

THE DEVELOPMENT OF A HEALTHCARE INNOVATION ADOPTION READINESS ASSESSMENT TOOL (HIARAT)

E. Leonard¹, I.H. de Kock^{1*} & W. Bam¹

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Contact details

* Corresponding author
imkedk@sun.ac.za

Author affiliations

¹ Department of Industrial
Engineering, Stellenbosch
University, South Africa

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ABSTRACT

A disconnect exists between innovations and the adoption of such innovations, specifically within healthcare facilities. This disconnect results in various healthcare challenges – ones that could be addressed by successfully adopting and integrating an innovation into organisational processes – not being addressed. To address the challenge of innovation adoption within healthcare, it is proposed that a tool be developed to identify areas that should be addressed to improve the chances of the successful adoption and integration of innovations into existing systems in a public healthcare facility. By assessing a facility's readiness for innovation adoption, it is possible to identify the barriers to the successful adoption of innovations. Knowing what such challenges or barriers to innovation adoption are will allow role players to address these challenges or barriers. The purpose of this paper is to develop the healthcare innovation adoption readiness assessment tool (HIARAT), which measures the maturity of a healthcare facility's innovation adoption process. The HIARAT was validated through a face validation workshop, and through a case study at a South African public healthcare facility.

OPSOMMING

'n Ontkoppeling bestaan tussen innovasies en die aanneming van sulke innovasies, spesifiek binne gesondheidsorgfasiliteite. Hierdie ontkoppeling lei tot verskillende gesondheidsorguitdagings wat tans nie aangespreek word nie, maar wat aangespreek behoort te kan word deur die suksesvolle aanneming en integrasie van 'n innovasie in organisatoriese prosesse. Om die uitdaging van innovasie-aanneming binne gesondheidsorg aan te spreek, word voorgestel dat 'n instrument ontwikkel word om gebiede te identifiseer wat aangespreek moet word om die kansen van die suksesvolle aanneming en integrasie van innovasies in bestaande stelsels in 'n openbare gesondheidsorgfasiliteit te verbeter. Deur die beoordeling van 'n fasiliteit se gereedheid vir innovasie aanneming, is dit moontlik om die struikelblokke tot die suksesvolle aanneming van innovasies te identifiseer. Om te weet wat sulke uitdagings of hindernisse vir die aanneming van innovasies is, sal rolspelers in staat stel om hierdie uitdagings of hindernisse aan te spreek. Die doel van hierdie artikel is om die gesondheidsorg-innovasie-aannemingsgereedskap-assesserings-instrument (HIARAT) te ontwikkel, wat die volwassenheid van 'n gesondheidsorgfasiliteit se aannemingsproses meet. Die HIARAT is gevalideer deur middel van 'n gesigs-evaluasie werkwinkel, en deur middel van 'n gevallestudie by 'n Suid-Afrikaanse openbare gesondheidsorgfasiliteit.

1 INTRODUCTION

Healthcare in South Africa faces many challenges, and is in need of major improvements [1]. These challenges include the quality of care being provided, health inequities (public healthcare versus private healthcare), rising costs, an ageing population, and managerial and operational weaknesses [2]. Nonetheless, South Africa has made significant progress in healthcare since 1994, including legislative and policy frameworks that allow for a single integrated health system [2], an essential drugs programme, free primary healthcare, and a better immunisation programme [3].

Globally, and in South Africa, there have been significant advances in healthcare research and technologies over the past few years, and large amounts of money have been allocated to research and development in the industry. In the 2015/16 financial year, the South African government spent R 11.3 billion on research and development across all sectors, 18.1 per cent of which was spent on healthcare-related research and development [4].

However, innovative solutions developed to improve aspects of healthcare frequently are not implemented at the facilities where they are needed [5]. The literature suggests that the adoption of these solutions in practice is hindered by a number of challenges. A need thus exists to evaluate the healthcare system, and more specifically healthcare facilities, with the aim of identifying the barriers and limitations to innovative solution adoption. Such an evaluation will allow healthcare managers to address the factors that hinder the successful adoption and integration of innovative solutions at their facilities, ensuring that the system is conducive to the adoption of innovations. The development of an ‘innovation readiness’ assessment tool will contribute towards more effectively achieving such assessments.

The research objectives that supported the aim of this investigation were:

1. To review the literature addressing the healthcare landscape in South Africa, current strategies for managing innovation, and innovative solution adoption in the South African healthcare environment.
2. To develop an assessment tool that can be used in healthcare facilities to assess their readiness for innovation adoption.
3. To test and validate the feasibility of the developed tool by performing a field trial at a public healthcare facility.

2 HEALTHCARE IN SOUTH AFRICA

South Africa has made innovative medical advances due to state-funded health research; some notable achievements include the first human heart transplant and computed tomography [6]. However, since the start of the 1980s there has been a restructuring of state expenditure in the healthcare system. In 1994 specifically, the emphasis of South Africa’s public healthcare services shifted towards the aim of increasing affordability and improving accessibility. This shift was accompanied by an increase in government spending on public healthcare [7], with the focus being placed on primary healthcare and “healthcare for all” [7]. Unfortunately, this has also meant a stagnation in the amount of state-funded health research [6].

Despite the apparent trade-off between innovation, increasing affordability, and improving accessibility, innovation remains a leading force in attaining the goal of minimising healthcare costs while maximising quality [8]. To innovate successfully, health research funding is necessary, in conjunction with effectively adopting healthcare innovations into appropriate sections of the national healthcare system.

Organisations tend to find the adoption of innovations difficult; the reasons for this range from the potential risks involved, to a lack of resources to carry out innovations [9]. Barriers to the adoption of innovations can be grouped into the characteristics of the organisation, the characteristics of the actual innovation, and the characteristics of the environment [10].

3 INNOVATION

Innovation is centred on processes and principles that are necessary for an invention to be developed into an innovation that will then be practically implemented [9]. Multiple different innovation adoption processes have been described by authors. These include the processes proposed by Rogers [11], Van Zyl [12], Hoffman [13], Kim [14], Ehigie and McAndrew [15], and Tidd and Bessant [10]. In order to choose an innovation process to use during the development of the HIARAT, the number of citations and the date of publication for each author's innovation process were considered. The top two most cited processes were proposed by Rogers [11] and Tidd and Bessant [10]¹. Of these two processes, Tidd and Bessant [10] were published in 2009, whereas Rogers [11] was published in 2003. Tidd and Bessant's [10] model was considered to cover the innovation adoption process effectively; and, because it had the second highest number of citations and was published more recently, the decision was made to use this innovation adoption model during the development of the HIARAT. However, it should be noted that this innovation adoption process element of the HIARAT can be changed or updated for future versions of the HIARAT, if deemed necessary for the tool's improvement.

Tidd and Bessant's [10] model of the innovation adoption process (Figure 1) shows the innovation adoption process from an organisation's perspective, looking to incorporate innovative opportunities. (These innovations can come from internal or external sources.)

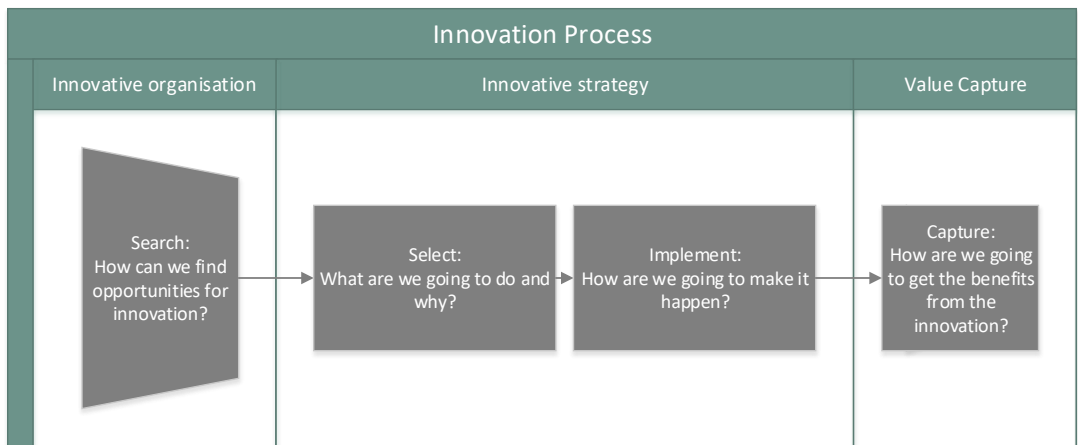


Figure 1: Process model of the innovation adoption processes within an organisation [10]

The first phase of the innovation process model (search) consists of finding areas in the organisation's environment where there is potential for change [10]. When managing the adoption process of an innovation in an organisation, the trigger or source of the innovation should be considered [10]. Triggers of innovation will influence the first phase of the innovation process model. Triggers of innovation can be influenced by multiple factors, including new markets, technologies, political rules, and public opinion [10].

Phase two (select) consists of the organisation weighing the risks and rewards to determine which innovations to pursue [10]. The third phase (implement) involves the organisation making the innovation a reality at its facility [10]. The goal of the innovation process is to derive some form of value from these innovations. The final phase (capture) entails encapsulating value from the innovation and, if the innovation fails, the reasons for failure [10]. The result of any process is the collective outcomes of participants or role players at each level [16].

¹ This was determined by considering the number of citations Rogers [11], Van Zyl [12], Hoffman [13], Kim [14], Ehigie & McAndrew [15] and Tidd & Bessant [10] each had on Google Scholar for the papers in which they described the innovation process (refer to the list of references for the papers that were considered) at the time of writing this article.

