Healthcare Technology Transfer in Sub-Saharan Africa: Conceptual Framework Evaluation

Rian Marais, Sara S. Grobbelaar, and Imke H. de Kock

***Abstract*—The research presented within this article sets out to evaluate a conceptual framework, consisting of five phases, aimed at facilitating health-related technology transfer to and within sub-Saharan African countries. The framework is constructed using a grounded theory process and is subsequently quantitively evaluated via a questionnaire survey instrument with two five-point Likert Scale measurement items namely perceived ease of use and usefulness. The survey addresses practicality via a frequency analysis with the framework receiving a perceived ease of use score of 2.992 and a usefulness score of 4.032. The survey instrument addresses the versatility of the conceptual framework's intended geographic application area through a variance analysis. For the perceived ease of use measurement item, Western and Central Africa received statistically significant p-values of 0.01178 and 0.02288, respectively, highlighting discrepancies in perceived ease of use within the first two phases of the conceptual framework. No statistically significant variances are uncovered with respect to the usefulness measurement item. The final evaluation measure addresses utility via a regression analysis with the relationship between technology adoption and the five phases receiving p-values ranging from 0.643, 0.694, 0.751, 0.715, and 0.927.**

***Index Terms*—Conceptual framework analysis (CFA), sub-Saharan Africa (SSA), survey instrument, technology transfer (TT).**

I. Introduction and Problem Statement

A. Background and the Sub-Saharan African (SSA) Context

THE availability of healthcare services at a sufficient level is widely considered as a fundamental humanitarian right. However, a significant discrepancy exists in the global availability, quality and general level of healthcare services between countries [1]–[3]. These discrepancies are further evident when reviewing various case studies documenting disease epidemics across SSA, with these outbreaks often due to inadequate supplies of fresh water, sanitation and basic immunization services [4], [5]. Furthermore, successful utilization of healthcare products and services are often hampered as a result of insufficient infrastructure throughout SSA [5]–[7].

Further investigation of literature reiterates the existence of a strong positive correlation between a country's socioeconomic development and the collective level of healthcare service provision when considering access to healthcare services, quality of healthcare service provided and the number of active healthcare professionals [8], [9]. This is often a result of superior healthcare policies, available hard infrastructure and medical education facilities which are typically present within developed countries [2], [10].

A preliminary evaluation of several case studies uncovered a variety of healthcare technologies being pioneered in developed environments [11]–[13]. As these technologies are largely constructed within first world countries with inter alia sufficient infrastructure and established and sustainable healthcare systems, they cannot merely be transplanted and immediately be successfully implemented in developing nations [14], [15]. Constraints such as widespread poverty, lacking education, healthcare systems and sanitation largely prohibit developing nations from adopting these technologies and thus, there exists a need to adapt to the local environment [16]–[18].

B. Technology Transfer (TT) As a Concept and Study Objective

From the outset, in relation to the TT process we refer to "transferor" as the entity whom is transferring the technology and "transferee" is the recipient of the technology [19]–[21]. Technology is not embodied solely in physical artefacts used to simplify processes but also entails knowledge, protocols and various sub-systems [17], [22], [23]. Transfer of tacit concepts has often been far more important to the transferee than the acquisition of new hardware [17].

TT is a mechanism which circumvents critical issues when attempting to implement foreign health technologies within a local context. TT is a subset of the wider spectrum of technology management as is characterized by the adoption and application of an existing innovation, technology or relevant knowledge, either implicitly and explicitly, within a foreign environment [19].

In this article, we present a framework (based on a structured literature review, see Section III) to provide decision makers with a structured process to facilitate healthcare TT to and within SSA. While the development, contents and flow of conceptual framework is discussed (see Section IV), the primary aim of this article is to evaluate this conceptual framework by implementing

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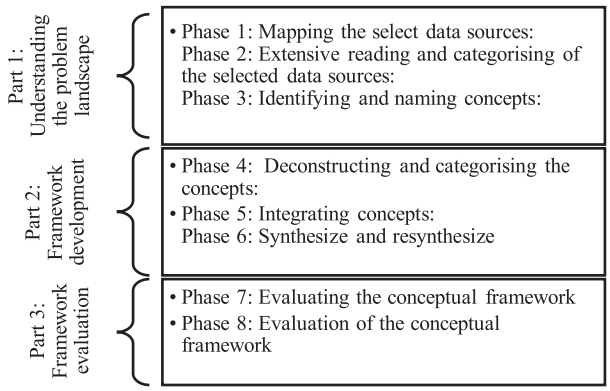


Fig. 1. Outline of the eight steps of CFA methodology followed during the construction of the conceptual framework.

a survey instrument to quantitatively measure the practicality, applicability, and utility of the framework (see Section V).

II. Methodology

The research methodology within this article consists of three major sections, namely: Part 1 which is about developing a structured literature review through which the core concepts to be included in the framework was identified. In part 2, we present the development of the conceptual framework while part 3 entails the presentation of results from a survey to evaluate the conceptual framework. Parts 1 and 2 are briefly described as background to the reader with part 3 the primary focus of this research article.

The methodology chosen for the conceptual framework's development is conceptual framework analysis (CFA) (a grounded theory methodology) as it enables researchers to elucidate the attributes, characteristics, expectations, constraints, perceptions and individual functions required within a conceptual framework [24]. CFA is founded on grounded theory and thus aims to produce a detailed comprehension and organization of data and concepts [24], [25]. The CFA process as presented in this article consist of eight-steps, namely: mapping selected data sources; extensive reading and categorizing of the selected data; Identifying and naming concepts; deconstructing and categorizing the concepts; integrating concepts; Synthesis and resynthesis; evaluating and analyzing the conceptual framework; and rethinking the conceptual framework and conclusion. These eight steps, along with a high-level summary of their interpretations for this research article are shown in Fig. 1 and shows how it was divided in three parts. The following sections outline the methodology for each part in more detail

A. Part 1: Understanding the Problem Landscape—The Systematised Literature Review

Part 1 includes phases 1 to 3 of the CFA as shown in Fig. 1. We conducted a systematic literature review to explore the extant literature on success factors of TT ventures. The idea behind this is to identify factors that could be managed by a TT manager or team of people manging TT. For a detailed account of this review please refer to a previous article by the authors where this part of the article is presented in detail [26]. We outline the search strategy and protocol as background to the synopsis if our review as presented in part 1 our review.

The following search term was used [("technology" or "healthcare") and "sub-Saharan Africa") and ("stakeholders" or "barriers" or "knowledge transfer" or "management conceptual frameworks") and ("infrastructure" or "information and communication technology (ICT)" or "information and communications technology")]. The search produced 84 literature sources collected from three academic databases namely Google Scholar (47), Scopus (21) and Emerald (16). This included peer reviewed journal articles, grey literature, working papers, conference papers and a master's level dissertation. Exclusion criteria were based on language (English), availability and relevance, geography (SSA), time period (published after 2000). Studies were screened for evidence of basic methodology and validation of research (empirical foundation). This ensured that all literature items uncovered during the primary search phase could be refined into a final database of 51 articles. Based on this process, Section III in this article presents a literature synthesis that was developed from the systematised literature review [published earlier in [26]]. Section III thus presents a summary review of available TT methods, infrastructure requirement for successful TT, required TT stakeholders, existing TT models and the general barriers encountered during a TT process in SSA.

B. Part 2: Framework Development

A conceptual theoretical framework is constructed by deconstructing the components that have been identified during the completion of the systematic literature review. These concepts were then clustered into five separate groupings which are subsequently synthesised into five phases, namely technology development; technology analysis; transfer method application; change management; andcommercialization. These five phases serve as the foundation of the conceptual framework and, are in turn evaluated by implementing a multi-level evaluation procedure consisting of semistructured interviews, a survey and case study applications. An overview of the framework is shown in Section IV with the expanded model of the framework shown in Appendix A.

C. Part 3: Framework Evaluation: Methods for the Survey Instrument and Analysis of the Survey Results

A conceptual framework evaluation was implemented to evaluate the conceptual framework's utility and ease of use, and to reinforce and improve the instrument's outcomes.

The research methodology implemented during the completion of the survey contains seven succinct steps given in Table I. For Step I, the survey instrument may either be adapted from existing elements or be newly constructed [20], [22]. The literature further highlighted that a questionnaire, supported by an extensive literature study, represents a well-tested survey instrument [20], [22]–[26]. Thus, to improve the survey instrument's efficiency, validity and applicability an existing survey instrument in the form of a questionnaire is selected [20], [22].

