

## A Maturity Model for Telemedicine Implementation

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**Abstract**— The South African National Department of Health (DoH) has, for more than a decade, recognized the potential benefit of information and communication technology (ICT) in the delivery of healthcare to rural areas. However, despite generous funding and proven technology, not many telemedicine systems have lasted beyond the pilot phase. The purpose of this paper is to propose a maturity model, which can be used to measure and manage the capability of a health system. Its aim would be to sustain health care delivery, after the pilot phase of a telemedicine project. This maturity model comprises of five existing frameworks, namely the Health Readiness Instrument for developing countries, the Layered Telemedicine Implementation Model, the PACS Maturity Model, the Telemedicine Process Model and the NHS Maturity model. The validity of this maturity model is tested by means of a focus group discussion that occurred during a workshop for provincial representatives from three South African provincial DoHs.

*Telemedicine; Maturity Model; eReadiness; South Africa*

### I. INTRODUCTION

The first phase of telemedicine implementation in South Africa began in 1999. This was guided by the National Strategy for Telemedicine. The objectives of the strategy focused on providing high-quality, cost-effective health care and education; improved recruitment and retention of health professionals; delivery of long-distance health care, and improvement in the accessibility of specialist health care.

By definition, telemedicine refers to the delivery of healthcare services (“medicine”) where distance (“tele”) is involved. For the purposes of this article, the more specific definition, given by Sood et al. is used, since it encapsulates and addresses the issue of the uneven distribution of health resources, specifically in South Africa’s public health sector:

“Telemedicine being a subset of telehealth, uses communications networks for delivery of healthcare services and medical education from one geographical location to another, primarily to address challenges like

uneven distribution and shortage of infrastructural and human resources.”

South Africa has a population of 48 million people, half of whom reside in rural areas. Despite being one of the largest economies in Africa, South Africa has a rural community which is characterized by very high poverty rates [1]. As a result, the first telemedicine strategy, published by the South African government in 1999, was recognized as a strategic tool to overcome the unequal distribution of healthcare resources.

Since then, many telemedicine projects have been launched, of which, few have survived past the pilot phase. Apart from the obvious waste of equipment and human resources, Yellowlees [2] considers the damage to the reputation of telemedicine as an even greater cost. The South African public health sector is already paying this price: in 2010, the Department of Health placed a moratorium on the launching of any new telemedicine projects until a strategy is in place to increase the success rate of such projects.

### II. PURPOSE AND METHODOLOGY

In this paper, a telemedicine maturity model is proposed. This model can be used to measure, manage and optimize all the components of a telemedicine system, as well as the health system within which it is implemented. A maturity model enables the capability maturity of a specific domain to be measured. In addition, it facilitates an improvement process that is best suited to an enterprise and which is in accordance with the prescribed best practices of the domain [3].

An overview of the content of this paper is given in Figure 1, where literature, concerning five related theoretical frameworks, is presented. Using these frameworks as a base, a concept maturity model for telemedicine implementation is proposed. This maturity model is then refined and validated during workshops with four provincial departments of health (DoHs). A conclusion follows, which describes firstly, the extent to which this maturity model enables the measurement of

maturity and secondly, its contribution to sustained telemedicine implementation.

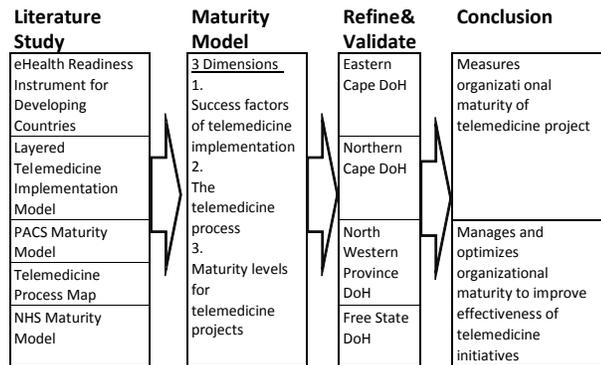


Figure 1: Research Methodology

### III. THEORETICAL FRAMEWORK

There are many frameworks, models, checklists, taxonomies, et cetera, that can be useful as input in such a model – all with their own strengths and weaknesses. However, of these, the five frameworks listed in Figure 1, were identified as having the most to contribute to such a maturity model for telemedicine. These are discussed in more detail in the following section.