3.1 Role players in the innovation process

Essentially, innovation is about people [9]. Rothwell [17] identified having certain key individuals present as a characteristic of successful innovation. The central role players in an organisation's innovation process can be identified as the following:

- i. **The networker**, who studies trends within technology, society, markets, and regulations to recognise opportunities. The networker is also responsible for creating connections with external organisations, or with individuals who have corresponding objectives [18]. The networker is also known as the technological gatekeeper [17]. The networker is active in Phase 1 – the search phase;
- ii. **The co-ordinator**, who ensures that projects' resources, objectives, and risks are balanced; and will promote concepts and opportunities. The co-ordinator must schedule, prioritise, and guarantee project completion through overcoming the obstacles that are faced [18]. The co-ordinator will be active in Phases 2, 3, and 4 – the selection, implementation, and capture phases;
- iii. **The builder**, who creates, demonstrates, and defines tangible concepts; the builder will ensure that the product or service is ready to be supplied to the customer [18]. The builder will be active during Phase 3 – the implementation phase;
- iv. **The anthropologist**, who must have an understanding of people's interactions (both emotional and physical) with services, products, their environment, and with other people. The anthropologist can anticipate stakeholders' needs and is able to influence people's attitudes and behaviours [18]. The anthropologist will be active during Phases 2 and 3 – the selection and implementation phases;
- v. **The product champion** [17] or leader, who ensures that the organisation's activities are aligned with its objectives and strategies. The leader will prioritise opportunities to implement and will monitor a project's metrics [18]. This person is committed to the implementation of the innovation, and is able to push the project through the internal barriers [17]. The product champion will be active during phases 2, 3, and 4 – the selection, implementation, and capturing phases.

3.2 Measuring innovation

The innovation performance of organisations has been extensively studied [19], because organisations recognise the value of innovations. However, the majority of metrics that have been studied tend to be for an organisation looking to incorporate innovation into its culture and develop innovative ideas, rather than to measure its ability to adopt an innovation (regardless of the source of the innovation). Hagedoorn and Cloodt [19] identified four indicators that are used to measure an organisation's innovative performance: research and development inputs, patent citations, patent counts, and new product announcements. From Hagedoorn and Cloodt's indicators, it can be speculated that the term 'innovative performance' refers to an organisation's ability to develop innovative concepts and ideas, but not necessarily its performance when adopting innovations. The innovation capability maturity model, which is based on the capability maturity model [18], can be useful in measuring an organisation's innovation ability throughout the stages of the innovation lifecycle. It is not limited to the measurement of an organisation's ability to produce innovative ideas or an innovative culture.

A capability maturity model (CMM) is a technique that determines how mature an organisation is, by comparing the organisation's processes and the methods used in these processes against structured levels that represent how reliably an organisation can sustain the desired outcomes [20]. A CMM allows an organisation to understand their current position in comparison with the best practices in a specific domain (e.g., innovation); the capability maturity gives the organisation an indication of what direction it should go in to improve its outcomes in a specific domain [20]. A maturity model shows what needs to be improved, but does not show how the improvement should take place [21]. The model helps an organisation set improvement priorities and objectives [21]. CMMs are used across many different industries, and for many different applications [20]. Despite the large number of domains where the maturity model has been applied, the objectives and structures of the models remain very similar [22] [20]. Maturity models are often used to aid the improvement of complex systems or concepts [22].

The levels that are used in maturity models define an evolutionary pathway to an ideal process at the highest maturity level [21]. CMMs tend to have the same five levels [20], which, as described by the capability maturity model integration, are [23]:

- Level 1: Initial (ad-hoc): in this level, the process is unpredictable and badly controlled;
- Level 2: Managed: in this level, processes are characterised for specific projects;
- Level 3: Defined (standard): in this level, processes are characterised for the organisation;
- Level 4: Quantitative (measured): In this level, processes are measured;
- Level 5: Optimising: in this level, there is a focus on improvement.

When assigning an organisation to a level, it must have met the requirements of each of the previous levels [20]. The CMM has been an inspiration and the basis for the development of many other maturity models that have been developed for application in different settings and domains, including the development of the innovation capability maturity model (ICMM) [24].

3.3 Innovation in healthcare

Healthcare innovation is defined as the introduction and adoption “*of a new concept, idea, service, process, or product aimed at improving treatment, diagnosis, education, outreach, prevention and research, and with the long-term goals of improving quality, safety, outcomes, efficiency and costs*” [8]. Healthcare innovations target healthcare processes (the methods used for the production of goods or for delivery of a service), products (the goods or services that the customer pays for), or structures (business models affecting the internal and external organisation structure) [8].

In spite of substantial improvements made within the healthcare industry, there are still many inefficiencies [25]. There is no longer a problem with a lack of innovative evidence-based medical practices; the issue is that not enough of these medical innovations are successfully adopted in health facilities [5]. Even if the case for an improvement is clear, strategies that will translate the innovative solutions into practice have not been effective, properly implemented, or used. The goal is not where the point of confusion lies; the path for achieving the goal is the challenge [26].

Multiple implementation theories have been published in an attempt to support effective innovation implementations. Healthcare researchers have begun to recognise the importance of implementation science [27]. Damschroder *et al.* [27] have compared many of these healthcare innovation adoption theories, and have revealed that considerable overlap exists; but they state that each theory misses one or more critical constructs. Damschroder *et al.* [27] thus created the ‘consolidated framework for implementation research’ (CFIR) by consolidating the common building blocks from the various other published theories. For the purpose of this investigation, the CFIR will be analysed further, assuming that it successfully encompasses the necessary building blocks of a healthcare implementation framework (because Damschroder *et al.* [27] have successfully consolidated the critical aspects from the existing adoption theories). Other innovation models and frameworks that have been found during the literature analysis tend only to be applicable to creating an innovative environment within the healthcare facility, and not to dealing with innovation adoption.

4 METHODOLOGY

The tool selected on which to base the HIARAT was the capability maturity model (CMM). The CMM most directly correlated with the aim of assessing a facility’s current state of readiness to adopt an innovation. The CMM enables the organisation being assessed to carry out an improvement process once the barriers to the innovation adoption process have been identified by the tool² [24]. The HIARAT should be a standardised approach that can be used at any healthcare facility to identify the facility’s barriers to innovation adoption; thereafter the healthcare facility can, of its own accord, carry out an improvement process suited to its challenges, needs, and resources.

² The scope of this investigation is to develop a tool that assesses how ready a facility is for innovation adoption; the tool does not provide the organisation with an improvement process. The tool highlights areas that hinder innovation adoption, thus identifying areas in the organisation where resources should be focused to address the barriers identified by the tool.

In order to develop the HIARAT, the general tool development process proposed by Whiting *et al.* [28], and the more specific developmental process for a CMM proposed by De Bruin *et al.* [29], were combined, as shown in Figure 2. These are the steps that were followed to develop the HIARAT.

During the preliminary conceptual phase, decisions on the scope of the tool and on the model’s architecture needed to be made. Thereafter the first draft of the tool was populated through item generation. Finally, the tool was subjected to testing, which included face validation and a field trial to refine the tool.

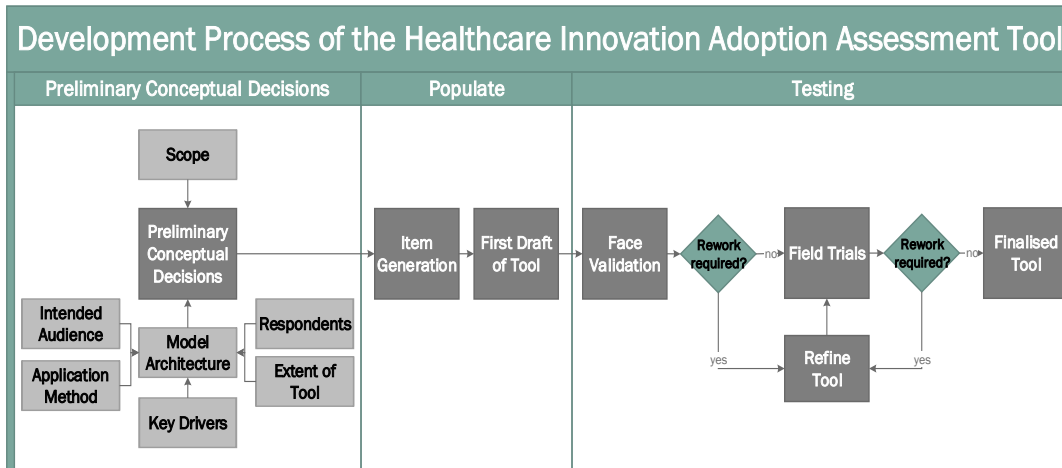


Figure 2: Combined tool development process followed to develop the HIARAT

5 THE HEALTHCARE INNOVATION ADOPTION READINESS ASSESSMENT TOOL (HIARAT)

The HIARAT is divided into two parts: i) the conceptual model that represents the organisation’s innovation adoption readiness – i.e., the innovation adoption capability maturity level of the facility, which is shown in Figure 3; and ii) the user interface, which is used to gather the necessary information from the facility being assessed in order for the process maturity capability levels for each of the domains to be determined. The user interface is shown in Appendix A. The results from the maturity analysis allow the facility to pinpoint the areas and factors of innovation adoption process that hinder the adoption of the innovation, for each of the domains. Once the barriers and limiting factors to successful adoption and integration of an innovation have been identified, the relevant role-players can proceed to identify actions that would address these barriers and limitations to the successful adoption and integration of an innovation. The tool thus acts as a decision support system; it does not focus on proposing any improvement initiatives, but rather on the identification of barriers and challenges to the adoption of innovation.