TABLE I
STEPS FOR DEVELOPING THE SURVEY

Step	Description
I	State the problem need
II	Plan the project
III	State the survey questions
IV	Construct survey
V	Conduct pilot tests
VI	Administer the survey
VII	Data analysis

TABLE II
MAIN SURVEY CATEGORIES AND QUESTIONS

Descriptive statistics and industry experience of respondents
What is the ratio of organisations working for profit versus not for profit?
From which countries have the respondents gained their experience?
In which areas of TT do the respondents have experience?
In which fields of healthcare do the respondents have experience?
What was the relative success of the respondent's technology transfer ventures?
Healthcare TT principles
What components determine a successful TT team?
What is the importance of stakeholder co-creation?
What is the importance of legal considerations on a TT venture?
What is the importance of implementing standardisation of project components
How do different training methods compare for TT ventures?
How do you achieve adoption and sustainability for a TT venture?
What is the perceived ease of use for the joint venture TT method?

Step II commenced with the construction of a research team responsible for the survey's construction, administration, data collection and the interpretation of the results. Literature highlights that the applicability of the respondents' experience surrounding the primary research question should be evaluated [27], [28]. Thus, predefined respondent exclusion criteria are implemented to promote the validity and usefulness of the survey's outcomes [27], [28].

The survey's aim is to evaluate the conceptual framework's ease of use and utility for healthcare-specific TT over the geographic region of SSA, therefore the questionnaire is divided into two distinct categories, namely descriptive statistics and industry experience of respondents; and healthcare TT principles. The research questions and their respective categories are given in Table II.

The first category of Table II included demographic questions to allow for consideration of the respondents' experience with regards to years of experience, operation in different SSA countries, technology management and healthcare fields. This section also aimed at evaluating the relative success or failure of the TT ventures that survey respondents are in the process of completing or have already concluded. The outline of the evaluation questions and their applicable measurement scales are shown in Appendix A (see Sections 1 and 2).

The second category of Table II contains action statements that covered the framework components and asked respondents to rank the perceived ease of use of these tools as well as usefulness to the TT process on a five-point Likert scale (See Appendix A, Section III).

In accordance with step V (see Table I) of the survey process, the questionnaire was subject to a pilot test through three phases using a predefined testing protocol. Each pilot test candidate was invited to complete the survey instrument after which the individual is electronically interviewed to acquire feedback on the various characteristics of the survey instrument. The feedback of the second and third pilot test mainly focused on improving the survey's clarity and removing ambiguity from several questions. Several additions to the predefined answers options are also implemented based on the outcomes of the second and third pilot tests

Upon completion of the pilot testing phase, phase VI (see Table I) was completed by administering the survey. An invitation link is sent to 563 potential respondents over the course of a 60-day period, and 89 completed survey responses were received. The survey was distributed to potential respondents through the Center for health market innovations (CHMIs) and global digital health network (GBHN) online contact forms.

Step VII of the survey development (see Table I) was the analysis of the data of the survey. This was completed using mean analysis, variance analysis and regression analysis. As the survey instrument represents a formative statistical model, no reliability analysis is performed. The findings from the survey are discussed in Section V.

III. UNDERSTANDING THE PROBLEM LANDSCAPE (PART 1)

This section provides a review of the literature synthesis that was developed from the systematised literature review as outlined in Section II-A. This section presents a review of available TT methods, infrastructure requirement for successful TT, required TT stakeholders, and the general barriers encountered during a TT process in SSA.

A. TT Methods

In total five TT methods are identified: traditional TT; foreign direct investments; trade agreements; joint ventures; and intellectual property and licensing. While this is not an exhaustive list of all methods available it does represent the most frequently implemented methods of TT.

Traditional TT refers to a simplistic method where the technology is merely imported from the transferor and utilized by the transferee [21]. Very basic adoption and integration procedures often are included in traditional TT [29]. This is mostly discussed in literature for country-to-country and firm-to-firm level TT and may provide an effective method for basic transfer objects in stable transfer environments that are resource-scarce [19].

However, as TT has evolved, this method has become largely inefficient. When compared with more modern techniques, traditional transfer lacks the required protocols to promote collaboration between involved stakeholders [30]. Modern-day TT has shifted away from linear processes into a more dynamic realm

with active feedback and input from stakeholders [21], [30], [31].

The second main TT method identified is a foreign direct investment and consists of foreign transferors, typically foreign governments or multinationals, investing human and economic resources into the transfer environment to gain access to its tangible and intangible resources [7]. Foreign direct investments require close regulation by the transferee's public regulatory body and intricate stakeholder collaboration is often mandatory [21]. A foreign direct investment enables economic growth for domestic firms through both foreign capital investment and access to a global pool of experience and information [32], [33]. Foreign direct investments are also intertwined with the concept of knowledge transfer as the transfer of personnel, and subsequently their implicit experiences, is often required [17], [33]

The third method of TT identified is trade agreements. These refer to the creation of "open door" trade policies, reduction of trade barriers and the trading of goods and services [32]. The public sector possesses the regulatory authority to manipulate policies to control the availability of international trade and subsequently realize both TT and other economic and social aims [34]. International trade agreements possess the potential for technology diffusion, as trading of goods and services may lead to knowledge transfer [32]. Products bought will be subject to reverse engineering to gain experience, while knowledgeable buyers deliver input on product design [35]. This results in a symbiotic relationship where both transferee and transferor benefit [32]. Trade agreements are applicable for country-to-country, firm-to-firm and firm-to-country TT and that they have routinely been utilized in conjunction with other methods of TT, such as foreign direct investments and, the fourth identified TT method, and joint ventures [32].

A fourth method, joint ventures comprise of a transferor and transferee entering a collaboration aiming to either co-create or explicitly transfer a transfer objects [36]. These ventures may be contained within an individual country's geographic region, however, the most generic form, known as an international joint venture, unfolds over a global scale [37]. Joint ventures are thus applicable to both country-to-country and firm-to-firm TT [36].

A joint venture typically originates from a transfer requirement shared between the transferor and transferee. Viewed from an economic standpoint, the transferor's requirement will be to expand products or services into a new market space or acquire new resources [38]. A geographic example would be modern-day China where there are a potential 1.3 billion clients [36]. Similarly, the transferee can utilize a joint venture as an economically efficient way to acquire advanced technology as well as substantial amounts of capital investment [36].

The final TT method identified is intellectual property and licensing. While IP protection and licensing may be beneficial to TT [21], [31], [32], it could also be argued that for a SSA context this TT method is far less beneficial [9], [39]. However, as a multitude of university based TTs heavily rely on licensing procedures, this TT method should not be disregarded and must rather be implemented as a support mechanism for the primary TT method [40]–[43].

While numerous TT methods can be utilized, joint ventures between developing SSA countries should be prioritized when possible to ensure maximum knowledge dissemination [36], [37]. However, as traditional linear TT is the most common TT method, it will be imperative to ensure the transfer method is supplemented with high levels of collaboration often found in joint ventures [21], [30], [44].

Finally, it should be noted that TT methods that require intensive capital funding to achieve results that only benefit a select portion of the population, will typically not be recommended unless they serve as a foundation for future health projects [7], [21], [45]. Thus, a detailed cost-benefit analysis should be implemented to ensure that the capital investment does not undermine existing social, cultural and political structures [21], [31].

B. Infrastructure Required

The literature recognizes internet access, power supply and telecommunication infrastructure to constitute the basic hard infrastructure requirements for any health-related TT [12], [32], [46], [47].

Numerous educational programs and a skilled workforce represent primary soft infrastructure requirements [3], [48]. However, political transparency becomes more influential as healthcare has primarily been championed by the domestic public sector [6], [49]–[51].

Case studies surrounding telemedicine and health information systems also highlighted the requirement for sustainability procedures as short term unsustainable success has been a frequent occurrence [3], [52]–[55].

Marketing and free trade policies have also been widely regarded as beneficial to health-related TT but these become immaterial if the soft infrastructure such as digital literacy and education programs are not in place [8], [34]. Thus, a strong marketing campaign which promotes technology adoption, has been identified as a primary requirement for the success of health-related TT [56].

C. Stakeholders Required for TT

The domestic public sector, i.e., the government of the technology recipient, could be incorporated into TT methods [32], [51], [57]. This becomes imperative when the scale of the transfer exceeds firm level. Governments must be encouraged to revise trade policies and ICT and telecommunication infrastructure expansion in addition to the improvement of the digital literacy of the population [32], [33], [58].

The literature found that there should be predefined communication channels between the transferee and transferor. These channels should also be consistently utilized and highly interactive [36], [59]. The creation of a dedicated TT team, separate from other company objectives, is also highly recommended [17], [59], [60]. This transfer team would ideally consist of members from the transferee, transferor as well as occasional third-party consultants [17], [36], [61].

A primary goal of the transfer team should be the creation of a joint pool of knowledge which is accessible by all stakeholders

relevant to the TT, especially for ground-level stakeholders and local community champions [17], [54], [62]. An additional benefit of incorporating local community champions is spreading the awareness of new healthcare technologies throughout the domestic healthcare environment [63]. This is a prominent challenge faced by the majority of new TT ventures in SSA [54].

If possible, the transfer team should possess a managerial hierarchy as this would enable managerial motivation and supervision [64]–[66]. As such, a dedicated incentive scheme may be created which rewards performance outputs in both monetary and intangible rewards [55], [64], [67], [68]. Alternatively, managers may attempt motivate the transfer team through advertising previous successes [65].