#### A. eHealth Readiness Instruments

eHealth readiness is defined as the "degree to which users, healthcare institutions and the healthcare system itself, are prepared to participate and succeed with implementation." Jennett *et al.* [4] specifically refer to eHealth readiness when they argue that time, money and energy, can be saved if the status quo of an eHealth/telemedicine system context is determined before implementation.

Legare *et al.* [5] have identified six different assessment tools, which can be used to measure e-readiness within a health context. However, information concerning the internal validity and reliability of these measuring devices is only available for two of the six tools. Of these, Khoja’s E-health Readiness Assessment Tool [6] was selected for the purposes of this paper, because it is specifically directed towards developing countries. This instrument covers five categories:

- Core readiness (planning and integration)
- Technological readiness (availability, reliability, affordability and ICT, and related infrastructure)
- Learning readiness (resources to provide training using the technology)
- Societal readiness (interaction between the institution and other institutions)
- Policy readiness (policies at government and institutional level to address common issues such as licensing, liability and reimbursement)

The first objective of a maturity model is to establish the capability maturity of an organization in terms of a

specific domain of practice. The strength of this eHealth readiness instrument lies in the fact that it provides us with a set of statements, which can be used as a yardstick to measure the eHealth readiness of an organization. The validity and reliability of this measuring instrument is determined through various studies [7] and can thus provide us with a set of statements, which can be used with confidence to establish, to a certain extent, the capability maturity.

The drawback of eHealth readiness tools lies in the fact that they do not accommodate the second purpose of a maturity model, namely to describe the best practices of the domain. Nor do they facilitate the process of moving that enterprise towards those best practices [3]. Molla and Licker [8] identified a similar drawback in developing a model and instrument for eCommerce adoption in South Africa, which led to their developing a maturity model for e-commerce.

#### B. The Layered Telemedicine Implementation Model

This progression towards maturity is recognized by Broens *et al.* [12] who explain that maturity is gained as one moves from one implementation layer to another. South Africa is not the only country where telemedicine projects have a significantly high failure rate. Broens *et al.* [12], in a systematic literature review, confirmed that, after the prototype phase, telemedicine projects are more likely to fail than succeed. They also looked to the literature to answer the question: “why is it so difficult [to implement telemedicine] and what goes wrong?” In this study, the theoretical model of Tanriverdi and Iacono [13] was used as a point of departure in the identification of the so-called *determinants for the successful implementation of telemedicine*.

Broens *et al.* [12] postulate that different *determinants* become applicable as telemedicine implementation maturity is gained. The *Layered Implementation Model* was developed accordingly. The relation between each *implementation layer* (and their associated *determinants* in brackets) are shown in Figure 2.

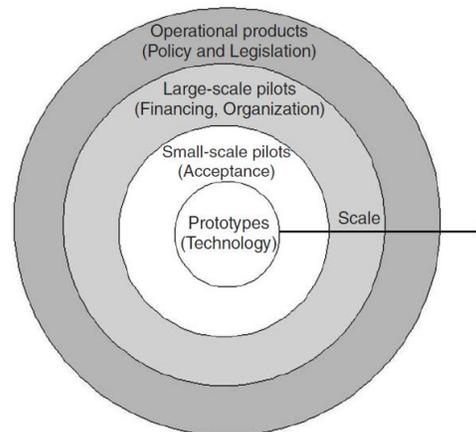


Figure 2: Layered Implementation Model [12]

C. The NHS Infrastructure Maturity Model (NIMM)

NIMM is an IT infrastructure maturity model that was developed by the NHS Technology Office, together with a number of different NHS IT Organizations in the United Kingdom [9]. During its development, the NHS team worked closely with Atos Healthcare, a consultant company, helping to define and develop the NIMM [10].

D. The PACS Maturity Model

Around the time when the NIMM was being developed, Van Wetering *et al.* [11] recognized the potential benefit of maturity models for healthcare services. They specifically considered teleradiology and developed a PACS (Picture Archiving and Communication System) model.

E. The Telemedicine Process Map

Telemedicine, by definition, is the delivery of healthcare services (“medicine”) over a distance. For a successful telemedicine process [14] to take place, irrespective of the context or required technology, each step of the Telemedicine Process (Figure 3) needs to be successfully executed.