5.1 Conceptual tool

The conceptual tool consists of three planes, as seen in Figure 3. The innovation adoption process axis versus the domains axis provides a description of the innovation adoption process of a specific organisation (Table 1). The maturity capability levels axis versus the domains axis provides specific maturity capability statements for each domain (Table 2).

The statements in the description matrix (Table 1) and in the specific domain maturity capability matrix (Table 2) are both used to create the user interface – the process maturity capability matrix in Figure 3. There are five domain-specific process maturity sections in this matrix that have to be filled in to determine the maturity levels. In order for the assessor³ to complete the specific domain process maturity capability matrices, information needs to be obtained from the healthcare facility whose innovation adoption readiness is being assessed. Once the information is obtained from the facility, these matrices can be used to determine the innovation adoption readiness of the organisation in each step of the innovation process and within each domain.

³ The assessor is an external body, such as a qualified industrial engineer or project manager, who assesses the readiness for innovation adoption within that facility.

Thereafter the descriptions of the innovation adoption process for a specific domain were compared with the same domain's maturity capability level statements; Table 3 to Table 7 were then developed, showing the process maturity capability for each of the five domains, which are referred to as the user interfaces of the HIARAT.

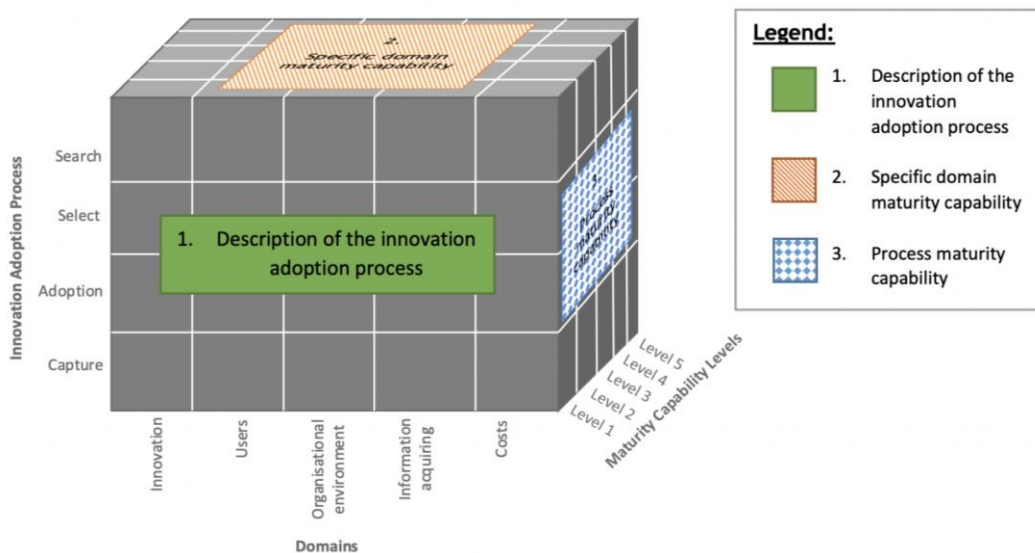


Figure 3: Conceptual framework of the HIARAT (see online version for colour)

5.1.1 Dimension 1: Capability maturity levels

There needs to be a way to measure the innovation adoption readiness of a healthcare facility. The general maturity levels, described by CMM and ICMM, provide an effective and descriptive way of measuring how ready the domains (which are necessary to support the innovation adoption process) are, seeing that it is difficult to measure analytically how 'innovation ready' an organisation is.

5.1.2 Dimension 2: Innovation adoption process

By including the innovation adoption process dimension in the HIARAT, the tool becomes more thorough in describing a healthcare facility's readiness to adopt an innovation. This is because the process dimension allows the organisation to determine what the barriers to innovation adoption are, but also in which phases of the innovation adoption process the barriers are. The innovation adoption process of an organisation is made up of five stages, as described by Tidd and Bessant [10].

5.1.3 Dimension 3: Domains

There are numerous variables that influence the item generation in the domain section (shown as 'Domains' in Figure 3). A domain describes a distinctive subset [30], which in this case is used to refer to a distinctive subset of the variables that affect (enable or hinder) the innovation adoption process.

In order to divide the domain items into sections⁴, the consolidated framework for implementation research (CFIR) was considered. This framework discusses five constructs that are critical to the innovation adoption process: the intervention characteristics, the outer setting, the inner setting, the characteristics of individuals, and the process reference [27]. The subsections of the barriers and enabling factors of innovation adoption, as described by Tidd and Bessant [10], were considered; these subsections are environmental characteristics, organisational characteristics, and characteristics of the innovation. Lastly, Van Dyk's [24] approach to determining the domains for the telemedicine service maturity model was considered. This approach was to consider the generic descriptions of the 5Ms of manufacturing (man, machine, method, material, and money) and align these with the telemedicine service [24].

⁴ These sections are necessary to divide the barriers and enabling variables into logical segments so that the assessment tool is more user-friendly; the capability maturity of the different domains during the innovation adoption process will vary, and this requires segmentation.

To divide the domains into sections, each of the 5Ms was considered and matched to the factors from the CFIR and the innovation adoption barriers. In summary, ‘machine’ aligns with the characteristics of the innovation, ‘man’ aligns with the characteristics of individuals, ‘method’ corresponds with the inner organisational setting, ‘material’ aligns with information acquisition, and ‘cost’ aligns with the financial aspects of the innovation, the organisation, and the outer setting. Thus, within the HIARAT, there are five domain sections:

- i. The innovation’s characteristics: This domain refers to the characteristics of the innovation(s) that are being considered for adoption and integration into the organisation. The maturity of the specific innovation’s characteristics being adopted into an organisation will be measured.
- ii. Users: This domain includes the stakeholders that are directly involved in the innovation adoption process, as well as stakeholders of the innovation (certain stakeholders will be role players in the adoption process)⁵. Different role players are active during each phase of the innovation adoption process. The presence of specific users, and those users having an influence in the organisation, will influence the success of the innovation adoption process.
- iii. The organisational environment: This is a broad domain that encompasses some of the other domains (users domain and costs domain). However, in order not to condense this domain overly, the organisational environment will include the goals and objectives of the organisation, the culture, policies, and the organisation’s structure.
- iv. Information acquisition: This domain includes the factors of the external environment that affect the innovation adoption process, and the information acquisition and communication that happens within the organisation.
- v. Costs: This domain’s variables include all the financial aspects related to adopting an innovation during each phase of the innovation adoption process.

5.2 User interfaces

The HIARAT’s user interfaces work like a marking rubric; for each user interface, the characteristics – applicable to each of the four stages of the innovation adoption process – are marked against the maturity level that is most applicable to the facility.

The first user interface, Table 3 in Appendix A, deals with determining the innovation adoption process maturity capability given a specific innovation’s characteristics. Seeing that this interface deals with a specific innovation, the assessor must determine whether the organisation has an innovation within one of the phases of the innovation adoption process. It is assumed that, if an innovation is in the adoption stage, for example, it would have gone through the preceding search and select phases. Within each stage of the innovation adoption process, there are characteristics of the innovation that have been identified, through the literature, that affect the innovation adoption process. These characteristics are measured against the five levels of maturity to determine the capability of the innovation – i.e., how well the innovation’s characteristics point to adoption within the organisation. Table 3 will thus help the organisation to determine whether the innovation is ready for adoption within the organisation, and/or what areas of the innovation/organisation need to be improved so that adoption will be a success. In the event that the organisation is not considering any innovation at the time of the assessment, this domain (Table 3) will be skipped.

The second user interface, the user domain, or Table 4 in Appendix A, deals with the people who are involved in the innovation adoption process. The users in this domain include the role-players who are directly involved in the innovation adoption process, and the stakeholders of the innovation (certain stakeholders will be role-players in the adoption process). The presence of specific users who have influence and control in the organisation will influence the success of the innovation adoption process. There are central innovation role-players within each stage of an organisation’s innovation adoption process. These users are measured against the five levels of maturity to determine the capability of the organisation’s users to facilitate and support the innovation adoption process. Table 4 thus helps the organisation to determine whether it has the necessary role-players in the organisation, and what areas need to be improved, from management support to the role players, and their roles, influence, and power to ensure a successful innovation adoption process.

⁵ Stakeholders are different from role players; role players will have a hands-on position during the adoption process, whereas stakeholders are interested parties who influence decisions but do not necessarily have a primary role in the adoption process. A stakeholder can be a role player, and vice-versa.

The third user interface, shown in Table 5 in Appendix A, deals with the organisational environment domain, where the innovation adoption process takes place. This interface includes the organisation's goals and objectives, and its structure, culture, and policies. The characteristics of the organisational environment are measured against the five levels of maturity to determine the capability of the organisational environment to follow and facilitate the innovation adoption process. Table 5 helps the organisation to determine what factors need to be improved to increase the effectiveness of the innovation adoption process.

The fourth user interface, Table 6 in Appendix A, deals with information acquisition throughout the innovation adoption process. The interface includes the organisation's access to information, the competitive pressures, the external policies, customer needs and resources, and the internal and external communication network. The factors influencing the organisation's information acquisition environment are, in turn, measured against the five levels of maturity to determine the capability of the organisation to acquire information during the innovation adoption process. Table 6 helps the organisation to determine what factors need to be improved for information acquisition.