D. Barriers Faced By TT

The most prominent barrier identified involves the factor endowment of the transfer environment Thus, the appropriateness of the technology with regards to the factor endowment of the transferee firm or country [30], [69] . Another challenge arises when the transfer environment is substantially different than the impact area for which it was developed. For example, a transfer object initially developed for the rural sector may face additional barriers if implemented in a residential setting [36], [70].

The marketability of the transfer object will often determine the level of adoption and diffusion experience. Thus, the nature, appeal, and marketability of technology in the recipient country may hinder the TT if poor [31], [36]. Similarly, the awareness of the transfer object is also important. Poor marketing schemes result in healthcare institutes, professionals and domestic governments officials being unfamiliar with potential transferred health technologies [2].

As previously mentioned, lacking hard and soft infrastructure may severely hinder the ability of the transfer object to be successfully implanted and adopted. Examples exist in multiple SSA countries where healthcare facilities do not possess the capability to utilize or adopt any e-Health related TTs due to lacking telecommunications, internet, power supply and supply chain infrastructure [4], [16], [32], [46], [52], [53], [71]. Additionally, poor economic, social, education and training infrastructure, common in SSA countries, provide further barriers to successful TT [32], [55], [71]–[74]. Furthermore, the policy implementations of the domestic sector are often burdened by corruption or poor governmental procedures [33], [69], [75], [76].

The final barrier identified stems from over emphasizing business value of a TT venture. If the success of a TT venture is only measured by the creation of new business value within the transfer environment it may rank poorly leading to a detrimental effect on the number of future TT ventures. The creation of public or societal value should also be incorporated both in the feasibility study of new TT ventures and in the final TT evaluation [21], [55], [63]. This is of particular importance when evaluating healthcare-related TT ventures.

IV. Conceptual TT Framework (Part 2)

This section aims to provide an abridged exposition of the major framework components by detailing the considerations and best practices for all nodes as well as the required relationship linkages between nodes and phases.

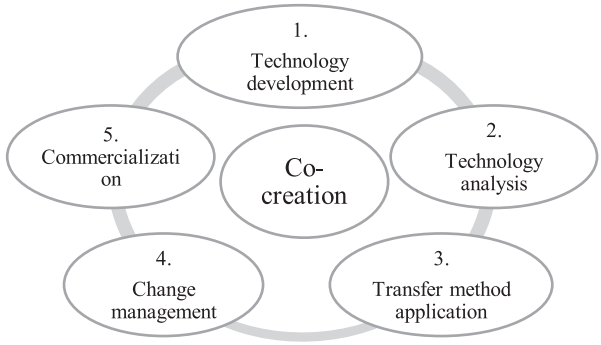


Fig. 2. Outline of the conceptual framework.

The conceptual framework consists of five phases as shown in Fig. 2. Each phase contains a series of interconnecting nodes. Nodes may be linked within a phase as well as across phases. Thus, the framework encourages all users to familiarize themselves with the entire process before initiating phase 1. An expanded model of the conceptual framework is available for review in Appendix B.

The framework aims to assist a user in constructing a TT team to subsequently progress through the five phases of the framework. This transfer team will initially comprise of the primary TT stakeholders, the transferor and transferee, but will continually be expanded to include additional relevant stakeholder entities that either possess utility for individual TT phases or for the TT as a whole. Co-creation is emphasized during each phase to encourage the growth of the TT team. The framework attempts to guide the transferor team by providing multiple considerations and best practices for the technology's development, analysis and subsequent transfer. After the technology has been transferred, several change management best practices have also been provided which, when implemented in conjunction with the commercialization phase, will provide the TT with a basis to achieve sustainability and further its dissemination.

A. Phase 1: Technology Development

1) Technology Donor: The technology donor should dedicate personnel capable of TT facilitation, transfer object training and stakeholder communication, keeping in mind that the number of required personnel is positively correlated with the scale of the TT. If the technology donor possesses codified knowledge of previous transfers of a similar nature and their current technology development and TT experience is substantial, the number of personnel required will be substantially reduced. The technology donor need to define legal ownership of the technology to the entire TT team as well as the intended alterations to this legal ownership after the TT has been completed. Lastly, the technology donor should attempt to identify their political and social constraints and how these may restrict the ability to perform the proposed TT.

2) Technology Recipient: The economic scale of the technology recipient, available resources need to be documented. Additionally, capturing the technology recipient's current experience

surrounding TTs is necessary when assigning stakeholder roles in the transfer method application phase. Finally, the technology recipient should take care in evaluating the opportunity cost of the potential TTs, both ensuring the correct TT is chosen and that any potential TT will not present a substantial business risk to the technology recipients' normal operations.

3) Transfer Object: The TT team must consider the following aspects of the technology being transferred.

1) Transfer object's maturity and total useful life.
2) Systems, if any, within which the transfer object functions.
3) Subsystems required, if any, for the transfer object to effectively operate.
4) The Transfer object's legal protection.
5) Technological complexity of the transfer object in terms of ease of manufacturing, utilization, modification and maintenance.

4) Co-Creation TT Team: Both the technology recipient and donor should explicitly regard the TT as a business venture and a strategic alliance and should construct and implement protocols which ensure the creation of a joint pool of knowledge surrounding the technology transferred. Additionally, a dedicated incentive scheme should be implemented that involves both monetary and intangible rewards and managers are encouraged to motivate the TT team through advertising previous successes. Finally, complete co-creation typically occurs when both stakeholders directly influence the technology's primary characteristics and features.

B. Phase 2: Technology Analysis

1) Stakeholder Collocation: It will be imperative to the TT venture that a funding plan be created, and it must be routinely updated. Each stakeholder must be aware of this plan and the expected magnitude and duration of their individual contributions. The TT team must consider funding in conjunction with the transfer environment, infrastructure requirements and the technology's characteristic to establish a detailed budget. A list must be populated of health-specific requirements, separate of the general TT requirements, for use in the screening of the transfer environment and subsequent evaluation. Finally, an individual within the TT team must explicitly be appointed as the public liaison. This party should ultimately be knowledgeable on the public sector's general procedures and health-related policies. If such an individual does not exist within the TT team third party consultation must be incorporated. The public liaison is encouraged to populate a list of TT requirements that can only be overcome with aid of the public sector.

2) Transfer Environment: The TT team should consist of personnel capable of analysing the transfer environment from multiple perspectives, such as economic, social, cultural, and political viewpoints. When feasible, designated personnel must be assigned to the evaluation of the transfer environment's market demand and requirements, healthcare system, public sector and the applicable transfer object supply chain. If possible, the framework recommends these evaluations be assigned to personnel with experience in these respective fields. Specific emphasis must be placed on identifying market conditions as the appropriateness and marketability of the technology within the transfer environment. Additionally, the transfer environment and technology's considerations should be completed in conjunction with one another. Obstacles created by either may be overcome through alterations to the other. However, the framework determinately encourages the TT team to alter the technology whenever possible due to financial and time implications of transfer environment alterations.

3) Hard Infrastructure Requirements: The TT team should attempt to access the international fibre cables running down the African East and West coast, such as the SEACOM cable. For landlocked countries, this will require government intervention and should be a priority for the public liaison role. Remote satellite internet access provides users with stable Internet access, but requires high capital expenditure and may only be feasible when a multinational has been incorporated as a stakeholder. Offline data capture allows users to complete tasks with basic computer or stationary equipment which can in turn be transmitted when internet access or telecommunication becomes available. This strategy may be implemented in rural areas after which the data could be transported to an urban centre with improved internet capabilities. For instances where the TT venture has been plagued by unstable electricity, implementing some form of back-up supply that can operate for short periods should be considered. Examples include an uninterrupted power supply, battery systems, fuel powered generators and even small scale solar panels.

Inadequate healthcare infrastructure may represent a substantial barrier as it will typically fall outside of the transfer scope for most TT ventures. Altering the technology itself to operate with the available healthcare infrastructure may often constitute the most feasible solution. When the technology requires a select healthcare device or system to operate, the TT team should consider incorporating this subdevice into the overall TT venture. Thus, the technology will comprise of both the subdevice and main technology object.

4) Soft Infrastructure Requirements: Lacking health-related education presents similar challenges when compared to lacking health-related hard infrastructure. As such, altering the technology itself to operate with the available health-related education may often constitute the most feasible solution. The framework also encourages the TT team to facilitate the dissemination of knowledge surrounding the technology thus inherently improving the health-related education of the domestic workforce. Additionally, the TT team should implement training programs irrespective of the current level of digital literacy in the transfer environment. These training programs should preferably be completed directly by personnel, however online training programs will be adequate for most cases. While these training programs may not be tailored specifically to the improvement of digital literacy, the TT team should include fundamental computer training for all TTs to developing nations.

