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Theorizing On Self-Efficacy Through Technology (SETT Theory)

Mwangi Cathy

Mudogo Collins

mHealth Kenya

Abstract: ***This article discusses a new world view towards technological solutions for health. The paper proposes the Self-Efficacy Through Technology (SETT) Theory as a complementing worldview to both previous and current theories including diffusion of innovation in health care. The position of the SETT theory is as a hybrid approach between diffusion of innovations and self-efficacy theory. The paper is divided into three main sections: Methods section which provides the processes that were followed to come to the conclusion that there was need for a new theoretical framework; a critique of the current worldviews/theory section focussing mainly on diffusion of innovation by Everett Rogers and self-efficacy theory by Bandura; and lastly a section on the theory we propose, the Self-Efficacy Through Technology (SETT) Theory.***

I. BACKGROUND

METHOD AND PROCESS OF THEORIZING

Critical observations were made in terms of the development, implementation and the impact of mHealth solutions on health outcomes. Our initial work titled "*Does message-based communication through mobile phones for medication and treatment adherence improve health outcomes: a systematic review"* (Mwangi & Mukanya, 2017) gave us a good empirical grip on the topic of mHealth solutions and outcomes. We looked at solutions that had positive impact and those that did not. In our findings, we realized the need for a strong theoretical framework upon which effective technological innovations for health should be grounded right from conceptualization phase through design and implementation to impact measurement phase. We came up with ten guiding questions. In analysing the current theories vis-à-vis the guiding questions, we identified that there were gaps and no proper linkage both in theory and practice between designing of some of the mHealth solutions and implementation (on the developer's or rather technology supplier' side) vis-a-vis uptake and desired impact (on the consumer's or rather targeted user's side). It is this disconnect that led us to the next thought process of bringing into play the concept of Self-Efficacy Through Technology (SETT). We derive this new theory by merging the two theories of diffusion of innovation by Everett Rogers and the self-efficacy theory by Bandura. This brings forth a new view point from which technological solutions for health can be based in an effort to have sustainable impact among targeted populations.

II. CURRENT WORLDVIEWS

DIFFUSION OF INNOVATION THEORY BY EVERETT ROGERS

The application of Everett Rogers' 1962 concept of diffusion to technology in healthcare is perhaps the most robust approach in explaining and predicting both push and pull factors or rather influencers to healthcare innovations (John Hopkins, FHI360, IntraHealth, & MSH, 2015). The theory holds that an innovation is spread through particular specific communication channels by members of a given social system. The theory has five key elements namely the Innovation, Communication channel, Social system, Time, and Adopters (Rogers, 1995). In its application, firstly the theory suggests that there are five types of innovators starting with those that would readily take the risk and grab the innovation (Innovators) to those that are very doubtful of the innovation that they would be hardest to convince to adopt the

innovation (Laggards). In between the innovators and the laggards are Early adopters, Early majority, and Late majority respectively. Secondly, it is important to know that diffusion follows five key steps namely knowledge, persuasion, decision, implementation, and confirmation. These steps are important in understanding where the target audience would be so that an appropriate solution is provided. In spite of the type of audience or the stage where they could be, the theory postulates that every innovation has five characteristics that determine its uptake. The main characteristics are as follows (John Hopkins et al., 2015; Dearing, 2009):

RELATIVE ADVANTAGE: This aspect of an innovation demonstrates its potential benefits over other possible innovations or rather the current approaches (Robinson, 2009). For example applying mobile telephony technology using short messaging has demonstrated its relative advantage in improving adherence to treatment or medication thus better health outcomes compared to other approaches such as relying on patient's memory which most often than not leads to forgetfulness (Lorig, 1999; Lenhart et al, 2010).

COMPATIBILITY: An innovation's level of compatibility refers to the degree to which it is aligned to emerging policies, programs, needs, societal values and norms and procedures (Robinson, 2009). Although mHealth innovations with some sort of similarities could have been implemented in many countries as is evidenced in the publications reviewed in our initial work (Mwangi & Mukanya, 2017), it is very difficult to copy and paste the exact same innovation and implement it in multiple countries without factoring in the values and practices for the country of implementation. In some cases, the language used in certain countries is different. Additionally, in some countries it could be better to have the systems communicating in different languages especially in countries with diverse tribes. If the language is not understandable to the user then the innovation has little chance of success. Nonetheless blinded translation of some content from one language to the other may alter the meaning thus affect understanding, uptake and sustainability of the innovation.