The final user interface, Table 7 in Appendix A, considers all of the finances involved during each phase of the innovation adoption process. The factors influencing the organisation's financial resources are measured against the five levels of maturity to determine the capability of the organisation to fund the stages of the innovation adoption process. Table 7 helps the organisation to determine which areas of the innovation adoption process need to be better funded.

6 VALIDATION

In order to validate the HIARAT, a face validation and a field trial were conducted (refer to Figure 2). When testing the HIARAT through face validation, a workshop was held where two subject matter experts were consulted. After adjustments were made in accordance with the validation workshop, a field trial was carried out to test and adjust the HIARAT further, where necessary. The field trial was conducted at a public healthcare facility in the Western Cape, with the assistance of the healthcare facility's manager.

6.1 Face validation workshop

To conduct the face validation, two subject matter experts were consulted, during two separate face validation workshops, to determine the applicability of the developed HIARAT to evaluate the innovation adoption readiness/maturity in public healthcare facilities. The developer of the HIARAT facilitated the face validation workshops; an information pack (which included the background on why the assessment tool was developed, the aim of the assessment tool, and the objective of the HIARAT) was sent to each subject matter expert before the face validation workshops. Each subject matter expert completed a questionnaire during the workshop. The main improvements suggested during the workshops were:

- i. To clarify who would be conducting the assessments;
- ii. To ensure that the user interface is self-explanatory (implying that footnotes, which include definitions and explanations, should be included in the user interface);
- iii. To decrease the tool's complexity by adding the statements into the user interface rather than having a separate questionnaire. (questionnaires were used to fill in the user interface for the first draft of the HIARAT.)

It should be noted that no major concerns or adjustments were suggested during the workshops; all suggestions made were deemed valuable and were incorporated into the revised HIARAT. It should also be noted that the scoring of the subject matter experts differed in a number of areas; however, even if one subject matter expert scored a certain dimension highly, and the other considered that dimension to be lacking in some areas, that specific dimension would still be addressed. All aspects of the HIARAT that were scored three or less (out of five) during the face validation workshops were addressed when creating the second draft of the HIARAT.

6.2 Field trial

The second stage in testing the HIARAT was carried out as a field trial at a public healthcare facility in the Western Cape Province⁶. The field trial was conducted to evaluate the usability, consistency, and validity [28] of the HIARAT. During the field trial, the developer of the HIARAT acted in her capacity as industrial engineer-in-training, and facilitated the assessment process of the healthcare facility. During the field trial, the user interfaces were filled out (**Error! Reference source not found.** to Table 7) by discussing the relevant information with the healthcare facility's manager. This manager is a medical doctor who also takes responsibility for the general management of the facility, and hence is also knowledgeable about the innovation adoption process at that facility.

The first user interface describes the innovation adoption process maturity capability for the innovation characteristics domain, in which the facility manager considered an innovation that had already gone through the innovation adoption process: an electronic scripting system. This innovation was created in-house through the recognition of a need within the facility. This innovation scored high maturity levels (between levels 4 and 5), meaning that the characteristics of this innovation bode well for adoption within the healthcare facility.

Table 3 effectively covered the aspects of an innovation that influence the innovation adoption process.

The second user interface describes the innovation adoption process for the users' domain, in which high maturity levels were scored; during each phase of the innovation adoption process, a level 4 was scored. The meaning of the maturity levels is that there are appropriate users within the facility who ensure a successful innovation adoption process. It is recommended that the facility formalise the innovation roles and ensure that all employees are encouraged to participate in the innovation adoption process.

Table 4 effectively covered the aspects of users that influence the innovation adoption process; however, the definition of the networker will be adjusted so that it is more suitable for a public healthcare facility. It was found that the search phase of the adoption process is mostly driven by changing upon needs within the facility, and not by people actively searching for the innovation. This is due to the limited resources available at a public healthcare facility.

The third user interface describes the innovation adoption process for the organisational environment domain; maturity levels of two to four were scored for the phases of the innovation adoption process for this domain. The range of maturity levels shows that there is room for improvement within the organisational environment domain. Ideally, the change-resistant culture within the facility should be addressed. The Western Cape Department of Health contributes to the barriers to the facility's innovation adoption process, and the organisation that is considered in the tool would include this government department because all public healthcare facilities in the Western Cape have to adhere to the goals, objectives, and values of the government department. The hierarchical structure of the organisation (which includes the healthcare facility and the Department of Health) creates obstacles to the innovation adoption process; the goals and objectives of the organisation are not clearly communicated to all personnel. And although the organisation's vision includes innovation, it is not actively encouraged. **Error! Reference source not found.** effectively covered the aspects of the organisational environment that influence the innovation adoption process, although there will be a slight change of wording for the descriptions of the search phase, and the organisation will be considered to include the government department, seeing that public healthcare facilities abide by its goals and objectives.

The fourth user interface describes the innovation adoption process for the information acquisition domain; maturity levels of one to four were scored for the phases of the innovation adoption process. The range of maturity levels shows that there is room for improvement within the facility's information acquisition domain. The information acquisition procedure should ideally be standardised, which would facilitate the information flow between personnel at different organisational levels, or from employees who are not clinical personnel but still work in the healthcare facility. In addition, it is proposed that project management policies be created and managed at the healthcare facility to improve the outcomes of the innovation adoption process, and to synchronise resources and activities optimally.

⁶ The public healthcare facility requested to remain anonymous in the written report.

Table 6 effectively covered the aspects of the information acquisition domain that influence the innovation adoption process. However, the phrase ‘competitive pressures’ in the select phase will be replaced with ‘benchmarking pressures’, as there are instinctive negative connotations to the first phrase, even with the definition that explains the meaning behind the phrase.

The final user interface describes the innovation adoption process for the cost domain; maturity levels of one to two were scored for the phases of the innovation adoption process. This low range of maturity levels shows that there is room for improvement within the organisation’s cost structure. The solution is thought to lie with the Department of Health; the government needs to provide the necessary funding that will support the uptake and implementation of innovations.

Table 7 effectively covered the aspects of the cost domain that influence the innovation adoption process. This table is necessary; however, in future developments, weightings will be considered, because even though costs are a factor that hinder or enable the innovation adoption process, they do not stop the innovation from progressing if the personnel involved are passionate about adopting it.

From the field trial, the conclusion can be drawn that the HIARAT is understandable by an external stakeholder at a public healthcare facility, and is effective in assessing a healthcare facility’s innovation adoption readiness. This maturity model is used at the discretion of the assessor, so it could be partially biased, and it is thus suggested that training for assessors is provided to ensure as little bias as possible. The feedback received while conducting the field trial was considered to refine the HIARAT further; this refined HIARAT is presented in Appendix A.

7 CONCLUSION

This investigation was undertaken to develop a tool to evaluate a healthcare facility to identify barriers and limitations to innovation adoption; the HIARAT was developed from this. The outputs from applying the HIARAT support the healthcare organisation in addressing the barriers to the innovation adoption process by identifying the areas that currently act as barriers, or where challenges to innovation adoption exist.

There is much room for further research and development of the HIARAT. These improvements and research areas fall outside the scope of this investigation. Seeing that the tool is assessing the innovation adoption readiness of a specific facility, it is envisaged that some sort of value, such as an innovation readiness score, could be beneficial to healthcare facilities. This value will allow the facility to see whether there is an improvement at the healthcare facility if the assessment is done more than once. In order to come up with a single innovation readiness score for a facility, each domain would have to be weighted according to the urgency of a domain or section within the innovation adoption process. The cost dimension for a public healthcare facility would be given a lower weighting than the other four domains, due to the nature of a public healthcare facility.

The tool could be developed to become more self-explanatory, so that a manager at a healthcare facility could administer the tool without needing an external assessor and/or an industrial engineer to conduct the assessment. Methods to achieve this could be through an Excel model where options from a drop-down menu are selected, or through a free web-based application where healthcare facilities would be able to compare their innovation readiness scores with each other, creating a benchmarking system between healthcare facilities.

The population phase of the tool development process could be re-visited to conduct the assessment extensively during this phase. The method suggested by De Bruin *et al.* [29] could be used; this entails the use of an electronic survey that includes quantitative measures for measuring the items in the model. Re-visiting the population phase would allow the model to grow and become more effective at assessing the innovation adoption readiness of a facility. Further research could be done to expand the reach of the model to include the assessment of private healthcare facilities. The HIARAT is specifically geared towards public healthcare facilities; but the factors that drive public and private healthcare innovations are different, and these factors would affect the HIARAT.