Lack of political transparency in the transfer environment may be mitigated through efforts by the TT team to incorporate domestic human rights groups currently active in the region. Similar attempts should be made to incorporate nonprofit healthcare organizations when political transparency has been deemed

an important transfer requirement. Finally, when TT occurs across borders and involves multiple countries, the TT team must identify the most politically stable nation, with established legal frameworks, and utilize this country as the base for the TT to neighbouring regions.

C. Phase 3: Transfer Method Application

1) TT Method: The joint venture method is strongly recommended for all healthcare TTs. The domestic public sector must be incorporated into all TT activities. This becomes imperative when the scale of the transfer exceeds firm level. The public liaison should encourage governments to revise free trade policies and ICT and telecommunication infrastructure expansion in addition to the improvement of the digital literacy of the population. Similarly, investment from any source that can be relayed into the transfer environment's healthcare infrastructure will aid in the mitigation of health-related TT barriers in SSA.

All small-scale transfers should be structured to ensure that scalability remains feasible. TTs that serve as pilot testing operations should have a predefined document depicting this proposed scaling process and the TT team is encouraged to conduct continual site visits during the transfer process. For health-related transfers, programs should be in place to stimulated community involvement and participation. Additionally, it is recommended that personnel from the transfer donor accompany the technology for a predetermined period. The TT team is also encouraged to present workshops that ensure all stakeholders will be trained to an equivalent level with regards to digital literacy before the TT progresses. Finally, it will be imperative that the TT team acknowledge the gap between the technology's design and the transfer environment's reality.

2) Stage-Gate Implementation: The TT team is encouraged to implement a stage-gate after the completion of the third phase of the TT when feasible. Multiple stage-gates throughout the TT are, however, not advisable due to the time and monetary constraints of these revision procedures. The TT must evaluate the following TT features to determine if the TT should be continued revised or abandoned: the level of co-creation within the team; stakeholders available to complete the required roles and responsibilities; market conditions; legality; availability of infrastructure; mitigation practices for lacking infrastructure; the chosen transfer method; the suitability off the technology and the transfer environment; and the transfer method application strategy.

D. Phase 4: Change Management

1) Technology Recipient Change Management: After the technology recipient has taken possession of the technology, they should designate either an individual or a team to monitor and disseminate the technology throughout the technology recipient's establishment. This deputy should be clearly highlighted within the transferee's establishment and have been given the authority to implement positive and negative incentive schemes focused on increasing the transfer object's dissemination. This authority should liaise with the corresponding transfer donor entity, to determine their best practices for the technology's adoption. This authority should also be familiar with the technology recipient's previous TTs. A subsequent guideline, which highlights both successful and failed previous best practices, should be created. This authority will also be responsible for documenting current best practices for future use. When permittable, this authority should incorporate local stakeholders, within the immediate transfer environment, and spread all adoption best practices to promote the TT's dissemination.

At this point of the transfer, the technology recipient should create codified documents which can be utilized in training sessions. Additionally, the transfer recipient should mandate training and educational sessions to all personnel in the transfer recipient's immediate sphere. Direct training should be utilized whenever possible and on-site demonstrations of the technology should be prioritized. The outcomes of these training sessions should be explicitly stated to all participants. Finally, a formal revision protocol should also be created aimed at monitoring the technology's adoption rate and documenting identified adoption barriers.

2) Technology Donor Change Management: After the technology recipient has taken possession of transfer object, the primary change management best practice for the transfer donor should be to stimulate continual involvement in the TT. The transfer donor is thus encouraged to incorporate an incentive program which rewards the personnel based on their involvement. Incentive programs should range from monetary rewards, peer recognition and intangible personnel rewards such as public exposure. However, the amount of personnel committed to the TT by the transfer donor should be reduced, depending on the future requirements of the TT. The smaller active personnel base will in turn allow for simplified, and often more economical, incentive reward schemes.

The transfer donor is strongly encouraged to create a channel aimed at providing transfer technology related assistance when required. This channel can range from a dedicated contact person to an active tool depending on the nature of the transfer object. This framework encourages the transfer donor to hold formal training sessions for the transfer recipient as often as possible. On-site visits by transfer donor personnel will be highly advantageous to the technology's adoption in the transfer environment. If the transfer donor has already produced an internal training program surrounding the technology, it is recommended that an invitation be sent to the transfer recipient to attend these internal training programs either in person or electronically.

E. Phase 5: Commercialization

1) Evaluation of the TT Impact: The evaluation of TT's impact is primarily to identify topic areas for which best practices can be refined for future TT ventures. It will also allow the TT team to evaluate the general success of the technology's introduction, adoption and integration. It is recommended that the following key areas should be evaluated: the market impact of the technology; the addition to the public value in the transfer environment; the political implications of the TT; the addition to the human capital base in the transfer environment; The Severity of the alterations required at the stage-gate feature; the addition

to the economic development in the transfer environment; the opportunity cost for all stakeholders involved; and the technology's improvement of the healthcare reach, cost, and effectiveness of the transfer environment

2) Sustainability of the TT: New stakeholders should be incorporated if they could be of potential benefit to the technology's dissemination. However, commercialization will tend to lie outside the scope and expertise of the TT team. Thus, the TT team should actively incorporate a stakeholder knowledgeable in licensing and commercialization activities. It will be the responsibility of the licensee to oversee the commercialization activities surrounding the transfer object. However, the TT team should have established predefined legal terms to ensure the technology's future management aligns with the agenda of the original TT.

The commercialization of a health technology will generally be founded upon two primary business strategies. The technology can be presented to the end-user free of charge and be funded by marketing of the public value of the technology. Alternatively, the technology may be licensed, and service charges will apply to the end-user. However, the chosen business strategy will be case-specific, and this framework does not promote one above the other. The licensee and TT team should, however, have a predefined business strategy before the transfer object's expansion may commence.

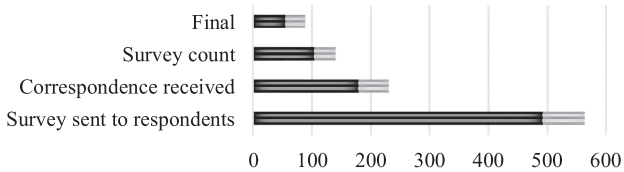
The general marketing strategies should be tailored to the technology in question as well as the business strategy chosen for the technology's commercialization. It is however important for the TT team to distinguish between the end-user of the technology and the client who commissioned it. For health technologies these two entities will almost never be the same.

When advertising to potential clients not involved in the creation of the technology, the marketing strategy should revolve around how the technology will solve the client's problem. How the technology will benefit the end-user, typically the patient, should not be prioritized over the client's priorities when dealing with isolated health practitioners. However, when advertising to the national public health sector, marketing of the patient's benefits should be prioritized over the health practitioner's benefits.

3) Knowledge Documentation: All documentation captured should be completed in a predefined business language understood by all the primary stakeholders. Similarly, all data captured during the TT should be documented in a predefined measurement system, such as International System of Units (SI) units. Finally, all documentation and communication among stakeholders should be completed in a predefined style with stakeholders being encouraged to adopt a universal organizational routine with regards to formalized communication.

When evaluating the stakeholders in phase II, care should be given to language barriers. While all stakeholders may understand a language, various levels of comprehension often arise. This has been especially pronounced in SSA countries. When possible, translating all codified documentation into a second langue will be highly advantageous.

With regards to the implicit knowledge of individual stakeholders, the framework recommends developing a standard set of questions to capture the nuances of how stakeholders completed their roles and responsibilities. Finally, a predefined structure for the documented knowledge base must be outlined before the commencement of phase I. This structure should be able to accommodate the accumulating knowledge base as the TT progresses.



	Survey sent to respondents	Correspondence received	Survey count	Final
CHMI	492	179	104	55
GDHN	71	51	36	34
Total	563	230	140	89

Fig. 3. Outline of the survey's response rate.

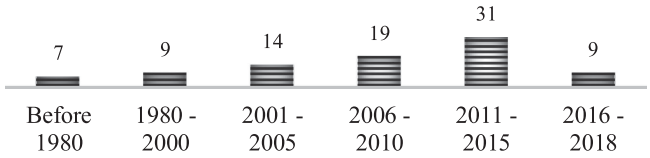


Fig. 4. Outline of TT projects' initiation year.

V. TT Framework Evaluation (Part 3)

A. Results: Descriptive Statistics

A total of 563 survey invitations were distributed to healthcare technology managers listed within the CHMI and the GDHN databases. In total, 230 different healthcare managers responded to the initial invitation by either indicating a willingness to complete the survey instrument or requesting additional information. The online link directing respondents to the survey was kept open for a 60-day period after the final invitation was distributed.

Once the online link expired, the survey had collected 140 responses, 51 of which are incomplete and subsequently discarded. Thus, a final total of 89 responses are utilized for the data results of the survey instrument. While the final sample size does not represent an exhaustive reflection of the entire population, the descriptive statistics do also provide a snapshot of the composition of the healthcare technology management field in SSA.

