



BUSINESS MODELS FOR SUSTAINED EHEALTH IMPLEMENTATION: LESSONS FROM TWO CONTINENTS

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ABSTRACT

There is general consensus that Computers and Information Technology have the potential to enhance health systems applications, and many good examples of such applications exist all over the world. Unfortunately, with respect to eHealth and telemedicine, there is much disillusionment and scepticism. This paper describes two models that were developed separately, but had the same purpose, namely to facilitate a holistic approach to the development and implementation of eHealth solutions. The roadmap of the Centre for eHealth Research (CeHRes roadmap) was developed in the Netherlands, and the Telemedicine Maturity Model (TMMM) was developed in South Africa. The purpose of this paper is to analyse the commonalities and differences of these approaches, and to explore how they can be used to complement each other. The first part of this paper comprises of a comparison of these models in terms of origin, research domain and design principles. Case comparisons are then presented to illustrate how these models complement one another.

1 INTRODUCTION

In 1998, the South African National Department of Health (DoH) published a telemedicine strategy [1], and since then, many telemedicine systems have been implemented in the public health sector of South Africa. A few of these systems are still operational, but most of them did not survive beyond the pilot phase. Apart from the obvious waste of equipment and human resources, Yellowlees [2] considers the damage to the reputation of telemedicine an even greater expense.

This problem is not limited to South Africa; internationally, valuable lessons can be learnt from successful and failed problems alike. Many international studies acknowledge the importance and challenge of finding models suitable for use in the facilitation, evaluation, and measurement of the success of eHealth and telemedicine projects. Hence, these models are vital for facilitating the success, sustainability and optimisation of telemedicine services [2][3][4][5][6].

The telemedicine maturity model (TMMM) was developed in South Africa to assist in the maturation of these systems. No formally documented evaluation of the contextual inquiry, value specification and operationalisation of these systems exists. In the absence of a well-documented history, the TMMM is primarily a means of getting a snapshot of the current state of the system, with the purpose of identifying priorities. Secondly, it constitutes a record, according to which, the effectiveness of improvement cycles can be measured.

In a different part of the world, the Center for eHealth Research (CeHRes) at the University of Twente in the Netherlands, has also developed a roadmap to rectify the poorly designed or badly implemented technologies, which have led to the many unsuccessful eHealth attempts [3]. This roadmap combines interdependencies between technology, human characteristics, and the socioeconomic environment. The projects that are developed according to the CeHRes roadmap undergo formative evaluation after each of these phases, namely contextual inquiry, value specification, design and operationalisation. In addition, after the operationalisation, or implementation, a summative evaluation is performed, to assess sustainability. The roadmap is currently being used in different research projects to test its usefulness and applicability. Thus far it has been received positively and has already shown the benefit of its holistic approach [5].

1.1 Purpose

These two frameworks were developed independently of one another, to address the same need. The purpose of this paper is to analyse the similarities and differences in terms of approach, and to explore how the models can be used to complement each other.

Both the CeHRes roadmap [5] and the telemedicine maturity model (TMMM) [25] are described in detail elsewhere. The purpose of this article is therefore not to give a full account of each, but rather to explore how they can be used to complement each other. A brief description of each model will be provided later in this paper, followed by an illustration of how the two frameworks integrate with, and complement one another.

1.2 Research Question

How can the TMMM and CeHRes roadmap be used as complements of each other in order to assist in the implementation and sustainability of eHealth projects?

1.3 Methodology

The first part of this paper compares the theoretical frameworks of the CeHRes roadmap and the TMMM, in terms of origin, research domain and design principles. This is followed by case comparisons to illustrate how these models complement each other in reaching the same goal, namely the successful and sustained implementation of eHealth solutions.

2 BUSINESS MODELS FROM TWO CONTINENTS

2.1 Research domain

A prerequisite to integrating the roadmap of the Centre for eHealth Research (CeHRes) and the telemedicine maturity model (TMMM) is that they belong to the same research domain. Sood et al. [6] considered 104 peer-reviewed definitions for telemedicine and then concluded that telemedicine is a subset of telehealth. This notion is supported by the community who support the telehealth wikipedia[7]: “telehealth is an expansion of telemedicine, and unlike telemedicine (which more narrowly focuses on the curative aspect) it encompasses preventative, promotive and curative aspects.”