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APPENDIX A

1 Description of the innovation adoption process (combined with Table 2 to develop the user interface)

Table 1: Description of the innovation adoption process using five domains

		Innovation adoption process			
		Search (Finding innovation opportunities; these can be internal or external)	Select (Portfolio management; what innovations will be adopted)	Adoption (Implementing the chosen innovation into the organisation)	Capture (Process control and risk management; tracking the success of the innovation)
Domains	Innovation (This could refer to process, product, organisational innovation, etc.)	Perceived advantage, evidence strength, design quality	Compatibility, trial-ability, complexity	Adaptability	Observability, verifiability
	Users (Medical personnel, patients, healthcare organisation, research & development organisations, regulatory agencies)	Networker	Co-ordinator, anthropologist, product champion	Co-ordinator, builder, anthropologist, product champion	Co-ordinator, product champion
	Organisational environment (Inner environment: goals, structure, culture, policies)	Organisation communication procedures, culture, learning climate	Decision-making procedure, influenced by organisational structure and goals & objectives	Implementation policies, change management	Quality control and risk management
	Information acquiring (Outer environment & internal information network: information access, competitive pressures, external policies, customer needs and resources, communication network)	External and internal communication channels, ease of information access	Competitive pressures, external policies and incentives, customers' needs & resources	Innovation adoption management: project management, communication network	Communication network: feedback systems, quality management
	Costs (Financial aspects of the innovation adoption process)	Research and development budget	Acquisition costs, financial incentives, financial resources, opportunity costs	Adoption costs	Operational and maintenance costs

2 Specific domain maturity capability (combined with Table 1 to develop the user interface)

Table 2: Process capability maturity statements per level

		Maturity capability levels					
		Level 0 None	Level 1 Ad-hoc (Unpredictable, poor control)	Level 2 Managed (Need for innovation identified, inconsistent outcomes)	Level 3 Defined (Innovation adoption procedures defined, consistent outputs)	Level 4 Quantitative (Innovation adoption process controlled and measured, integrated into organisation's activities)	Level 5 Optimising (Emphasis on improving outputs of innovation adoption process; resources and activities synchronised)
Domains	Innovation (This could refer to process, product, organisational innovation, etc.)	No innovation.	Uncertain needs for innovation.	Need for the innovation identified but no clear plan to achieve the adoption process.	The need for the innovation is clear, the process to adopt the innovation into the organisation is defined.	The need for the innovation is clear and the evidence behind the innovation is verifiable; the success of the innovation can be measured, and the innovation process is controlled.	The innovation is compatible with the facility, has a clear advantage, and is of a high design quality.
	Users (Medical personnel, patients, healthcare organisation, research & development organisations, regulatory agencies)	No users.	One or two innovation role-players with little to no influence at the facility, no management support.	Innovation role-players (not their sole role) in the facility with some influence are identified. Limited management support and involvement.	Innovation role-players identified, and have influence within the facility. There is management support, but their commitment and involvement is inconsistent.	Innovation role-players have been identified in the facility, they have control over the innovation adoption process. There is management support and commitment, management is consistently involved and accepts a degree of accountability for the innovation adoption process.	All employees are involved in the innovative adoption process. There is management support and commitment, management is consistently involved, supportive, and accepts accountability for the innovation adoption process.
	Organisational environment (Inner environment: goals, structure, culture, policies)	Environment provides no room for innovation adoption process.	Organisational structure prevents innovation adoption process from the beginning; there is no policy for innovation adoption; and culture is change resistant.	The need for an innovation adoption process has been identified, but no standardised policy for adoption is followed.	Structured innovation adoption procedures considered a standard business process; learning culture is practised inconsistently.	Structured risk management and project management procedures, and implementation policies. Clear performance control. Culture is risk tolerant, learning is encouraged.	Health facility's goals and objectives are conducive to a culture of learning and improvement. Supportive environment.
	Information-acquiring (Outer environment & internal information network: information access, competitive pressures, external policies, customer needs and resources, communication network)	No channels, no access to information.	Information is difficult to access, or no effort is put into acquiring information.	Organisation acquires information, but irregularly.	Standard process for acquiring information from external communication channels and internal communication procedures.	There is a greater ease of information access, the process of information acquiring does not only fall on one person; it is integrated into the organisation's activities. Could be a result of policies and incentives.	An emphasis on satisfying customers' needs and involving internal and external customers drives the information-acquiring process.
	Costs (Financial aspects of the innovation adoption process)	No finances.	Inconsistent and non-permanent sources of funding.	Funding is consistent but not permanent.	Consistent, permanent source of funding.	Accountability for spending, (no spending unaccounted for).	Spending is optimised.

Table 3: Innovation adoption process maturity capability for the innovation’s characteristics domain

Innovation			Maturity capability levels					
			Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
			None	Ad-hoc (Unpredictable, poor control)	Managed (Need for innovation identified, inconsistent outcomes)	Defined (Innovation adoption procedures defined, consistent outputs)	Quantitative (Innovation adoption process controlled and measured, integrated into organisation's activities)	Optimising (Emphasis on improving outputs of innovation adoption process; resources and activities synchronised)
<p><i>If the organisation is not looking at a specific innovation, skip this section and continue to 'Users'</i></p> <p>(The specific innovation looking to be implemented by the organisation: this could refer to process, product, organisational innovation, etc.)</p>			No innovation.	<i>Uncertain needs for innovation.</i>	<i>Need for the innovation identified but no clear plan to achieve the adoption process^[1].</i>	<i>The need for the innovation is clear; the process to adopt the innovation into the organisation is defined.</i>	<i>The need for the innovation is clear and the evidence behind the innovation is verifiable, the success of the innovation can be measured, and the innovation process is controlled.</i>	<i>The innovation is compatible with the facility, it has a clear advantage, and is of a high design quality.</i>
Innovation Adoption Process [2]	Search (Finding innovation opportunities; can be internal or external)	<i>Perceived advantage^[3], evidence strength^[4], design quality^[5]</i>	No innovation present in the search phase.	The evidence and design quality of the innovation leads the organisation to recognise a potential need for the innovation, but this need is not certain. The perceived advantage of the innovation varies drastically among stakeholders[6].	The evidence and design quality of the innovation leads the organisation to recognise the need for the innovation. The perceived advantage of the innovation varies considerably among stakeholders.	The evidence and design quality of the innovation leads the organisation to recognise the need for the innovation. The perception about the innovation among stakeholders is that it is advantageous.	The evidence strength and design quality of the innovation lead the organisation to recognise a clear need for the innovation. The evidence behind the innovation is verifiable, and the design of the innovation means its ² success or failure can be measured.	The perceived advantage of the innovation among stakeholders is high. The innovation's design quality is high.
	Select (Portfolio management; what innovations will be adopted)	<i>Compatibility^[7], trial-ability^[8], complexity^[9]</i>	No innovation present in the select phase.	Compatibility of the innovation with the organisation is poor; there is a high level of complexity that clouds the need for the innovation.	There is a relative compatibility of the innovation with the organisation; however, the innovation is not trial-able. The innovation's complexity does not detract from the need for the innovation (although the complexity is high).	The innovation is compatible with the organisation; however, it is necessary to make minor changes to the innovation before adoption. The level of complexity of the innovation does not detract from the need of the innovation. The innovation is trial-able.	The innovation is compatible with the organisation. The level of complexity of the innovation does not detract from the clear need of the innovation. The innovation is trial-able allowing for the organisation to gauge what the success of the innovation will be.	The innovation is completely compatible with the organisation. The complexity of the innovation does not take away from the clear advantage that the innovation provides the organisation. The innovation is trial-able.

¹ This process includes the phases of innovation adoption: search, select, adoption, capture.

² A specific innovation cannot be in different phases of the innovation adoption process at the same time. It is assumed that in order to be adopted the innovation will sequentially go from Search to Select to Adoption to Capture.

³ Perceived advantage refers to the relative advantage that adopting this specific innovation will have for the organisation.

⁴ Evidence strength refers to the evidence supporting the innovation, the strength is the extent to which the evidence is sound and convincing.

⁵ Design quality refers to the quality of the actual innovation's design, including how the innovation is presented.

⁶ Stakeholders are interested parties' who influence decisions but do not necessarily have a primary role in the adoption process, stakeholders in the innovation adoption process of a healthcare facility include: medical personnel, patients, the healthcare organisation, Research & Development organisations, and regulatory agencies.

⁷ Compatibility refers to how well the innovation, that will potentially be adopted, fits into the organisation's existing systems (the technical, physical and organisational systems).

⁸ Trial-ability refers to how easily the innovation can be tested or prototyped at the organisation before being implemented.

⁹ Complexity links to the compatibility of the innovation, it is the extent to which the innovation is challenging to use or understand. The complexity of the innovation is influenced by the time it will take to adopt the innovation, the steps required to adopt the innovation, the scope that the innovation covers, how radical and disruptive the innovation is, and how intricate the innovation is.