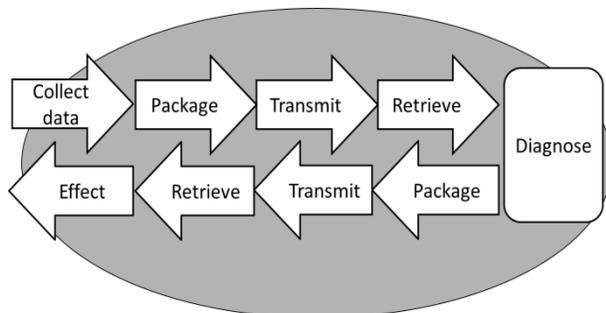


Figure 3: The Telemedicine Process Map [14]

IV. TOWARD A MATURITY MODEL FOR TELEMEDICINE IMPLEMENTATION

These frameworks can be used individually to support telemedicine implementation. However, no one framework offers a comprehensive maturity model for telemedicine implementation.

In the following section, these five frameworks are combined to develop a three dimensional framework (Figure 4). This can be used to measure, manage and optimize all the components of a telemedicine system, as well as the health system within which it is implemented. The three dimensions of this model are:

- eReadiness Categories
- Telemedicine Process Steps
- Maturity Levels

These three dimensions are discussed in the following section.

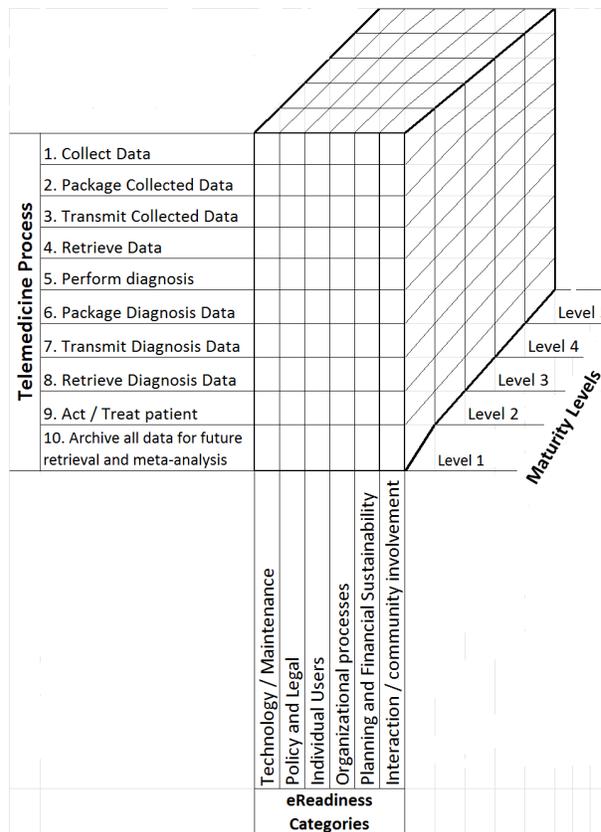


Figure 4: A maturity model for telemedicine implementation

A. eReadiness Categories

Khoja’s [6] eHealth readiness categories are aligned with the determinants, proposed by Broens *et al.* [12], for the successful implementation of telemedicine. Both Khoja and Broens *et al.* recognize *technology* and *policy* as determinants for the successful implementation of telemedicine. Technology is also one of the so-called submodels of the NHS Infrastructure Maturity Model [10]. *Governance* – which can be translated here as *policy*, is one of the classes within the business submodel.

*Core readiness, learning readiness* and *societal readiness* are additional eHealth readiness categories and Broens *et al.* have added *user acceptance, finance* and *organization (internal and external)* to their determinants. The NHS Infrastructure Maturity Model [10] includes *procurement, financial management, business alignment, people and skills* as well as *standards & procedures*.

Frameworks [6], [10] and [12] are used as a point of departure in order to define, in consultation with representatives from the DoH, the following categories of an axis of the maturity model.