In the CeHRes Roadmap, eHealth is defined as “all kinds of information and communication technology used for supporting health care and promoting a sense of well-being” [5]. The terminologies *eHealth* and *telehealth* are most often used interchangeably. Semantically the difference between these two concepts is that eHealth applications are not limited to healthcare over a distance, as is the case with telehealth.

The TMMM is based on three frameworks specific to telemedicine [3][8][9], as well as another two frameworks relating to information systems [10] and eHealth in the general sense of the word [4]. The CeHRes roadmap, on the other hand, is based on a number of theoretical frameworks, of which four apply specifically to telemedicine and telehealth applications [11][12][13][14], six to eHealth in the general sense of the word [15][16][17][18][19] and five relate to information systems [20][21][22][23][24].

Whilst the TMMM is more focused on telemedicine, it still falls within the eHealth domain. The CeHRes roadmap, on the other hand, provides a more balanced generic frame, but it is significant to note that five out of the sixteen theoretical frameworks, on which it is based, relate to telemedicine. The substantial overlap between these two frameworks thus warrants a comparative study.

2.2 Design principles

The CeHRes roadmap and the TMMM are based on six [5] and seven [25] design principles respectively. The alignment between the design principles of the respective models is discussed below.

Continuous evaluation and impact measurement

Continuous evaluation cycles are inherent to the CeHRes roadmap as well as the TMMM. Each evaluation cycle of the CeHRes roadmap uses its own qualitative and quantitative methods to assess the outcomes. The TMMM, on the other hand, uses the same dashboard for each and every evaluation cycle.

Organisational change

eHealth technology development changes the organisation of healthcare. Any attempt to measure and manage eHealth technology should include all factors that influence organisational change, for example people, policies, methods and financing [2] [3] [4] [8]. Both the CeHRes roadmap and the TMMM are designed so that the conditions through which the technology is positioned in organisational structures, cultures, and working practices are also considered.

Stakeholder involvement

Telemedicine services inevitably cut across epistemic communities, for example medical practitioners, engineers, patients or public health actors [23]. Stakeholders should be involved throughout the development process, to ascertain if the technology fits its context. Both the CeHRes roadmap and the TMMM recognise that the development of eHealth/telemedicine solutions is a participatory process.

By involving the right stakeholders in the process, they can contribute their domain knowledge for solution creation and, in so doing, contribute to the validity of the model. As a consequence, greater stakeholder acceptance is achieved [10]. The CeHRes roadmap emphasizes the involvement of persuasive design techniques. Whereas the TMMM is “simple and intuitive to use” and is written in “plain language without technical jargon”, this is one of the key design features.

Holistic approach

Both frameworks recognise the importance of following a holistic approach, they furthermore recognise the technical and non-technical ICT capabilities. The holism provides a mix in research activities that improves the understanding of the technology that needs to be developed, how it needs to be developed, and how it can be implemented.

2.3 Differences between the models

The previous sections established that the CeHRes roadmap and the TMMM were developed to address the same problem. The substantial overlap, with respect to the research domains of these two frameworks was described and the alignment between the design principles of these models was explained.

However, there are also a few differences between these models: Firstly, the CeHRes roadmap is used to facilitate the *development* of eHealth innovations, from the contextual enquiry phase to implementation and summative evaluation. The TMMM, in the absence of historical documentation of the development of a telemedicine solution, focuses on the *measurement* of the maturity of an existing - often incomplete - telemedicine service. The CeHRes roadmap is a guide towards the establishment of a telemedicine service, whilst the TMMM is concerned with the maturation of the existing - although often incomplete - telemedicine service.

Secondly, the formative feedback of the CeHRes roadmap is mainly of qualitative nature, whilst the maturity descriptors of the TMMM are linked to a quantifiable scale. Thirdly, the TMMM is focussed on telemedicine, which is a subset of eHealth, whilst the CeHRes roadmap has a much wider application.

3 COMBINING THE CEHRES AND THE TMMM

Despite the differences outlined above, both the CeHRes [5] roadmap and TMMM [25] proved to be effective in facilitating, implementing and sustaining telemedicine projects. How can the TMMM and CeHRes roadmap be used as complements of each other in order to assist in the implementation and sustainability of eHealth projects? In the pursuit of answering this research question, a new model is proposed in this section by combining the CeHRes roadmap and the TMMM.