Innovation			Maturity capability levels					
			Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
<p><i>If the organisation is not looking at a specific innovation, skip this section and continue to 'Users'</i></p> <p>(The specific innovation looking to be implemented by the organisation: this could refer to process, product, organisational innovation, etc.)</p>			None	Ad-hoc (Unpredictable, poor control)	Managed (Need for innovation identified, inconsistent outcomes)	Defined (Innovation adoption procedures defined, consistent outputs)	Quantitative (Innovation adoption process controlled and measured, integrated into organisation's activities)	Optimising (Emphasis on improving outputs of innovation adoption process; resources and activities synchronised)
			No innovation.	Uncertain needs for innovation.	Need for the innovation identified but no clear plan to achieve the adoption process[1].	The need for the innovation is clear; the process to adopt the innovation into the organisation is defined.	The need for the innovation is clear and the evidence behind the innovation is verifiable, the success of the innovation can be measured, and the innovation process is controlled.	The innovation is compatible with the facility, it has a clear advantage, and is of a high design quality.
Innovation Adoption Process [2]	Adoption (Implementing the chosen innovation into the organisation)	Adaptability ^[10]	No innovation present in the adoption phase.	The innovation is not able to adjust easily to meet the organisation's needs: there is a high level of training required for adoption, as well as a high level of re-engineering required.	The innovation is able to adjust to meet the organisation's needs; however, the re-engineering required to accomplish this is complex. A moderate level of training is required for adoption.	The innovation is able to adjust to meet the organisation's needs through a straight forward re-engineering process; training is required for adoption.	The innovation is able to adjust easily to meet the organisation's needs; minimal training and re-engineering required for adoption.	The innovation meets the organisation's needs without making adjustments. Little to no training and re-engineering are required for adoption.
	Capture (Process control and risk management, tracking the success of the innovation)	Observability ^[11] , verifiability ^[12]	No innovation present in the capture phase.	The innovation has poor observability; there is no clear way to measure the outcomes of the innovation. The proposed outcomes of the innovation are not verifiable as there is little to no quality evidence relating to the proposed outcome of adopting the innovation.	The innovation's outcomes are observable, although there is no defined way to measure the outcomes of the innovation. The proposed outcomes of the innovation are not verifiable; there is little quality evidence relating to the proposed outcomes of adopting the innovation.	The outcomes of the innovation are observable; there is a defined way to measure the outcomes of the innovation. The proposed outcomes of the innovation are not verifiable; there is little strong quality evidence relating to the proposed outcomes of adopting the innovation.	The outcomes of the innovation are observable; there is a clear way to measure the outcomes of the innovation. The proposed outcomes of the innovation are verifiable by quality evidence relating to the proposed outcomes of adopting the innovation.	The innovation's observability is excellent; there is a clear way to measure the outcomes of the innovation. The proposed outcomes of the innovation are verifiable due to the strong and high-quality evidence relating to the proposed outcome adopting the innovation.

¹ This process includes the phases of innovation adoption: search, select, adoption, capture.

² A specific innovation cannot be in different phases of the innovation adoption process at the same time. It is assumed that in order to be adopted the innovation will sequentially go from Search to Select to Adoption to Capture.

³ Perceived advantage refers to the relative advantage that adopting this specific innovation will have for the organisation.

¹⁰ Adaptability refers to how easily the innovation is able to adjust to the organisation. This includes how much training is required for innovation adoption and integration into business and organisational processes, what level of re-engineering of the innovation is required, and how well the innovation can be adapted to meet the organisation's needs.

¹¹ Observability refers to how easily the adopted innovations' outcomes can be observed and measured by the organisation.

¹² Verifiability refers to the evidence strength and quality relating to the proposed outcome of adopting the innovation.

Table 4: Innovation adoption process maturity capability for the users' domain

			Maturity capability levels					
			Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
			None	Ad-hoc (Unpredictable, poor control)	Managed (Need for innovation identified, inconsistent outcomes)	Defined (Innovation adoption procedures defined, consistent outputs)	Quantitative (Innovation adoption process controlled and measured, integrated into organisation's activities)	Optimising (Emphasis on improving outputs of innovation adoption process; resources and activities synchronised)
Users (Medical personnel, patients, healthcare organisation, R&D organisations, regulatory agencies)			<i>No users.</i>	<i>One or two innovation role-players⁷ with little to no influence at the facility, no management support⁸.</i>	<i>Innovation role-players (not their sole role) in facility with some influence are identified. Limited management support and involvement.</i>	<i>Innovation role-players identified, and have influence within the facility. There is management support, but their commitment and involvement is inconsistent.</i>	<i>Innovation role players have been identified in the facility, they have control over the innovation adoption process. There is management support and commitment, management is consistently involved and accepts a degree of accountability for the innovation adoption process.</i>	<i>All employees are involved in the innovation adoption process. There is management support and commitment, management is consistently involved, supportive, and accepts accountability for the innovation adoption process.</i>
			No users in the search phase.	There is an individual(s) who performs the tasks of a networker within the organisation; however, this is not their formal role and they have little to no influence. No management support.	There is an individual(s) who performs the tasks of a networker within the organisation; however, this is not their formal role, and they have some influence in the organisation. Limited management support and involvement.	There is an individual(s) who performs the tasks of a networker within the organisation; this is included in their formal role, and they have influence in the organisation. There is management support, but their commitment and involvement is inconsistent.	There is an individual(s) who performs the tasks of a networker within the organisation; this is included in their formal role, and they have influence in the organisation and are respected. The individual(s) has responsibilities and actively participates in the innovation adoption process. There is management support and commitment; management is consistently involved and accepts a degree of accountability for the innovation adoption process.	There is an individual(s) who formally performs the tasks of a networker within the organisation, but all employees are encouraged and involved in contributing to the responsibilities that the networker has. Employees actively participate in the innovation adoption process. There is management support and commitment; management is consistently involved, supportive, and accepts accountability for the innovation adoption process.
Innovation Adoption Process	Search (Finding innovation opportunities; can be internal or external)	<i>Networker⁹</i>						

⁷ Stakeholders are different from role-players; role-players will have a hands-on position during the adoption process, whereas stakeholders are interested parties who influence decisions but do not necessarily have a primary role in the adoption process. A stakeholder can be a role-player.

⁸ The extent of the organisation's managerial support, patience, commitment, involvement, and accountability during the innovation adoption process can contribute towards the success or failure of an innovation adoption process. Managers have significant influence over the decision to adopt an innovation, even though they are often not the intended users.

⁹ The networker studies trends within technology, society, markets, and regulations to recognise opportunities. The networker will also interact with people within the organisation to recognise the internal needs and opportunities. The networker is responsible for creating connections with external organisations, or with individuals who have corresponding objectives.

<p>Select</p> <p>(Portfolio management; what innovations will be adopted)</p>	<p><i>Co-ordinator</i>¹⁰, <i>anthropologist</i>¹¹, <i>product champion</i>¹²</p>	<p>No users in the select phase.</p>	<p>There are individuals who perform the task of co-ordinator, anthropologist, and product champion within the organisation; however, this is not their formal role and they have little to no influence. No management support.</p>	<p>There are individuals who perform the task of a co-ordinator, anthropologist, and product champion within the organisation; however, this is not their formal role, though they have some influence in the organisation. Limited management support and involvement.</p>	<p>There are individuals who perform the task of a co-ordinator, anthropologist, and product champion within the organisation; this is included in their formal role, and they have influence in the organisation. There is management support, but their commitment and involvement is inconsistent.</p>	<p>There are individuals who perform the task of a co-ordinator, anthropologist, and product champion within the organisation; this is included in their formal role, and they have influence in the organisation and are respected. The individuals have responsibilities and actively participate in the innovation adoption process. There is management support and commitment; management is consistently involved and accepts a degree of accountability for the innovation adoption process.</p>	<p>There are individuals who formally perform the task of a co-ordinator, anthropologist, and product champion within the organisation, but all employees are encouraged and involved in contributing to the responsibilities that the co-ordinator, anthropologist, and product champion has. Employees actively participate in the innovation adoption process. There is management support and commitment. Management is consistently involved, supportive, and accepts accountability for the innovation adoption process.</p>
<p>Adoption</p> <p>(Implementing the chosen innovation into the organisation)</p>	<p><i>Co-ordinator</i>, <i>builder</i>¹³, <i>anthropologist</i>, <i>product champion</i></p>	<p>No users in the adoption phase.</p>	<p>There are individuals who perform the task of a co-ordinator, builder, anthropologist, and product champion within the organisation; however, this is not their formal role and they have little to no influence. No management support.</p>	<p>There are individuals who perform the task of a co-ordinator, builder, anthropologist, and product champion within the organisation; however, this is not their formal role. They have some influence in the organisation. Limited management support and involvement.</p>	<p>There are individuals who perform the task of a co-ordinator, builder, anthropologist, and product champion within the organisation. This is included in their formal role, and they have influence in the organisation. There is management support, but their commitment and involvement is inconsistent.</p>	<p>There are individuals who perform the task of a co-ordinator, builder, anthropologist, and product champion within the organisation. This is included in their formal role, and they have influence in the organisation and are respected. The individuals have responsibilities and actively participate in the innovation adoption process. There is management support and commitment, and management is consistently involved and accepts a degree of accountability for the innovation adoption process.</p>	<p>There are individuals who formally perform the task of a co-ordinator, builder, anthropologist, and product champion within the organisation, but all employees are encouraged and involved in contributing to the responsibilities that the co-ordinator, builder, anthropologist, and product champion have. Employees actively participate in the innovation adoption process. There is management support and commitment, and management is consistently involved, supportive, and accepts accountability for the innovation adoption process.</p>
<p>Capture</p> <p>(Process control and risk management; tracking the success of the innovation)</p>	<p><i>Co-ordinator</i>, <i>product champion</i></p>	<p>No users in the capture phase.</p>	<p>There are individuals who perform the task of co-ordinator and product champion within the organisation; however, this is not their formal role and they have little to no influence. No management support.</p>	<p>There are individuals who perform the task of co-ordinator and product champion within the organisation; however, this is not their formal role. They have some influence in the organisation. Limited management support and involvement.</p>	<p>There are individuals who perform the task of co-ordinator and product champion within the organisation. This is included in their formal role, and they have influence in the organisation. There is management support, but their commitment and involvement is inconsistent.</p>	<p>There are individuals who perform the task of co-ordinator and product champion within the organisation. This is included in their formal role, and they have influence in the organisation and are respected. The individuals have responsibilities and actively participate in the innovation adoption process. There is management support and commitment, and management is consistently involved and accepts a degree of accountability for the innovation adoption process.</p>	<p>There are individuals who formally perform the task of co-ordinator and product champion within the organisation, but all employees are encouraged and involved in contributing to the responsibilities that the co-ordinator and product champion have. Employees actively participate in the innovation adoption process. There is management support and commitment, and management is consistently involved, supportive, and accepts accountability for the innovation adoption process.</p>

¹⁰ The co-ordinator ensures that the projects' resources, objectives, and risks are balanced, and will promote concepts and opportunities. The co-ordinator must schedule, prioritise, and guarantee project completion through overcoming obstacles faced.