Fig. 3 presents a comparison of the survey's response rate for respondents identified via the CHMI and GDHN databases. The higher response rate of respondents from the GDHN, 47,89%, in comparison to respondents from the CHMI, 11,18%, is wholly attributed to the larger amount of contact information listed on the GDHN database. Nearly all respondents within the GDHN network could be directly contacted via email and telephone whereas respondents from the CHMI could only be contacted via an online contact form.

Fig. 4 highlights the year of commencement for each survey respondent's healthcare TT venture. Of the 89 projects captured

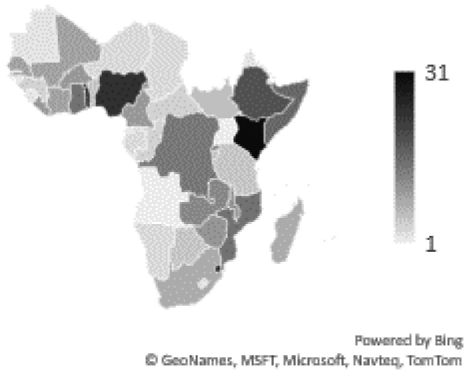


Fig. 5. Summary of geographic application areas of projects per country.

by the survey responses, 73 commenced after 2000 with more than a third starting between 2011 and 2015. While not in the scope of this article, Fig. 4 may also serve as the foundation for future research investigating how different healthcare and TT components have evolved in SSA over a 40-year period.

A recurring theme evident throughout the conceptual framework is stakeholder co-creation and the relationship between the primary TT stakeholders. The driving forces behind the development and implementation of healthcare TT in SSA are directly linked with the facilitation of stakeholder co-creation. To this extent, the survey aims to identify the primary motivation behind healthcare TT ventures. Healthcare TT ventures in SSA are seldom initiated for commercial drive or to increase the market reach of the parent organization. While some projects contained elements of both commercial drive and social impact, the survey's data results highlight the need to ensure that phase 1 of the conceptual framework, technology development, does not emphasize the commercialization of the transfer object. Thus, phase 1 should almost exclusively focus on constructing a relationship between the primary stakeholders based on the transfer object's potential community impact.

As mentioned in the problem statement the survey is partly completed to investigate the conceptual framework's applicability to the entire SSA region. To this extent, survey respondents are asked to indicate the country in which their transfer object is implemented as well as countries in which they had previously implemented healthcare technologies.

A heatmap of SSA is shown in Fig. 5, highlighting the various countries in which respondents had directly implemented healthcare technologies. Kenya, with 31 responses, represents the country with the highest concentration of implemented healthcare technologies surveyed. While not imperative, a pleasing aspect of the survey's data is that every SSA country contained at least one response claiming to have direct experience in that country. Higher concentrations of responses are observed in Western and Eastern Africa with Central and Southern Africa depicting a lower concentration.

Out of the 89 complete survey responses, 68 respondents indicated that they possess experience with healthcare technology implementation in one or more of the four regions of SSA. Eastern Africa represents the most healthcare TT experience with 24 respondents while Western, Central and Southern Africa

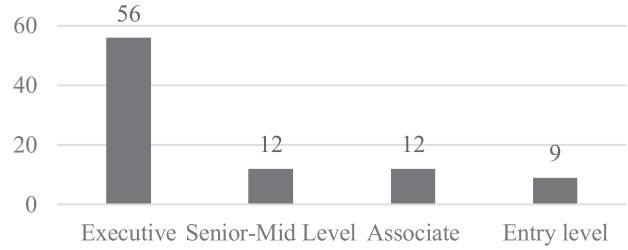


Fig. 6. Count of survey respondents' levels of experience ($N = 89$).

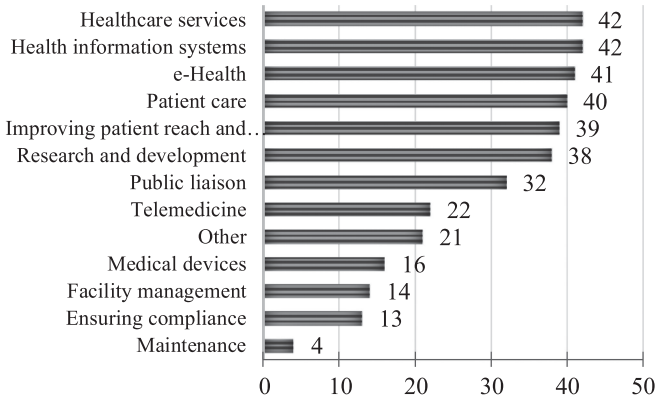


Fig. 7. Count of respondents' healthcare application experience ($N = 89$).

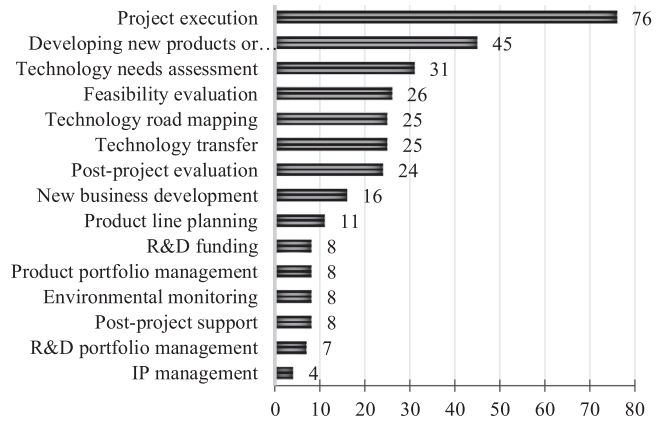


Fig. 8. Count of respondents' technology management experience ($N = 89$).

received 19, 12, and 13 responses, respectively. Fig. 6 summarizes the level of career experience of the survey's respondents. As healthcare technology implementations are mostly overseen by managing or country directors, executive and senior-mid management positions account for the majority of the survey's respondents. Several responses are also captured from interns and junior personnel. After follow-up communications, these lower-tiered respondents are identified to be the personnel designated with the knowledge capture of the transfer object's development and implementation for subsequent internal revisions.

The results presented in Figs. 7–9 highlight the applicability of the survey respondents' experience with respect to the fields of healthcare, technology management and TT. For all the demographic questions pertaining to the respondents' experience,

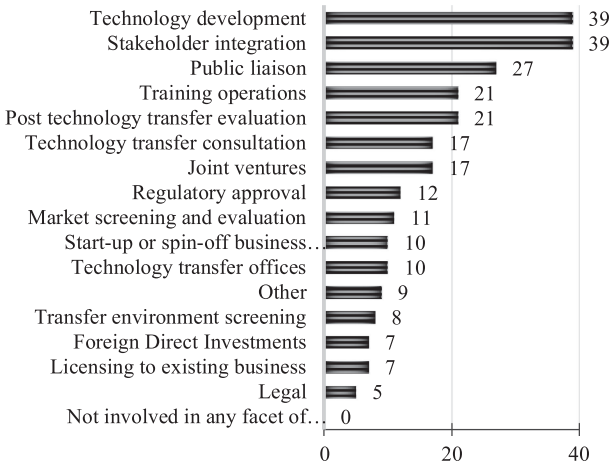


Fig. 9. Count of respondents' TT experience ($N = 89$).

respondents are not limited to a single entry but rather multiple checkboxes. Thus, an individual respondent could select multiple options based on their individual industry experience.

Fig. 7 summarizes the fields of healthcare in which respondents accumulated industry experience. At least 40 or more respondents indicated that they possessed direct industry experience in healthcare services, health information systems, e-Health, and patient care. Fig. 7 also highlights that experience surrounding physical medical devices is restricted to 18% of the respondents while healthcare services, e-Health, health information systems, supply chain improvements all received more than twice this. This reinforces an important healthcare TT characteristic in that the transfer object is much more likely to encapsulate an entire system or service than an individual physical artefact. All the 89 respondents indicated that they possessed industry experience in at least 2 or more fields of healthcare with respondents selecting 4 on average. Respondents selecting "other" almost exclusively stated healthcare education when promoted to elaborate. This indicates a missing response option for the fields of healthcare questions within the survey. This also shows the relative importance of healthcare education and training in healthcare technology management in SSA.

Fig. 8 summarizes the fields of technology management in which respondents accumulated industry experience. Of the 89 respondents who completed the entire survey, 76 indicated they possess industry experience in project execution, representing just over 85% of the sample set. Phases 1 to 3 of the conceptual framework run concurrently and pertain to the project execution of a TT. As project execution is predicated by every managerial best practice outlined within phase 1 through phase 3, Fig. 8 clearly highlights that the majority of the survey respondents possess direct experience with respect to the conceptual framework's TT healthcare principles. All the 89 respondents indicated that they possessed industry experience in at least 1 or more fields of technology management with respondents selecting between 3 and 4 on average. While present in the response options, no respondent selected the "other" option for technology management fields.