3.1 The CeHRes Roadmap

The Centre for eHealth Research (CeHRes) of the University of T, developed this roadmap to assist in the development of new eHealth solutions. This roadmap is shown in Figure 1, followed by a brief discussion in each of the steps.

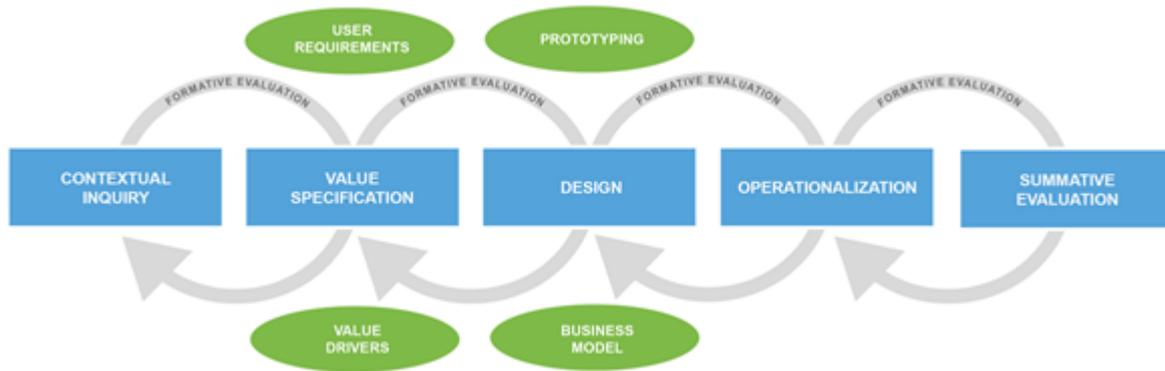


Figure 1: The CeHRes roadmap

Contextual Inquiry

Get a good understanding of the problem (sense-making, delve into the true purpose before creating something), the involved stakeholders, intended users of the technology and their context. The methods that can be used in this phase are (amongst others) literature study, stakeholder focus groups, interviews and observational research.

Value specification

Values are what the stakeholders deem vital for the technology or successful implementation. The value expectations need to be surfaced and then further defined according to the requirements for the technology, based on the value specification and contextual inquiry. These requirements are an important input for the development team, which enables them to create prototypes for the technology that are tested in the design phase. The value specification can be done by conducting focus groups or interviews with intended end-users or stakeholders. Prioritisation techniques such as the analytic Hierarchy Process [26] may be used in this phase to distinguish relative importance between values and stakeholders.

Design

In iterative design rounds, the technology is designed with the input of its intended end-users to ensure that it suits their needs and abilities; this is the user context. In this stage the collected value specification can be transposed into a business model that describes the rationale of value creation and value capturing, relevant for the implementation of the designed technology. Research in this phase is done by moving from testing low fidelity prototypes such as mock-ups, to end-users in scenario-based interviews. Based on the outcomes, high fidelity prototypes can be created by the design team; a working prototype is thus made and is again tested with end-users in their natural work context. Expert methods such as cognitive walkthroughs based on usability heuristics, and usability tests with end-users, can be done to test the prototypes. Value and underlying requirements can be evaluated using importance or costs, which then results in a business model.

Operationalisation

In this phase the technology is implemented into its intended organisation/context. Users start using the technology at work or at home. Implementation activities such as education, audits, and promotional activities are part of this phase to guide the process. Measurements may include interviews, questionnaires, audits or analysis of initial usage data (e.g. log files) to assess whether the implementation was successful.

Formative evaluation

Each of the development cycles described above, comprises a formative evaluation to ensure that assumptions that were tested in the phase are answered properly and can be used as input for the next development activity. For example, after conducting focus groups and interviews during the contextual inquiry, an overview of the context of the problem, involving stakeholders or actors, possible (directions of) solutions and project goals is created by the researcher(s). To ensure that these results can be used without problems in the value specification phase (where these results are used to elicit value prioritising and are translated into design requirements), the results are evaluated with the design team and key stakeholders. The question; ‘do these results sufficiently reflect the situation and scope of the problem to continue with the project, or is additional research needed or should goals be changed?’ is asked. By including this formative evaluation, results that may lead to stakeholder dissatisfaction can be identified in the early development phases when changes or adjustments to the technology design are still possible and fairly easy to do.