¹¹ The anthropologist must have an understanding of people's interactions (both emotional and physical) with services, products, their environment, and with other people. The anthropologist can anticipate stakeholders' needs and is able to influence people's attitudes and behaviours.

¹² The product champion ensures that the organisation's activities are aligned with their objectives and strategies. They will prioritise opportunities to implement and will monitor a project's metrics. This person is committed to the implementation of the innovation and is able to push the project through the internal barriers.

¹³ The builder creates, demonstrates, and defines tangible concepts; the builder will ensure the product or service is ready to be supplied to the customer.

Table 5: Innovation adoption process maturity capability for the organisational environment domain

			Maturity capability levels					
			Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
Organisational environment (Inner environment: goals, structure, culture, policies)			None	Ad-hoc (Unpredictable, poor control)	Managed (Need for innovation identified; inconsistent outcomes)	Defined (Innovation adoption procedures defined; consistent outputs)	Quantitative (Innovation adoption process controlled and measured; integrated into organisation's activities)	Optimising (Emphasis on improving outputs of innovation adoption process; resources and activities synchronised)
			<i>Environment provides no room for innovation adoption process.</i>	<i>Organisational structure prevents innovation adoption process from the beginning; there is no policy for innovation adoption, and culture is change resistant¹⁴.</i>	<i>The need for an innovation adoption process has been identified, but no standardised policy for adoption is followed.</i>	<i>Structured innovation adoption procedures are considered a standard business process; learning culture is practised inconsistently.</i>	<i>Structured risk management procedures, project management procedures, and implementation policies. Clear performance control. Culture is risk tolerant; learning is encouraged.</i>	<i>Health facility's goals and objectives are conducive to a culture of learning and improvement. Supportive environment.</i>
Innovation Adoption Process	Search (Finding innovation opportunities; can be internal or external)	<i>Organisation communication procedures¹⁵, culture¹⁶, learning climate¹⁷</i>	The organisational environment is not conducive to searching for innovations to adopt.	The organisation's communication procedures are poorly controlled; there is a change resistant culture within the organisation. The climate within the organisation is risk averse and does not promote learning.	The organisation's communication procedures are controlled but the procedures are not standardised. There is a change resistant culture within the organisation. The climate within the organisation is risk averse; however, there is a culture of learning that is inconsistently promoted.	The organisation's communication procedures are controlled and standardised. An organisational culture of learning is practiced. There is a level of tolerance towards risk.	The organisation's communication procedures are well controlled. The organisational culture is risk tolerant; learning is encouraged.	The organisation's communication procedures are excellently controlled. The organisational culture is tolerant to change, and the climate within the organisation is supportive and promotes learning.

¹⁴ Change resistant: Behavioural barriers within an organisation consist of decision-makers' motivations, priorities, rationality, and inclination towards risk and change.

¹⁵ Communication procedures refer to the organisation's established external and internal communication policies that are enforced and followed throughout the organisation.

¹⁶ Organisational culture affects the ease and success of the innovation adoption process. The level of collaboration influences the organisation's culture, and integration between departments and personnel, by how tolerant to risk the organisation is, and whether a climate of learning is encouraged. The behaviours of the users in the organisation also influence the organisational culture. Behaviours include preconceived beliefs about the innovation, resistance to change, and the attitude towards risk.

¹⁷ An organisation that is learning orientated means that research and development within the company, knowledge retention, and support for skill development is encouraged.

<p>Select (Portfolio management; what innovations will be adopted)</p>	<p><i>Decision-making procedure</i>¹⁸; <i>influenced by organisational structure</i>¹⁹ <i>and goals and objectives</i>²⁰</p>	<p>The organisational environment is not conducive to selecting innovations.</p>	<p>Decision-making procedures are poorly controlled and structural aspects of the organisation prevent an innovation from being selected. The goals and objectives of the organisation are not communicated clearly, and do not encourage innovation.</p>	<p>Decision-making procedures are poorly controlled. The organisational structure does not prevent an innovation from being selected, although it potentially creates further obstacles to selecting an innovation. The goals and objectives of the organisation are not communicated clearly, although they do encourage innovation adoptions.</p>	<p>Decision-making procedures are well controlled. The organisational structure does not impede the selection of an innovation. The goals and objectives of the organisation are communicated and encourage innovation adoptions.</p>	<p>Decision-making procedures are well controlled. The organisational structure does not impede the selection of an innovation. The goals and objectives of the organisation are clearly communicated, and stimulate innovation adoptions.</p>	<p>Decision-making procedures are controlled effectively and the organisational structure is not a barrier to selecting an innovation for adoption. The goals and objectives of the organisation are communicated clearly and understood by all employees in the organisation. The goals and objectives of the organisation include innovation and encourage the innovation adoption process to thrive.</p>
<p>Adoption (Implementing the chosen innovation into the organisation)</p>	<p><i>Implementation policies</i>²¹; <i>change management</i>²²</p>	<p>The organisational environment is not conducive to adopting innovations.</p>	<p>Implementation is poorly controlled. There is no change management procedure.</p>	<p>Implementation is controlled but there are no formal implementation policies. The need for change management is recognised; the change management procedure is sporadically practised and not formalised.</p>	<p>Implementation is controlled, and there are formal implementation policies. The change management procedure is formalised; however, it is still sporadically practised.</p>	<p>Implementation is controlled; there are formal, structured implementation policies. The change management procedure is formalised and is practised regularly.</p>	<p>Implementation is excellently controlled; there are formalised implementation policies. Change management is a formal policy that is continuously practised and controlled.</p>
<p>Capture (Process control and risk management; tracking the success of the innovation)</p>	<p><i>Quality control</i>²³ <i>and risk management</i>²⁴</p>	<p>The organisational environment is not conducive to capturing innovations.</p>	<p>Quality assessments are poorly controlled and sporadically carried out. There is no formal risk management procedure in the organisation.</p>	<p>Quality assessments are controlled but there are no formal quality management procedures. The need for risk management is recognised; risk management is sporadically practised and not formalised.</p>	<p>Quality assessments are controlled, there are formal quality management policies. The risk management procedure is formalised; however, it is still sporadically practised.</p>	<p>Quality assessments are controlled; there are formal, structured quality management policies. The risk management procedure is formalised and is practised on a regular basis.</p>	<p>Quality assessments are excellently controlled; there are formalised quality management policies. Risk management is a formal policy that is continuously practised and controlled.</p>

¹⁸ An organisation must have a structured, established decision-making process and effective management of this decision-making procedure.

¹⁹ Organisation structure includes the age, size, and architecture of the organisation (the organisation's architecture could be a flat organisational structure, a hierarchical organisation, or something in between the two). The organisation includes the healthcare facility and the government Department of Health.

²⁰ Goals and objectives: are these goals clearly communicated, and are they conducive to a positive innovation adoption environment within the healthcare organisation?

²¹ Implementation policy is the course of action by which the organisation abides when implementing a new process, product, etc. The quality of an organisation's implementation policies can be an indication of the success or failure to adopt an innovation.

²² Behavioural barriers within an organisation consist of decision-makers' motivations, priorities, rationality, and inclination towards risk and change; for this reason, change management is required to control the change process, and to minimise resistance as far as possible.

²³ Quality control policies will minimise the potential risks of adopting a new innovation, meaning that there will be a higher chance of innovation adoption success.

²⁴ Risk management is required to predict and evaluate potential risks, and to put procedures in place that control and mitigate the identified risks as far as possible.

Table 6: Innovation adoption process maturity capability for the information acquisition domain

Information-acquiring (Outer environment and internal information network: information access, competitive pressures, external policies, customer needs and resources, communication network)			Maturity capability levels					
			Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
			None	Ad-hoc (Unpredictable, poor control)	Managed (Need for innovation identified; inconsistent outcomes)	Defined (Innovation adoption procedures defined; consistent outputs)	Quantitative (Innovation adoption process controlled and measured; integrated into organisation's activities)	Optimising (Emphasis on improving outputs of innovation adoption process; resources and activities synchronised)
			<i>No channels, no access to information.</i>	<i>Information is difficult to access, or no effort is put into acquiring information.</i>	<i>Organisation acquires information, but irregularly.</i>	<i>Standard process for acquiring information from external communication channels and internal communication procedures.</i>	<i>There is a greater ease of information access, the process of information acquiring does not only fall on one person; it is integrated into the organisation's activities. Could be a result of policies and incentives.</i>	<i>An emphasis on satisfying customers' needs; involving internal and external customers drives the information acquiring process.</i>
Innovation Adoption Process	Search (Finding innovation opportunities; can be internal or external)	<i>External and internal communication channels; ease of information access²⁵</i>	No communication channels in place.	Information is difficult to access; communication channels (internal and external) exist, but no effort is put into acquiring information from these channels.	Information is accessible through the communication channels (internal and external) that exist. Effort is put into acquiring information from these channels; information acquisition is sporadic.	Information is accessible through the communication channels that exist. There is a standardised procedure that is followed for acquiring information from these channels. It is easy to access information.	Information is easily accessible through the communication channels that exist. There is a standardised procedure that is followed for acquiring information from these channels; information is consistently obtained and is integrated into the organisation's activities.	Information is easily accessible through the communication channels that exist; the organisation is continuously looking to establish new communication channels. Customers (internal and external) are considered and involved when searching for innovative opportunities.
	Select (Portfolio management; what innovations will be adopted)	<i>Benchmarking pressures²⁶, external policies and incentives²⁷, customers' needs and resources²⁸</i>	No pressures or resources to select an innovation.	Competitive pressures have no effect on innovation selection. No external policies or incentives in place that pressure the organisation to select an innovation. Customers' needs are not known or considered. Innovations are selected randomly.	Competitive pressures lead to the organisation irregularly selecting innovations to adopt. Some external policies or incentives are in place that pressure the organisation to select an innovation. Customers' needs are known but are not consciously considered. Innovation selection is managed.	Competitive pressures lead to the organisation acquiring and selecting what information to pursue further. External policies or incentives are in place that pressure the organisation to select an innovation. Customers' needs are known and are consciously considered during selection. Innovation selection is managed, and the selections of innovations has a consistent output.	Competitive pressures lead to the organisation selecting innovations to adopt faster. External policies or incentives are in place that pressure the organisation to select an innovation. Customers' needs are known, and are consciously considered and given a higher weighting during selection. Innovation selection is integrated into the organisation's activities.	The selection procedure emphasises satisfying customers' needs. External policies or incentives are in place that pressure the organisation to select an innovation.