For the purposes of the framework presented in this paper, the success determinants are organized as follows:

- Technology and maintenance: ICT availability, reliability, training, usability
- Policy and legislation: Governmental and institutional policies and procedures, standardization and security
- Individual users: Trust and willingness of users and decision makers, producing evidence, change in way of doing
- Organizational processes: Decision making processes, work procedures
- Planning and financial sustainability: Business models which will ensure continuation of the telemedicine endeavor
- Interaction/involvement with community: Interaction with society and other institutions

### B. Maturity Levels

In a maturity model, the current maturity level is measured, in the first instance, by how many other levels serve as a guide to system maturity. Most maturity models show five maturity levels [3]. These generic levels correspond with the levels of the NIMM [10], as well as the PACS Maturity Model [11], and were adopted for the purpose of this study. The NIMM level descriptors appear in brackets:

- Level 1: Initial, ad hoc process (Basic)
- Level 2: Managed, stable process (Controlled)
- Level 3: Defined, standard process (Standardised)
- Level 4: Measured process (Optimised)
- Level 5: Optimizing (Innovative)

### C. The telemedicine process

The steps involved in the telemedicine process can be compared to the links of a chain. If one of these steps is not executed properly, no telemedicine service, of any sort, can be delivered [14]. It is therefore important that the maturity is measured and managed with respect to each of these steps. The telemedicine process is included in its entirety, as the third dimension of the proposed maturity model.

The 10<sup>th</sup> step was added as a recommendation by representatives from the department of health: "Archive all data for future retrieval and meta-analysis".

### D. Involving the users of the model

The purpose of this maturity model is to assist those who are responsible for the implementation of telemedicine projects in South Africa. Its aim is to enable them to manage their health system and to ensure the successful and sustained implementation of telemedicine. Although both the public and the private health care sectors are included, for the purposes of this paper, only health care workers from the public health

sector, were involved in the refining and validating of this framework.

Three telemedicine training workshops were held on 14 June, 4 August, and 31 August, 2011, respectively. These involved four of the nine provincial Departments of Health (DoHs) in South Africa. Major changes were made to the maturity model based on the conclusions which emanated from the first workshop (14 June, 2011). The most significant of these changes was the inclusion of the telemedicine process. Further proceedings from this workshop are reported on in another paper (15). The descriptors of the framework were refined during the second workshop (4 August, 2011). *Validation?*

The remainder of this paper is devoted to an analysis of the outcomes/results of the third workshop (31 August, 2011) as a means of validating this framework. This workshop involved 25 delegates from two of the largest and most rural provinces. The 25 people who attended this final workshop (31 August, 2011) included:

- 13 medical practitioners,
- 10 ICT Technicians and
- 2 delegates responsible for e-learning and administration.

10 of the delegates (5 from each province) were either radiographers, radiologists or radiographic technicians.

### E. Methodology

The delegates were briefed about the frameworks presented in this paper and the 25 attendees were purposely allocated to a specific group. Each group was then provided with a 10 x 6 matrix, based on the first two dimensions of the maturity model ("The Telemedicine Process" and "E-Readiness Categories"). Finally, the groups were asked to reach consensus about the level of maturity present in each of the 60 blocks of the matrix.

### F. Results

The maturity maps from each of the respective groups are shown in Figures 5, 6, 7 and 8 (the colour-coded scale has been converted to gray-scale for the purposes of this paper.)

- Radiology from province A (Figure 5)
- Radiology from province B (Figure 6)
- Doctors (general practitioners) from both provinces (Figure 7)
- ICTechnologists from both provinces (Figure 8)
- The remaining delegates consisted of managers and training co-ordinators.