Summative evaluation

Depending on the type of technology and its intended effects, a summative evaluation is done. Throughout the process formative evaluations are carried out (the iterative aspects of the roadmap). In this phase, usage and effects can be measured. Analysis of (long term) log files and questionnaires or interviews, to assess user satisfaction and user experience, are an important part of the summative evaluation because possible effects (or the absence of an effect) may be explained by factors of uptake or actual usage. Further, effect studies (RCTs, time series analysis and observational studies) may be necessary to assess whether the technology made a difference in health related outcomes, organisational outcomes, or behavioural outcomes [27].

3.2 The telemedicine maturity model (TMMM)

Maturity models are conceptual multistage models that describe typical patterns in the development of organisational capabilities and usually depict a sequence of stages. Together, these stages form an anticipated, desired or logical path from an initial target maturity state [28] [29] [30]. Maturity models, firstly, provide a way of measuring the status quo by means of maturity level indicators. Secondly, they facilitate an improvement process that best suits the enterprise, while remaining within the prescribed best practice parameters of the particular domain [31]. The construct of the telemedicine maturity model (TMMM) includes three dimensions as shown in Figure 2. A short description of each of these dimensions follows.

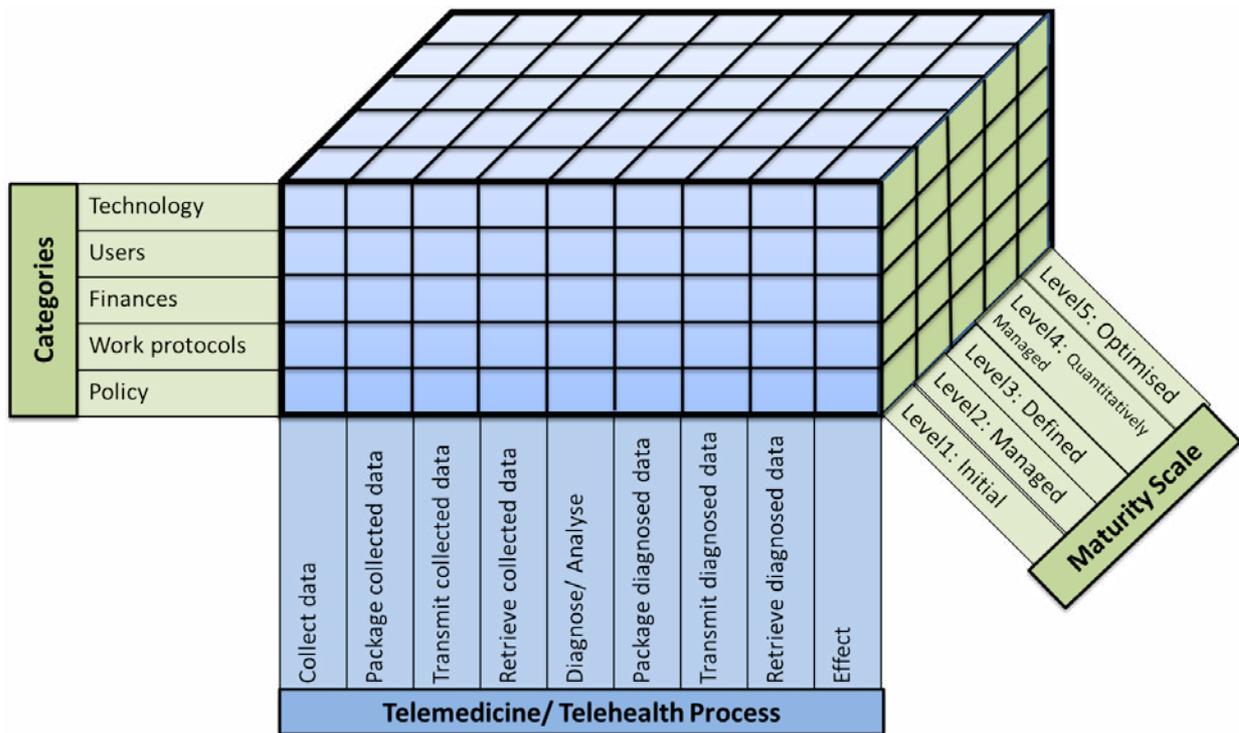


Figure 2: Construct of the telemedicine maturity model

Maturity scale

The generic levels, which are used in the majority of maturity models, are shown as one of the dimensions in Figure 2.