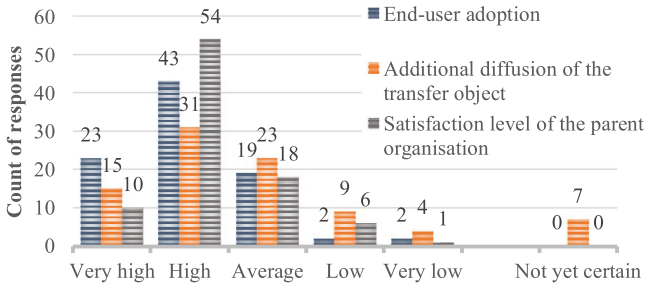


Fig. 10. Relative success of the survey's healthcare initiatives ($N = 89$).

Fig. 9 summarizes the fields of TT in which respondents accumulated industry experience. An interesting anomaly is identified when comparing the respondents' data from Figs. 8 and 9. Only 25 of the 89 respondents indicated they possess TT experience as a subset of technology management, yet no respondents indicated they do not possess experience in any subset of TT even when presented with the response option. A possible explanation may be that technology managers do not fully understand the categorization of TT components as presented in our survey and simply view them as additional fields of technology management, however without further investigation this explanation cannot be substantiated.

When reviewing components related to stakeholder co-creation, 39 respondents indicated they possess experience for both the transfer object's development and stakeholder integration while public liaison, training and joint ventures received 27, 21 and 17 responses, respectively. All the 89 respondents indicated that they possessed industry experience in at least 1 or more fields of technology management with respondents selecting 3 on average. Only five respondents selected "other" yet three of these did not elaborate when prompted.

As outlined in the methodology section of this article, three evaluation questions are presented to each respondent requiring each respondent to rank the end-user adoption, additional diffusion of the transfer object and overall satisfaction level of the healthcare initiative for which they are completing the survey. While all three questions implemented a five-point Likert scale, a not yet certain option is also included for the additional diffusion question. Fig. 10 summarizes the responses for all three of these evaluation questions.

The data presented in Fig. 10 is subsequently utilized during the variance and regression analyses. As such, it is important to note that all three evaluation question responses are not normally distributed, and care is taken not to implement statistical methods requiring such data sets. Additionally, seven respondents indicated that they are "not yet certain" about the diffusion of their transfer object. Thus, for all future diffusion related calculations shown in this article, the sample size is reduced from 89 to 82.

B. Results: Frequency and Mean Analysis

Fig. 11 provides an overview of the perceived ease of use frequency outcomes for each of the conceptual framework's foundations. This frequency graph is filtered to display the

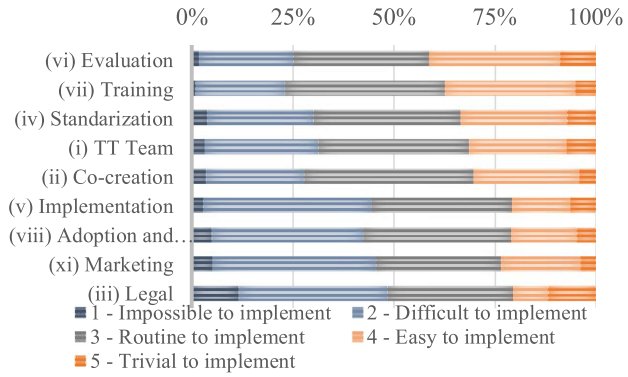


Fig. 11. Results of the analysis for the perceived ease of use measurement item across the nine conceptual framework foundations.

framework foundation scores in a descending order to highlight which foundations are deemed to be comparably easier to implement. In terms of perceived ease of use, approximately 70% of survey respondents reported that project evaluation, training, project standardization, the workings of the TT team and stakeholder co-creation are considered routine or easy to facilitate. This appears to indicate that the constituents of these foundations are fairly commonplace in healthcare TT ventures and are addressed on a regular basis.

For project implementation and marketing, 45% of respondents indicated these items are difficult to implement while similarly for adoption and sustainability and legal 49% and 42% of respondents indicated these items are difficult to implement, respectively. This indicates that they are comparably more difficult to facilitate. Approximately 40% of these aggregated foundation scores indicate that a specific section of the conceptual framework is considered "difficult" to implement in healthcare TT ventures within SSA. However, each foundation is argued to be feasible as "impossible to implement" scores represent less than 6% of the survey's responses if legal considerations are excluded.

Thus, in contrast with the perceived ease of use frequency graph, refer to Fig. 11, the usefulness outcomes clearly highlight that the majority of the survey respondents consider the framework's best practices to be beneficial to a TT venture. As TT is a dynamic and complex process, it is expected that the difficulty of several best practices greatly varies when compared with others.

The second step implemented when evaluating the perceived ease of use and usefulness of the framework is to determine the arithmetic means of each action statement presented to the survey respondents. Table III provides an abridged summary of these components by showing the arithmetic means for the nine framework foundations as well as the five phases of the conceptual framework with regards to perceived ease of use. While this represents a basic method of data analysis it does provide a high-level indication that the framework's phases, individually as well as collectively, are 'routine to implement' across the respondents of the survey with a grand mean approximating a score of 3. Table III highlights the consistency of the perceived ease of use of the framework's phases as the individual arithmetic means are all within a 2% margin of the grand mean.

TABLE III
ARITHMETIC MEANS FOR FRAMEWORK FOUNDATIONS AND PHASES FOR PERCEIVED EASE OF USE

Foundation	Description	$\bar{x}$
i	The TT team	3.064
ii	Stakeholder Co-creation	3.034
iii	Legal Considerations for Project Components	2.727
iv	Standardization of Project Components	3.067
v	Project Implementation Methods	2.801
vi	Project Evaluation Procedures	3.236
vii	Training Methods for the Technology	3.185
viii	Adoption and Sustainability	2.787
xi	Marketing	2.770
Phase	Description	$\bar{x}$
1	Technology Development	3.050
2	Technology Analysis	2.943
3	Transfer Method Application	2.930
4	Change Management	3.016
5	Commercialization	3.019
Grand mean		**2.992**

TABLE IV
ARITHMETIC MEANS FOR FRAMEWORK FOUNDATIONS AND PHASES FOR USEFULNESS

Foundation	Description	$\bar{x}$
i	The TT team	3.944
ii	Stakeholder Co-creation	4.176
iii	Legal Considerations for Project Components	3.629
iv	Standardization of Project Components	4.097
v	Project Implementation Methods	3.764
vi	Project Evaluation Procedures	4.166
vii	Training Methods for the Technology	4.326
viii	Adoption and Sustainability	4.187
xi	Marketing	3.837
Phase	Description	$\bar{x}$
1	Technology Development	3.790
2	Technology Analysis	3.826
3	Transfer Method Application	4.234
4	Change Management	4.262
5	Commercialization	4.047
Grand mean		**4.032**

Table IV provides an abridged summary for the usefulness measurement item while also highlighting that the framework's phases, individually as well as collectively, are considered to be "useful" across the respondents of the survey with a grand mean approximating a score of 4.

However, as with the frequency analysis, it should be noted that no comparison between the phases or foundations can be statistically determined by this mean analysis. The comparison between phases or foundations is addressed in the variance and regression analyses shown later in this article.

Table IV also highlights the consistency of both the framework's phases as the various arithmetic means are all within a 6% margin of the grand mean (in relation to usefulness). While the small variance in range does not lend credence to conclusive framework revisions, the data in Table IV does indicate that to a small extent the later phases of the framework are more useful than Phases 1 and 2.

TABLE V
LOWEST SCORING ARITHMETIC MEANS FOR BOTH PERCEIVED EASE OF USE AND USEFULNESS

Measurement item	Managerial best practices	$\bar{x}$
Perceived ease of use	Outlining a monetary incentive scheme for team members.	2.596
Perceived ease of use	Defining the project as a profitable business venture or a strategic alliance.	2.573
Perceived ease of use	Routinely evaluating team members and removing members with limited future use for the project.	2.562
Usefulness	Outlining a monetary incentive scheme for team members.	3.157
Usefulness	Defining the project as a profitable business venture or a strategic alliance.	3.416
Usefulness	Selecting infrastructure mitigation practices from a standardized list.	3.416

The lowest 10% of all the managerial best practices evaluated by the survey instrument is shown in Table V. When comparing the lowest-scoring component with the grand mean, only a 0.43 difference is observed with regards to perceived ease of use measurement item. Similarly, this measurement item has a relatively low range, 0.921 in total, among all the managerial best practices evaluated. This coupled with the grand mean given in Table III, indicates that all best practices are comparatively considered "routine to implement" across the respondents of the survey. When compared with the perceived ease of use measurement item, the data results pertaining to usefulness display a wider range, in total 1.427, with the lowest-scoring component being 0.783 below the grand mean. To this extent outlining a monetary incentive scheme is concluded to be less useful during the initial phase of a TT venture.