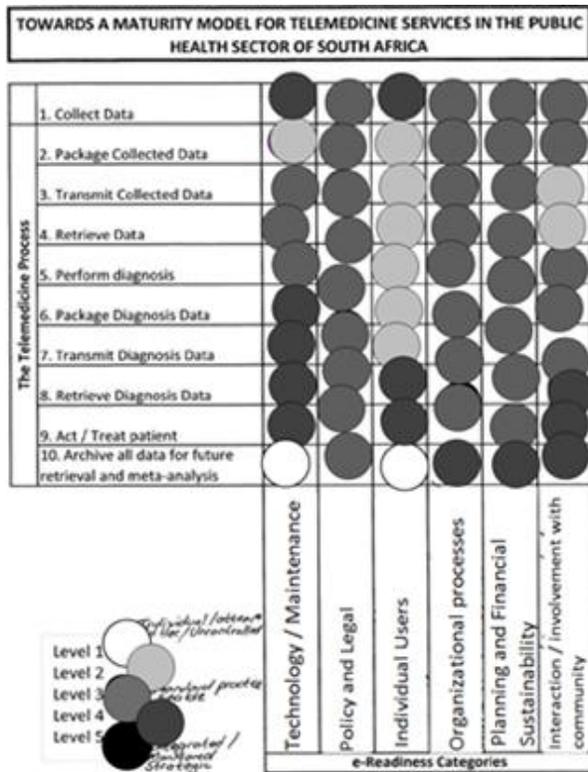


Figure 5: Radiology Maturity of Province A

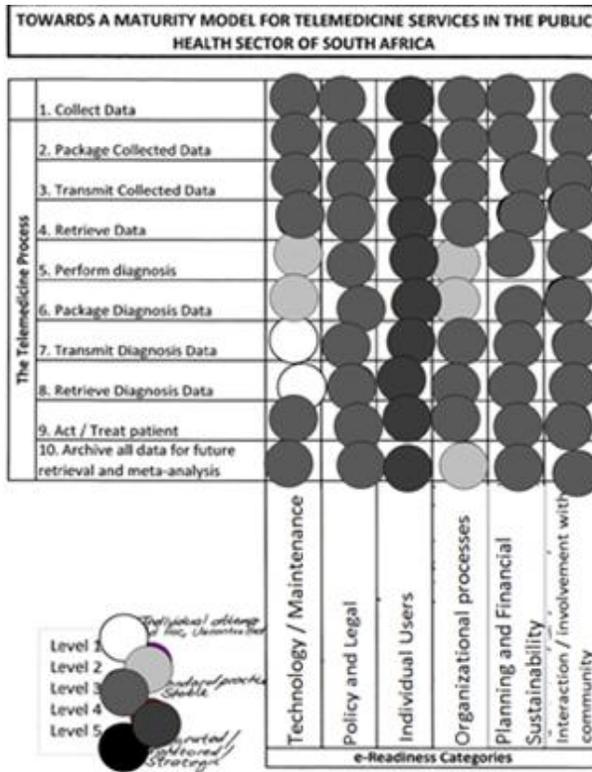


Figure 6: Radiology Maturity of Province B

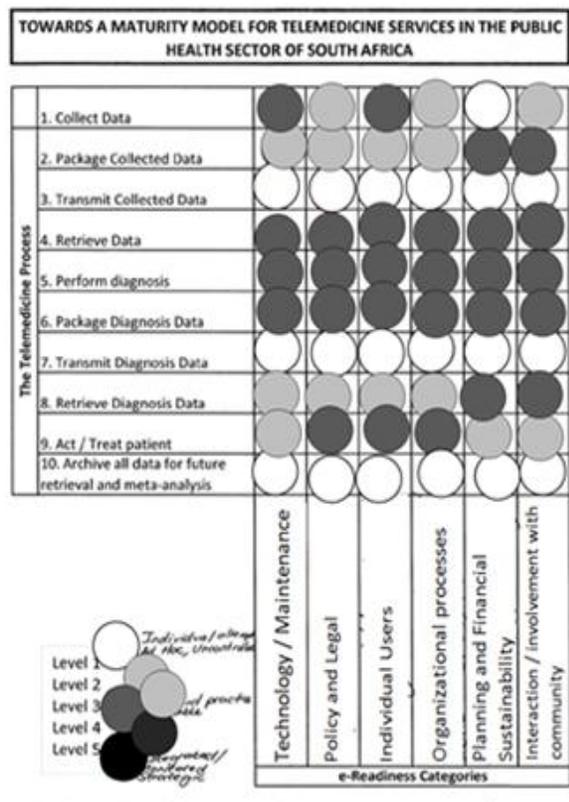


Figure 7: Doctors' perception of telemedicine maturity

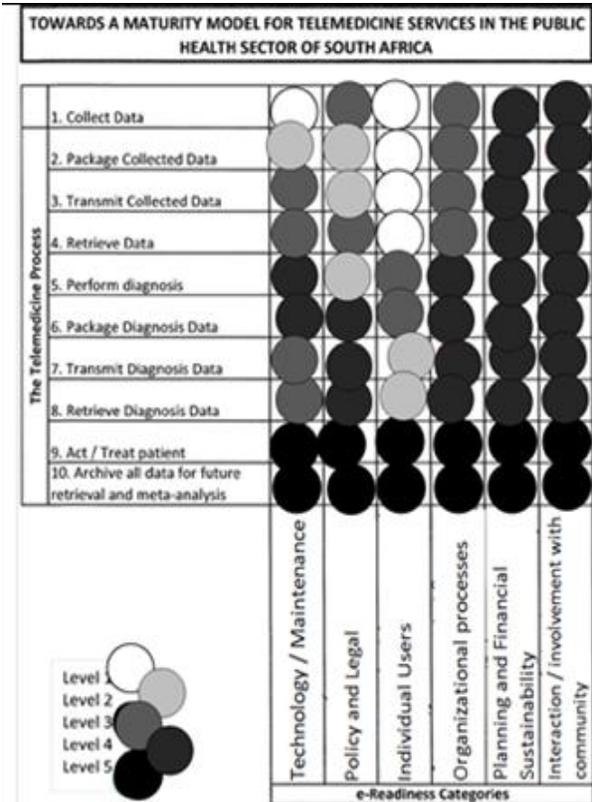


Figure 8: Technologists perception of telemedicine maturity

One of the groups, involved in the workshop, did not reach consensus on the maturity levels of the telemedicine projects involved. Their maturity map is therefore, not included in this paper. This inability to reach consensus can probably be attributed to the diversity within this group, in terms of their exposure to, and perspective on, telemedicine.

### G. Discussion

All the delegates participated in a discussion to reflect on the significance of the results of the workshop. These are summarized as follows:

There was a significant difference in the maturity maps provided by the various groups. It is also not surprising that the two maps that showed the greatest degree of similarity, were the two maps produced by the groups who belonged to the same area of telemedicine specialization, namely radiology. (Figures 5 and 6).

Furthermore, the perceived maturity for teleradiology was higher than the perceived maturity for telemedicine, as expressed by the general practitioners (Figure 7), which is in line with a general tendency for teleradiology technology and infrastructure to be more mature than the other telemedicine specializations.

The maturity map, produced by the practicing doctors (Figure 7), clearly shows their frustration with the lack of connectivity, which they felt prevented the telemedicine process from being completed to its full extent.

It is also interesting to note that the doctors (Figure 7) tended to allocate the same maturity level to a certain step of the telemedicine process, irrespective of the eReadiness category under consideration. In contrast, the other groups tended to allocate similar maturity levels to eReadiness categories, irrespective of the telemedicine process. In future, the construct of the framework should be reconsidered to avoid such generalizations across categories.