Telemedicine process

Most maturity models focus on the maturity of processes within a certain organisation and enterprise. Telemedicine/telehealth - as per definition - crosses the boundaries of organisations, enterprises and even jurisdictional borders and countries. In fact, each specific process frequently crosses a different boundary. For a successful telemedicine/telehealth process to take place, irrespective of the context or required technology, each step in the telemedicine process needs to be successfully executed [32]. Hence, this process is included as one of the dimensions of the TMMM.

Categories

In the design principles of both the CeHRes roadmap and the TMMM, the importance of a holistic approach is recognised. Not only technology, but also users, work processes, finances and policy influence the successful and sustained implementation of eHealth solutions. In adding these domains as a third dimension, the TMMM ensures that all of these are considered.

3.3 An integration of the CeHRes roadmap and the TMMM

These models are not a duplication of each other, but rather complement one another. Figure 3 is a framework which combines the CeHRes roadmap with the TMMM. It is suggested that each maturity level serves as a stage gate for each of the phases of the CeHRes roadmap.



Figure 3: The CeHRes roadmap and TMMM complementing each other

Table 1 shows how the TMMM maturity scale is adapted to serve as stage gates for the respective phases of the CeHRes roadmap. The maturity levels (ad hoc, stable, standard, quantitatively managed and optimised), as well as the maturity categories (technology, users, work processes, finances and policies) are taken directly from the TMMM.

Table 1: TMMM maturity levels adapted to serve as stage gate

| | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 |
|-----------------------|---|---|---|---------------------------|----------------------------|
| | Ad Hoc | Stable | Standard | Quantitatively managed | Optimized |
| Technology | Experiments | Prototype technology | Available, maintainable and reliable | Quantitative Management | Technological Innovation |
| Users | The participating sample of end-users is motivated to use this solution for development purposes. | The participating sample of end-users is trained and motivated to use this prototype. | Users are able and motivated to use this eHealth solution consistently as a standard. | Human resource management | Human resource development |
| Work processes | Ad Hoc | Superficial execution of work processes | Consistent execution of work processes related to this solution. | Quality Control | Continuous Improvement |
| Finances | R&D Funding | R&D Funding | Included in budget (not dependent on R&D funds) | Accountability | Investment |
| Policy | Existing policies not necessarily considered. | Existing policies considered. | Formal policy developed to support eHealth solutions. | Governance | Strategy |

Stage gate 1

The first phases of the CeHRes roadmap, namely “contextual enquiry” and “value specification” are characterised by ad hoc processes and experimental technology (first column of Table 1). All the stakeholders are represented from the start. However, these representatives are only a sample of the population that will use this solution, once it is operationalised. The work processes are ad hoc and financed in the name of research and development. It is possible that some stakeholders are aware of relevant policies, but it is not necessarily considered.

Stage gate 2

A prototype is developed during the CeHRes design phase. Only once maturity level 2 is reached (second column of Table 1), with respect to all the categories, should the development team consider moving towards the operationalisation phase. At maturity level 2, the prototype technology is used, which includes the sample of end-users, who participate in the process. Since this prototype is not yet operationalised, the work processes are only executed and financed superficially.

Stage gate 3

If a proper eHealth development process is followed, as prescribed by the CeHRes roadmap, one should expect to reach at least maturity level 3 (standard), for all TMMM categories, after operationalisation, as shown in the third column of Table 1.

Stage gate 4

Summative evaluation is one on the key design features of the CeHRes roadmap and it manifests in maturity level 4 of the TMMM, as shown in the fourth column of Table 1.

Stage gate 5

Optimisation is not part of the original CeHRes roadmap. However, on the TMMM, optimisation and continuous improvement are explicitly considered in maturity level 5. It is hence added to Figure 2 and considered to be one of the improvements to be made to the CeHRes roadmap.