C. Results: Variance Analysis

The variance analysis completed for the perceived ease of use measurement item aims to highlight variances within the four regions within SSA. To this extent, each SSA region is evaluated using an least significant difference (LSD) analysis of variance (ANOVA) test to determine if a specific region differs from the rest of SSA. This allows for the perceived ease of use of each phase of the conceptual framework to be compared between each major region within SSA and the rest of SSA. This subsequently enables modifications aimed at maximizing the conceptual framework's ease of use for specific regions within SSA.

The results of the LSD ANOVA test are summarized in a graphical format in Fig. 12 All error bars represent a 95% confidence interval as an alpha value of 0.05 is implemented during the statistical calculations. When reviewing the outcomes of the variance analysis per SSA region, both Western- and Central Africa produced p-values indicating a statistically significant difference in their means with the other regions of SSA. The p-values of Western Africa and Central Africa are 0.01178 and 0.02288 respectively across all phases of the framework. While not immediately apparent when reviewing Fig. 12, a definite graphical variance is witnessed when individually comparing Western and Central Africa to the other SSA regions, as shown in Figs. 13 and 14.

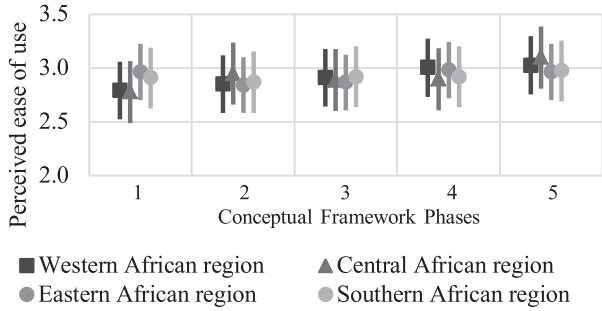


Fig. 12. Variance analysis results for perceived ease of use between the regions of SAA.

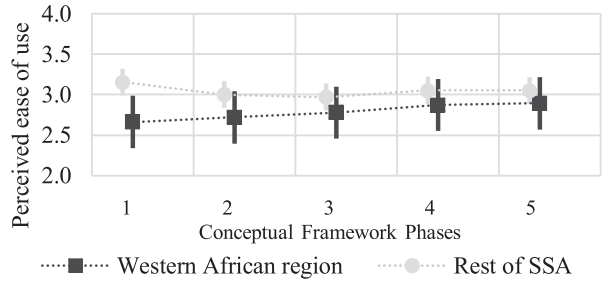


Fig. 13. Variance analysis comparison for perceived ease of use between Western Africa and SSA.

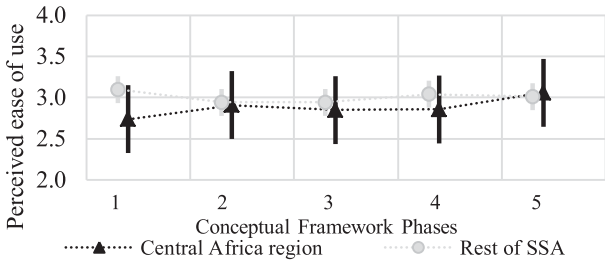


Fig. 14. Variance analysis comparison for perceived ease of use between Central Africa and SSA.

When further investigating the trendlines within the individual phases shown in Fig. 13, phase 1, technology development, and phase 2, technology analysis, are the primary contributors to the statistically significant difference produced by the LSD ANOVA test for Western Africa. Phases 3 to 5 do not yield any statistically significant results for this region in comparison to the rest of SSA. Thus, based on the results of this variance analysis, a conclusion is made that phases 1 and 2 of the conceptual framework are not as easy to implement in the region of Western Africa. Similarly, to Western Africa, when further investigating the trendlines within the individual phases shown in Fig. 14, phase 1, technology development, is the primary contributor to the statistically significant difference produced by the LSD ANOVA test for Central Africa. Phases 2 to 5 do not yield any statistically significant results for this region in comparison to the rest of SSA. Thus, based on the results of this variance analysis, a conclusion is made that phase 1 of the conceptual framework is not as easy to implement in the region of Central

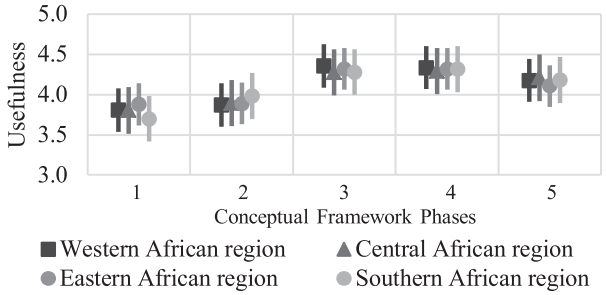


Fig. 15. Variance analysis results for usefulness between the regions of SSA.

TABLE VI
REGRESSION COEFFICIENTS FOR CONCEPTUAL FRAMEWORK PHASES VERSUS ADOPTION, DIFFUSION, AND SATISFACTION FOR PERCEIVED EASE OF USE

Phase	Adoption	Diffusion	Satisfaction
1	+0.077 Intermediate	+0.182 Very weak	+0.300 Weak
2	+0.014 Intermediate	+0.188 Very weak	+0.238 Weak
3	-0.007 Intermediate	+0.138 Very weak	+0.271 Weak
4	-0.001 Intermediate	+0.063 Intermediate	+0.243 Weak
5	+0.009 Intermediate	+0.175 Very weak	+0.267 Weak

Africa. The LSD ANOVA tests for Eastern and Southern Africa did not produce any statistically significant results indicating that these regions perceived any of the individual phases of the conceptual framework differently compared with the rest of SSA. The p-values of Eastern Africa and Southern Africa are 0.91 and 0.79, respectively, across all phases of the framework. As such, these graphs have been omitted.

As with the perceived ease of use item, the variance analysis completed for the usefulness measurement item aims to highlight variances within the four regions within SSA. To this extent, each SSA region is also evaluated using an LSD ANOVA test to determine if a specific region differs from the rest of SSA. This allows for the usefulness of each phase of the conceptual framework to be compared between each major region within SSA and the rest of SSA which will subsequently allow for modifications to the conceptual framework aimed at maximizing the framework's utility for specific regions within SSA.

The results of the LSD ANOVA test are summarized in a graphical format in Fig. 15. As before, all error bars represent a 95% confidence interval as an alpha value of 0.05 is implemented during the statistical calculations.

When reviewing the outcomes of the variance analyses per SSA region for usefulness, the LSD ANOVA tests produced no statistically significant results for any region. Thus, no conclusion can be made regarding the comparative level of utility of the conceptual framework between the four major regions of SSA. This holds true over each individual phase of the conceptual framework.

The p-values of Western, Central, Eastern and Southern Africa are 0.729, 0.777, 0.991, and 0.246, respectively, across all phases of the framework. As all these p-values are larger than 0.05, no graphical illustrations are included as each individual region closely follows the trendlines of the rest of SSA.

D. Results: Regression Analysis

The following section presents the results of the regression analysis highlighting the relationship between the measurement items perceived ease of use and usefulness and the adoption, diffusion and satisfaction scores captured during the second category of the questionnaire.

Each respondent is asked to rank the relative adoption and diffusion levels of the transfer object during their respective TT venture as well as their satisfaction levels pertaining to the TT venture. These three evaluation items are subsequently implemented in conjunction with the perceived ease of use measurement item to determine the Spearman rank-order correlation coefficient for each phase of the conceptual framework. Table VI gives a summary of the correlation coefficients of each evaluation items over all five phases of the conceptual framework.

The results presented in Table VI offer no statistical evidence to support that a correlation, either negative or positive, exists between the adoption of a transfer object and the ease of use of the framework's phases. A very weak positive correlation is observed for the diffusion of the transfer object beyond the initial transferee.

Throughout this article, no linkage has been uncovered or identified between the ease of which a TT venture's components are completed and the ultimate success of that TT venture in terms of transfer object adoption or diffusion. Thus, the results presented in Table VI are in accordance with what is generally expected. For evaluation purposes, the regression analysis identifying the relationship between the usefulness of each phase of the framework and the transfer object's adoption and diffusion is of much higher importance.

It is noted that there is a positive, albeit weak, correlation between the conceptual framework's phases and the levels of satisfaction reported by the survey respondents. As this evaluation item requires all survey respondents to quantify their TT ventures success in terms of monetary and time expenditures, it is expected to witness a positive correlation here. However, as this evaluation item is based on a subjective response, its validity and application towards the conceptual framework is largely unsubstantiated when considered alongside the adoption and diffusion correlation coefficients.