²⁵ The ease of information access influences the rate of the innovation adoption process, the decision of whether to adopt the innovation, and whether the organisation receives information about available innovations to address current challenges faced by the organisation.

²⁶ Benchmarking pressure is a result of a competing organisation or well-respected organisation adopting a particular innovation compelling the organisation being considered to do the same.

²⁷ External policies and incentives could be policies or incentives from the government or from international organisations. Public opinion could be a contributing incentive to adopt an innovation; incentives could be monetary.

²⁸ Knowing the customers' needs (includes internal and external customers) can influence what innovations will be selected for adoption. Involving customers in the innovation adoption process will mean that the process is more likely to succeed in meeting the customers' needs.

	Adoption (Implementing the chosen innovation into the organisation)	Innovation adoption management policies; project management²⁹, communication network³⁰	No communication channels in place; innovation adoption management is non-existent.	The organisation's internal communication network is not effective, making information difficult to access. Project management policies exist but are poorly controlled.	The organisation's internal communication network is effective for transmitting information about the adoption process. Project management policies exist and are managed; however, the outcomes are inconsistent.	The organisation's internal communication network is effective for transmitting information about the adoption process; the internal communication network has been standardised. Project management policies exist and are managed; the outcomes of adoption are consistent.	The organisation's internal communication network is effective for transmitting information about the adoption process; the internal communication network has been integrated into the organisation's activities. Project management policies are managed; the outcomes are consistent and measurable.	The organisation's internal communication network is optimised and provides a channel for internal customers to offer input during the adoption stage of the process. There is greater ease of involving customers in the adoption stage of the process. Project management policies exist and are optimally managed.
	Capture (Process control and risk management; tracking the success of the innovation)	Communication network: feedback systems, quality management³¹	No communication channels in place to capture information from the innovation.	The organisation's internal communication network is not effective; feedback on the adopted innovation is difficult to access. Quality management policies are not communicated to the appropriate personnel. This leads to poor process control.	The organisation's internal communication network provides feedback about the adopted innovation; however, this happens irregularly and is difficult to access. Quality management policies are communicated to the appropriate personnel; the policies produce inconsistent outcomes.	The organisation's internal communication network is effective, feedback is a standard practice within the organisation. Quality management policies are communicated and practised by the appropriate personnel.	The organisation's internal communication network is effective; feedback on the adopted innovation is easy to access. Quality management policies are well communicated and practiced; the quality of the adopted innovation is measurable.	The organisation's internal communication network effectively provides feedback on the status of the adopted innovation, allowing for optimal control over the implemented innovation. Quality management policies are known and practised by all personnel.

²⁹ Project management includes managing the planning, initiating, and controlling procedures during the adoption phase. Project managers need to ensure that the innovation is adopted within an allocated time frame while realising the objectives of the innovation.

³⁰ Communication network refers to the organisation's external and internal communication channels, and how well the organisation is networked with external organisations.

³¹ Quality management will minimise the potential risks of adopting a new innovation, meaning that there will be a higher chance of innovation adoption success.

Table 7: Innovation adoption process maturity capability for the costs domain

Costs (Financial aspects of the innovation adoption process)			Maturity capability levels					
			Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
			None	Ad-hoc (Unpredictable, poor control)	Managed (Need for innovation identified, inconsistent outcomes)	Defined (Innovation adoption procedures defined, consistent outputs)	Quantitative (Innovation adoption process controlled and measured, integrated into organisation's activities)	Optimising (Emphasis on improving outputs of innovation adoption process, resources and activities synchronised)
			<i>No finances.</i>	<i>Inconsistent and non-permanent sources of funding³².</i>	<i>Funding is consistent but not permanent.</i>	<i>Consistent, permanent source of funding.</i>	<i>Accountability³³ for spending, (no spending unaccounted for).</i>	<i>Spending is optimised³⁴.</i>
Innovation Adoption Process	Search (Finding innovation opportunities, can be internal or external)	<i>Research & development budget³⁵</i>	No budget.	Research & development budget is present within the organisation, however the source and amount allocated to this budget is inconsistent.	Research & development budget is consistent, however the funding is not permanent.	Research & development budget is consistent and permanent.	There is personal accountability for everything spent from the research and development budget, no spending is unaccounted for.	The spending in the research & development budget is optimised to receive the best results of searching for innovations.
	Select (Portfolio management, what innovations will be adopted)	<i>Acquisition costs³⁶, financial incentives³⁷, financial resources³⁸, opportunity costs³⁹</i>	No finances.	Inconsistent sources of funding for acquisition of innovations, little to no financial resources allocated to the selection phase, no financial incentives to select an innovation. Acquisition costs overshadow the benefits of adoption.	The budget available for the acquisition costs is consistent, however the funding is not permanent. Some financial resources are allocated to the selection phase, no financial incentives to select an innovation. The costs of acquisition overshadow the benefits of adoption.	The budget available for the acquisition costs is consistent and permanent. Financial resources are allocated to the selection phase, there are financial incentives to select an innovation. Opportunity benefits are considered with the same weighting as the costs of acquisition.	There is personal accountability for everything spent from the finances allocated to acquisition, no spending is unaccounted for. Financial resources are appropriately allocated to the selection phase, there are financial incentives to select an innovation to be adopted.	The budget available for the acquisition costs is consistent and permanent. Financial resources are optimally allocated to the selection phase to ensure maximum benefits from these resources. There are financial incentives to select an innovation to be adopted.

³² Funding consistency: financial resources available for the innovation may not be consistent, which will affect the innovation adoption process.

³³ 'Accountability' refers to the organisation's ability to account for the finances spent on the innovation. Thus, the organisation's ability to report on the spending of the financial resources in relation to the adoption of an innovation or the impact of the adoption of such an innovation.

³⁴ 'Optimised spending' refers to ensuring that spending is as effective as possible, getting the most value for the money spent.

³⁵ 'Research and development budget' relates to the success that the company will have during the search phase of the innovation adoption process. The greater the research and development budget is the higher the chances are that the organisation will find an innovation that is compatible and meets their needs. A limited budget in this phase would mean limited information access.

³⁶ 'Acquisition costs' relates to how much money the organisation will need to spend to attain the innovation (this is closely related to the research and development budget).

³⁷ 'Financial incentives' is an incentive provided as money in order to adopt an innovation.

³⁸ Financial resources will not necessarily come from the organisation's budget, the financial resources could be funded by the government, by an NGO, by an international governing body etc.

³⁹ 'Opportunity costs' are those costs benefits which would be missed out on if the company failed to adopt an innovation.

	Adoption (Implementing the chosen innovation into the organisation)	<i>Adoption costs</i> ⁴⁰	No finances.	Inconsistent sources of funding for adoption of an innovation.	Consistent sources of funding for adoption of an innovation, however funding is not permanent.	Consistent and permanent sources of funding for adoption of an innovation.	There is personal accountability for everything spent from the finances allocated to adoption, no spending is unaccounted for.	The budget available for the adoption costs is consistent and permanent. Financial resources are optimally allocated to the adoption phase to ensure maximum benefits from the opportunity are realised.
	Capture (Process control and risk management, tracking the success of the innovation)	<i>Operational</i> ⁴¹ <i>and maintenance costs</i> ⁴²	No finances.	Inconsistent sources of funding for operational costs of innovations. Little to no financial resources allocated to the maintenance of the innovation.	Consistent sources of funding for operation and maintenance of an innovation, however funding is not permanent.	Consistent and permanent sources of funding for operation and maintenance of an innovation.	There is personal accountability for everything spent from the finances allocated to operation and maintenance of the innovation, no spending is unaccounted for.	The budget available for the operation and maintenance costs is consistent and permanent. Financial resources are optimally allocated to the capture phase to ensure maximum benefits from the opportunity are realised.

⁴⁰ 'Adoption costs' include the initial investment required to adopt the innovation versus the opportunity costs of the innovation (benefits).

⁴¹ 'Operational costs' are the finances required once the innovation has been adopted into the organisation to operate the innovation.

⁴² 'Maintenance costs' are the finances required once the innovation has been adopted into the organisation to maintain the innovation.