4 CASE COMPARISONS

The paper seeks to determine how the TMMM and CeHRes roadmap can be used as complements of each other in order to assist in the implementation and sustainability of eHealth projects. A new model was proposed in the previous section in which the TMMM and CeHRes roadmaps are combined. In this section, the complementary characteristics of the two models are demonstrated through case examples.

Cases 1 and 2 are examples from the South African public health sector (from which the TMMM originates). In the first case, a complete technology development process was executed - similar to the CeHRes roadmap - up to the point of operationalisation. This is not the case in example 2. This is reflected by the maturity maps of the two respective cases and confirms the model proposed in the previous section.

In case 3, we have applied the TMMM to a study that was performed based on the CeHRes roadmap, to show how the TMMM can be applied (retrospectively in this case) to roadmap-based projects. In this case, TMMM coding was performed by the researchers involved in the project, due to time and practical constraints. Ideally, this is done with the involvement of key stakeholders.

4.1 Case 1: Teleradiology in South Africa

Of all the telemedicine specialisations, teleradiology applications have been the most successfully integrated into health systems [3]. In South Africa, most private hospital groups, and some networks of public hospitals, have fully functional teleradiological services. A typical teleradiology process is described by the “Telemedicine process” dimension of Figure 4: Digital radiological images are uploaded to a Picture Archiving and Communication System (PACS), where it is linked with existing health information or previous images taken from a specific patient. This information can then be viewed and shared amongst radiographers, radiologists and other clinicians irrespective of the location of the users.

Figure 4 also shows the maturity map for the teleradiology process, as compiled by a group of stakeholders from a certain South African provincial department of health. The numbers represent how this group gauge the maturity of the status quo, based on the previously explained maturity scale.

Although the CeHRes roadmap was not known to the developers of this solution, prior to the implementation of this teleradiology system, stakeholders were involved in processes similar to the CeHRes roadmap, with respect to contextual inquiry, value specifications, design and operationalisation [33]. This may explain why, in most instances, a maturity value of “3” (standard processes) was allocated. If the CeHRes roadmap is to be followed further-on, the

next and final step will be to perform summative evaluation. However, used in combination with the TMMM, the ultimate goal is optimisation and continuous improvement.

| | | | | | | | | | | |
|----------------------------|----------------|---|---|-----------------------------|-----------------------------|---|------------------------------------|----------------------------|----------------------------|------------------------------|
| Maturity Categories | Technology | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | Users | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |
| | Finances | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | Work protocols | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 |
| | Policy | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 |
| | | Take digital radiographical image | Digital image converted into DICOM format | Upload image to PACS system | Open image from PACS system | Specialist diagnose and prescribe treatment | Specialist attach report to e-mail | Transmit via e-mail-server | Open e-mail and attachment | Execute prescribed treatment |
| | | Telemedicine/ Telehealth Process | | | | | | | | |

Figure 4: Maturity map for the teleradiology process

4.2 Example 2: Tele dermatology in South Africa

At the same provincial department of health, a certain dermatologist used mobile phone technology to treat his patients on a continuous basis. This process is an isolated initiative of one specialist. In this case, no formal contextual inquiry, value specification or design was done prior to operationalisation, as prescribed by the CeHReS roadmap. This tele dermatology service was only developed through a few iterations of design and prototyping, as shown in Figure 5.

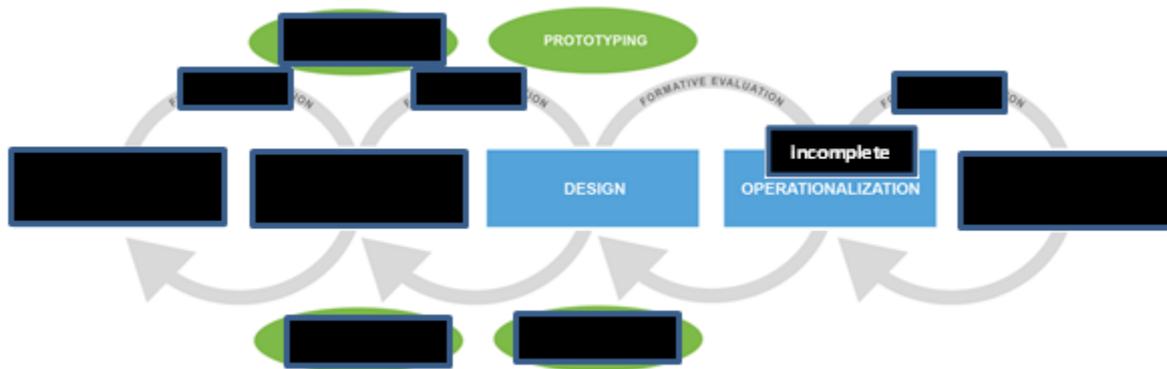


Figure 5: CeHRes roadmap steps followed in the development of the tele dermatology solution

