANGE (positive) *****	10, 48, 49, 52, 55, 56, 57, 62, 63 <b>TOTAL: 9 questions</b>
STAGE E BEHAVIOUR ACTION *****	5, 6, 7, 8, 11, 12, 15, 17, 51, 52, 53, 55, 56, 57, 61, 62 <b>TOTAL: 16 questions</b>
STAGE F BEHAVIOUR MAINTENANCE **	17, 51, 52, 53, 54, 55, 56, 57, 60, 61, 62 <b>TOTAL: 11 questions</b>

Use of the internet	
Stage	Questions
STAGE A UNAWARE OF E-HEALTH *****	16 <b>TOTAL: 1 question</b>
STAGE B PERCEIVED USEFULNESS *****	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 13, 21, 22, 35, 38, 39, 40, 41, 42 <b>TOTAL: 19 questions</b>
STAGE B PERCEIVED EASY OF USE *****	24, 25, 26, 27, 36, 37 <b>TOTAL: 6 questions</b>
STAGE C ATTITUDE *	32 <b>TOTAL: 1 question</b>
STAGE D INTENTION ****	28, 31, 33, 34 <b>TOTAL: 4 questions</b>
STAGE E ACTUAL USE *****	5, 6, 11, 12, 28, 29, 31, 36, 37 <b>TOTAL: 9 questions</b>
STAGE F USE MAINTENANCE **	31, 37 <b>TOTAL: 2 questions</b>

Tables 1 and 2. Matching between each question of the E3OG questionnaire and each state of the model.

#### 4. Discussion and conclusions

The model is currently being tested in several clinical trials and it is being validated and evaluated at different levels and by the different stakeholders and consistent feedback is being provided. With their suggestions a refinement of the model will be proposed.

In order to test the model, the system will be implemented in several clinical pilots that will be tested in the following months.

#### 5. Acknowledgements

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#### 6. References

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