Table VII presents a summary of the Spearman rank-order coefficients for adoption, diffusion and satisfaction versus the five phases of the conceptual framework. The results presented within Table VII are arguably the most important within this research article with respect to the evaluation of the conceptual framework. The regression analysis and the resulting Spearman rank-order correlation coefficients clearly highlight the usefulness of the conceptual framework's phases as well as the individual nodes within these phases. As each item measured within the survey instrument produced a Spearman coefficient indicating a positive strong correlation or higher, it can be concluded

TABLE VII
REGRESSION COEFFICIENTS FOR CONCEPTUAL FRAMEWORK PHASES VERSUS ADOPTION, DIFFUSION, AND SATISFACTION FOR USEFULNESS

Phase	Adoption	Diffusion	Satisfaction
1	+0.643 Strong	+0.517 Moderate	+0.573 Moderate
2	+0.694 Strong	+0.630 Positive - Strong	+0.631 Strong
3	+0.751 Strong	+0.684 Strong	+0.652 Strong
4	+0.715 Strong	+0.632 Strong	+0.673 Strong
5	+0.927 Very Strong	+0.958 Very strong	+0.867 Very strong

TABLE VIII
CORRELATION COEFFICIENT MATRIX FOR ADOPTION, DIFFUSION, AND SATISFACTION EVALUATION ITEMS

Phase	Adoption	Diffusion	Satisfaction
Adoption	1.000000	+0.851531 Very Strong	+0.863435 Very Strong
Diffusion	+0.851531 Very Strong	1.000000	+0.809611 Very Strong
Satisfaction	+0.863435 Very Strong	+0.809611 Very Strong	1.000000

that all the nodes presented within the conceptual framework are useful in facilitating the adoption of a healthcare transfer object in the geographic regions of SSA. Thus, there is a direct relationship between implementing the conceptual framework and the transfer object's final level of end-user adoption.

The usefulness of all nodes within phase 1, technology development, returned a strong positive correlation with the end adoption of the transfer object. This outcome highlights the importance of the construction of the dedicated TT team and establishing a co-creation relationship between the transferor and transferee as outlined within phase 1 of the conceptual framework. Legally binding the transferor to the TT venture of its entire life cycle and implementing a universal starting point regardless of the transfer object also share a very positive correlation with the transfer object's levels of adoption.

The usefulness of all nodes within phase 2, Technology Analysis, returned at least a moderate positive correlation with the end adoption of the transfer object. The framework nodes promoting knowledge dissemination and co-creation between an extended TT team all returned very strong correlation coefficients. The use of a standardized tool to screen the transfer environment as well as best practices pertaining to legal counsel both produced coefficients indicating moderate to strong positive correlations with regards to the transfer objects levels of adoption.

The usefulness of all nodes within phase 3, Transfer Method Application, returned at least a moderate positive correlation with the end adoption of the transfer object. The framework best practices advocating the use of the joint venture TT method produced a very strong coefficient with respect to the transfer object adoption level. This again highlights the importance of the TT team and a co-creation relationship between team members. Other nodes advocated within phase 3 such as the creation of a prototype and incorporating and incentivizing early-adopters produced strong coefficients. The use of standardized internal revision protocols for the TT produced the lowest positive correlation within all five phases. However, as this item is still producing a positive moderate correlation, it shows the overall strength of each framework node with respect to the final level of transfer object adoption.

The usefulness of all nodes within phase 4, change management, returned at least a strong positive correlation with the end adoption of the transfer object. The implementation of all training related best practices advocated within phase 4 of the conceptual framework returned very strong positive correlation coefficients with respect to the transfer objects level of adoption. Nodes promoting sustainable communication for the TT team, both internally and externally, returned strong positive correlation coefficients.

Phase 5, commercialization, returned the strongest correlation coefficient for all phases with respect to the adoption of the transfer object. The framework node advocating for the implementation of knowledge codification and future co-creation knowledge sharing both produced very strong positive correlation coefficients. Best practices within the framework pertaining to marketing to additional stakeholders returned comparatively less strong correlation results highlighting that the adoption of the transfer object is less dependent on incorporating additional stakeholders. However, marketing items still produced positive strong correlation coefficients.

While not pertinent as the final level of adoption, the diffusion of the transfer object beyond the original end-users is also regarded as a method with which the relative success of a TT venture can be measured. To this extent, the results of the regression analysis between the conceptual framework's phases and the diffusion scores captured from the survey's respondents are given in Table VII. The results of the regression analysis regarding satisfaction scores are also given in Table VII.

Finally, the correlation coefficients for the relationship between the adoption, diffusion and satisfaction evaluation items are given in Table VIII. These high correlation coefficients highlight that the discussions for the correlation between usefulness and adoption also pertains to the diffusion and satisfaction regression analysis outcomes. It is important to consider that the high similarities between the responses provided for the three evaluation items may indicate that respondents did not understand the differences between these evaluation items. However, when reviewing the high proportion of executive and management level candidates among the survey respondents in Fig. 10, this consideration is unlikely given the career experience of most respondents.

It is important to restate that the sample size utilized in the regression analysis for diffusion contained only 82 samples, 7 fewer than used in both the adoption and satisfaction calculations. As shown in Fig. 10, seven respondents indicated that they do not yet know the extent of their transfer object's diffusion and as such these data sets are excluded from all calculations pertaining to diffusion.

VI. Discussion

The results of the framework evaluation in this journal article highlight the importance of stakeholder co-creation in healthcare TT. This is shown by mean results of 3.034 and 4.176 for perceived ease of use and usefulness, respectively, indicating it is perceived as being routine to implement and a useful component of TT.

For both perceived ease of use and usefulness, the TT team best practice of outlining a monetary incentive scheme returned respondent scores ranking within the bottom three of all measurement questions. Similarly, the best practice of routinely evaluating team members and removing members returned the lowest overall score for perceived ease of use. Thus, these best practices are considered comparatively less important with respect to a successful TT team.

The best practice advising the implementation of a joint venture received respondent scores of 2.708 and 4.022, respectively, for perceived ease of use and usefulness. This indicates that joint ventures are considered useful, but rank between difficult and routine to utilise. All training related best practices received similar scores indicating that training is in general routine to implement and considered useful, based on the results of both perceived ease of use and usefulness. Additionally, of all the foundations measured, training received the highest average score for the usefulness measurement item.

The framework foundation relating to the legal considerations of project components received a collective respondent score of 2.727 for perceived ease of use and 3.629 for usefulness. Both these scores represent comparatively low values indicating legal considerations are more difficult to implement and less useful when considering the other framework foundations.

The results of the variance analysis comparing Western Africa with the rest of SSA provided insight on how Western Africa differs from SSA as a whole when executing phases of TT. It produced a statistically significant result indicating that both phases I and II of the conceptual framework are more difficult to implement in Western Africa. No statistically significant result is produced for any phase of the conceptual framework when evaluating the usefulness measurement item.

Similarly, Central Africa exhibited difficulty in implementing Phases I and II of the conceptual framework, based on the statistically significant results of the variance analysis. No statistically significant result is produced for any phase of the conceptual framework when evaluating the usefulness measurement item.

Eastern Africa contrastingly did not yield any statistically significant results indicating any difference from the variance analysis comparing Eastern Africa with the rest of SSA. This is applicable for all five phases of the conceptual framework when evaluating perceived ease of use of usefulness.

The variance analysis for Southern Africa comparing Southern Africa with the rest of SSA correspondingly did not yield any statistically significant results indicating any difference. This is applicable for all five phases of the conceptual framework when evaluating perceived ease of use of usefulness.

Overall, the evaluation of the framework over the entire region of SSA, the grand mean for perceived ease of use and usefulness is 2.992 and 4.032, respectively. This indicates that respondents consider the framework to be collectively routine to implement and useful.

VII. Conclusion

The data results of the survey presented within this article highlight the applicability, practicality, versatility, and utility of the conceptual framework.

As shown by the descriptive statistics, the survey respondents possessed healthcare TT knowledge which was directly applicable to the geographic region of SSA. The proportionally high number of respondents who claimed to operate on an executive or managerial level also lends further authority to the data collected by the survey.

As shown by the frequency and mean analysis the survey respondents consider each phase of the conceptual framework to be in line with routine or normal operating procedures with respect to perceived ease of use. Similarly, survey respondents consider each framework component to be at least marginally useful, with the majority ranked as useful. Thus, the survey highlights that the framework was not complicated to implement yet still useful for TT stakeholders in SSA.

As shown by the variance analysis the survey's data results highlight the relevance of the phases of the conceptual framework within the four regions of SSA. It also allows the conceptual framework to be tailored depending on the individual transfer environment by highlighting the differences, both for perceived ease of use and usefulness, between the four major regions in SSA.

As shown by the regression analysis the level of adoption and diffusion achieved by the respondents' transfer object exhibit a strong positive correlation with the usefulness of the best practices stated within the conceptual framework across all five phases. These regression coefficients, along with the results of the mean analysis and variance analysis, display the collective usefulness of the conceptual framework for healthcare TT ventures in SSA.

A recommendation for future research would be to evaluate the applicability of the healthcare TT framework with respect to other industries. As universal TT principles account for a substantial portion of the framework's theoretical base, the framework may have applications in other industries or market sectors. Thus, further empirical study into the framework's nonhealthcare applicability is also recommended.

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