The method may be effective, but the maturity level of all the elements of this tele dermatological service is low (Figure 6) and it is therefore not likely to be sustainable. It is proposed that all stakeholders be involved in following the entire CeHRes roadmap and in using the maturity map, as a means of formative evaluation after each iteration.

| | | | | | | | | | | |
|---|----------------|--------------------------------------|--------------------------------|--------------------|----------------------------|---|------------------------------|-------------------------------|------------------------------|-------------------|
| Maturity Categories | Technology | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Users | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Finances | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 2 | 2 |
| | Work protocols | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Policy | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 2 |
| | | Take photo of skin with mobile phone | Convert image into .jpg format | Send image via SMS | Open image on mobile phone | Specialist diagnose and decide on treatment | Type SMS with recommendation | Send SMS with recommendations | Read SMS with recommendation | Execute treatment |
| Telemedicine/ Telehealth Process | | | | | | | | | | |

Figure 6: Maturity map for the teledermatology process

4.3 CASE 3:

Multi-resistant micro-organisms pose a constant threat to patient safety, because they cause infections that are difficult to treat. In the EurSafety Health-net project, an Infection Manager is developed to provide a cross-border Web-based platform for infection management. Correct and prudent antibiotic use is proposed as an important strategy in infection management and it is operationalised in Antibiotic Stewardship Programs (ASPs). The goal of ASPs is to improve the prescribing of antibiotics and utilisation of institutional care settings, worldwide. These ASPs aim to support healthcare workers (HCWs) who prescribe medication, via various interventions. Among these interventions are decision support applications for HCWs to optimise dosage, type, duration of therapy, and education applications for HCWs. In this project, applications are developed that support the aforementioned interventions.

After an initial contextual inquiry and value specification, five eHealth tools were identified as necessary for a successful ASP: resistance monitoring application, formulary and prescription application, (economic) evaluation application, bed-side information application, and a day-2-bundle for patient evaluation [34]. Together, these applications should collectively address the purpose stated above, namely the prudent use of antibiotics. For the purposes of this paper, the development of a bed-side information application for nurses is selected as the main example. In this case, the CeHReS roadmap was explicitly followed.

Example 3 (ASP program)

1. ASP contextual inquiry: literature study, expert discussions → stakeholder selection + stakeholder focus group
2. Information application contextual inquiry + value specification: literature study + two nurse focus groups
3. Information application Design: requirement notation and validation (in progress)

To identify the scope of the problem associated with prudent antibiotic use and the implementation of an ASP, a contextual inquiry was performed. To uncover which stakeholders are involved and to explore requirements for solutions, a literature study was carried out and a stakeholder focus group was established. In accordance with the literature

study, the stakeholders who were invited to participate were all involved in the prescription or administration of antibiotics in a ward of a local hospital in the Netherlands. Based on this focus group; tasks, problems, information needs, and requirements for a solution were discussed and the stakeholder-specific needs and values, were identified. These needs were linked to different ASP interventions, such as local susceptibility monitoring (to analyse local resistance patterns, in order to provide dynamic and localised prescription advice) and a day 2 evaluation of patient progress. Nurses expressed a clear need for information and education about antibiotic use, in order to better administer them and monitor their effects. This need was included in a new version of the CeHRes Roadmap, in the form of a contextual inquiry for a nurse information application on the use of antibiotics. A literature study, scenario-based focus groups and expert validations of the results were performed to complete the contextual inquiry and value specification for this application. Hereafter, the results of the first Roadmap phases were translated into functional requirements for the application, as a first step into the design phase. This case is currently in the design phase, where low and high fidelity prototypes are tested with end-users and other key stakeholders (managers and pharmacists).

The maturity map of the tool.