The maturity map of the ICT Technicians (Figure 8) received much critique from the other delegates. Based on the discussion that followed, the conclusion they arrived at was that there is a distinct difference between ICT Technicians', and health practitioners', perceptions of telemedicine maturity.

General feedback, regarding the use of the model to measure maturity, included a proposal to divide some of the eReadiness categories into more specific categories. For example, there could be different maturity levels associated with "decision making processes" and "work procedures" but in this model they are both grouped under "organizational processes.

Workshop delegates expressed a need for more specific maturity level indicators, both to avoid subjectivity, and as an indication of the direction to take to facilitate improvement.

## V. CONCLUSION

Change management was identified, in the literature [2], [16] as well as by the DoH representatives, as the key to the successful implementation of telemedicine. A maturity model for telemedicine implementation could thus be instrumental in managing this change.

Delegates reached consensus that the value of this workshop did not lie in the actual measurable outcomes, but in the fact that different role players, with diverse viewpoints, communicated their opinions based on a common holistic framework. Despite the fact that it is simple and intuitive to use (which is one of the design features of a maturity model [10]), it provides users with a tool to assess the entire context of their telemedicine initiatives.

Initiatives in the future should firstly, focus on the refinement of the construct of this model, in order to avoid ambiguity and subjectivity. Secondly, more research is required to determine if and how this model can be used as a tool to manage and optimize organizational maturity and, in so doing, improve the effectiveness of telemedicine initiatives.

### ACKNOWLEDGMENT

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