Even though many insights into stakeholder values and technology requirements surfaced in this Roadmap-driven research, insight into the technological status quo and translation into 'hard' or technological objectives (as can be measured with the TMMM) were not part of the research involved in this case. By creating a maturity map, additional insights became relevant. To assess the maturity for each category and telemedicine process phase, a grid is used.

The technology grid is given in Figure 7. In this grid, the current maturity level of the telemedicine phase 'collect data' or various pharmacological information and protocols is level 2: *"Useful (but not necessarily standard) technology to execute this task through telemedicine"*. It is made available by the governing institution. The desired maturity level is level 5: *"Appropriate and useful technology and technology upgrades are continually and efficiently introduced by the governing institution"*. In this way, each of the TMMM phases for technology, as well as the other categories was scored. Thus, the scores correspond with the levels in the grid. The TMMM maps, as shown in Figure 7 and Figure 8, show that there could be improvement regarding the technology, users and protocols.

| | | | | | | | | | | |
|---|---|------------------------------------|-----------------------------|-----------------------------|--|----------------------------|-----------------------------|---|--------------------------|---|
| Maturity Categories | Technology | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 2 |
| | Users | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 |
| | Finances | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | Work protocols | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| | Policy | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | Various pharmacological information and protocol applications | Card-sorted information repository | Transmit via internet/ WLAN | Q&A interface on repository | Question concerning antibiotic treatment | Q request on Q&A interface | Transmit via internet/ WLAN | Card-sorted & tailored information (answer) | Informed decision making | |
| Telemedicine/ Telehealth Process | | | | | | | | | | |

Figure 7: Maturity map (current situation, during design phase)

| | | | | | | | | | | |
|---|---|------------------------------------|-----------------------------|-----------------------------|--|----------------------------|-----------------------------|---|--------------------------|---|
| Maturity Categories | Technology | 5 | 5 | 3 | 5 | 5 | 3 | 3 | 5 | 5 |
| | Users | 4 | 4 | 4 | 5 | 5 | 4 | 4 | 5 | 5 |
| | Finances | 4 | 4 | 3 | 3 | 4 | 4 | 4 | 4 | 4 |
| | Work protocols | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 4 | 4 |
| | Policy | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | Various pharmacological information and protocol applications | Card-sorted information repository | Transmit via internet/ WLAN | Q&A interface on repository | Question concerning antibiotic treatment | Q request on Q&A interface | Transmit via internet/ WLAN | Card-sorted & tailored information (answer) | Informed decision making | |
| Telemedicine/ Telehealth Process | | | | | | | | | | |

Figure 8: Maturity map (intended situation, planned operationalisation)

Although the TMMM is more appropriate for telemedicine (curative healthcare over a distance), in this example it is shown that it can also be applied to any telehealth application (any form of healthcare over a distance).

5 CONCLUSION

The Centre for eHealth Research (CeHRes) roadmap and the telemedicine maturity model (TMMM) were both developed to address the same need, namely to provide a framework

according to which eHealth technology can be developed. These models are not a duplication of each other, but rather complement one another.

The strength of the CeHRes map lies in the fact that it guides the development of the eHealth technology from the outset until the implementation and operationalisation. The TMMM, on the other hand, provides a means of continuously measuring and benchmarking cycles, according to the same quantifiable yardsticks/dashboards. These yardsticks are useful during the innovation process, but also provide guidance, with respect to the maturation and optimisation of telemedicine systems, after implementation. The CeHRes roadmap focuses on involving stakeholders and end-users in the development process to ensure that the technology that is developed is meaningful and adds value to the care process. The TMMM focuses on the outcome of development, or a readily existing telemedicine service which can be applied, taking different stakeholder views into account.

The case comparisons presented in this paper are retrospective accounts from both South Africa and the Netherlands to demonstrate the complementary use of these frameworks. The case comparisons show that combining the models by complementing the TMMM with a post-hoc roadmap evaluation, and vice versa, offer additional insights in understanding the success and difficulty of developing and implementing eHealth technologies. The integration of the models and use thereof at the *start* of an eHealth project shows even larger opportunities. Future work could include a pro-active effort in using these frameworks in a complementary way to facilitate the design, operationalisation and optimisation of eHealth solutions.

6 REFERENCES

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