SIMPLICITY OR COMPLEXITY: How easy or difficult an innovation is to use determines its level of uptake and utilization. Simpler ideas are easier and faster to adopt than complex ideas that would require the targeted end user to develop new skills and understandings (Robinson, 2009). This is quality that cannot be taken lightly. Any application developed will only be successful if it is easy to use. An example is the money transfer via mobile phone innovation in Kenya (M-PESA). The M-PESA platform which has proven to be easy to use among millions of Kenyans, old and young, educated and uneducated, male and female cutting across all social-cultural and economic classes without any formal training is a great example of how important the ease of use of an innovation is in an effort to have it adopted (https://www.safaricom.co.ke/business/corporate/m-pesa-payment-services).

TRIALABILITY: Refers to the need for there to be easy ways of trying out or clear experimentation plans of an innovation. Once tested or tried, an innovation provides an opportunity to learn from the lessons gathered so that there can be minimal risks to users during implementation (Robinson, 2009). Many studies in mobile innovations are based on pilots done. The pilots are great as they inform the scalability of the project and people get to learn from any mistakes that may have been experienced in the pilot. Any innovation has to go through a trial so that it can be improved before it goes to scale. This is also an opportunity to get feedback from the participants on the content that is being communicated and how impactful it may have been. It is at this point that content can be improved based on feedback from the participants of the pilot.

OBSERVABILITY: The easier it is for individuals to see the results of an innovation, the more likely they are to adopt it. Visible results lower the uncertainty and also stimulate peer discussion of a new idea, as friends and neighbours of an adopter often request information about it (Robinson, 2009). When role models are provided, adoption of a given innovation becomes quicker.

According to Everett Rogers, these five qualities determine between 49 and 87 percent of how adoption of new products may vary. These five qualities make a valuable checklist to frame focus group discussions or project evaluations. They can help identify weaknesses to be addressed when improving products or behaviours (Rogers, 1995).

Other scholars and program experts have been able to identify more than just five characteristics or rather desired qualities of innovations. Some of the additional innovation characteristics include type of target groups where innovations tend to be adopted much faster among homophylous groups compared to heterophylous groups. Influence of opinion leaders and infrastructure (Cain & Mittman, 2002).

III. APPLICABILITY OF THE THEORY TO THE AFRICAN CONTEXT

This theory is still relevant today given that mobile technology innovations are being developed with the objective of ensuring that there is high adoption rate to complement both the already overwhelmed health sector human resources and limited available services. Beyond adoption of the new technologies, the overall expected outcome is usually to influence behaviours such as adherence to treatment. Mobile technology has been used to communicate adherence messages to patients suffering from communicable or non-communicable diseases. For example the diffusion of innovations principles were used in a program in South Africa that was launched in 2009 known as Brothers for Life (BLF). BLF is a program that promotes HIV testing and voluntary medical male circumcision (VMMC) among other things. For VMMC, BFL used the Diffusion of Innovations principles of Observability and Trialibility by interviewing men who underwent the VMMC procedure and publicizing the interviews through a national campaign using Television and Radio. Through storytelling, BFL connected other men to the experiences of their peers and encouraged them to make a decision to go forward with the procedure. In support of these activities, BFL also created a short messaging (SMS) number that men and women could text to get answers to their questions about VMMC and directions to the nearest clinic. BFL successfully increased knowledge of VMMC from 8% in

2009 to 47% in 2012. Statistical data also shows BFL activities led to an increase in VMMC uptake (https://www.brothersforlife.org).

LIMITATIONS OF THE DIFFUSION OF INNOVATION THEORY

Application of this theory has demonstrated some unique limitations. For example the theory has ability to facilitate adoption of innovations that are sometimes not well understood or even desired by adopters. This theory is more of a self-centred theory with little or no role being assigned to other influencers of adoption such as mass media and only creates awareness to new innovations. Media directly influences early adopters, but these people are generally well informed and careful media users and therefore the theory has little influence. Change agents have a great influence to making any changes and they would be the ones to lead in the diffusion efforts. Without them, the theory may not be very effective.

STRENGTHS OF THE DIFFUSION OF INNOVATION THEORY

The diffusion of innovation theory provides more and better strategies for overcoming barriers to diffusion. The trialability nature of the theory provides innovators an opportunity to test and improve the innovation before taking it to scale. The observable nature of the theory makes it more likely to be accepted by the users.

SELF-EFFICACY THEORY BY BANDURA

Early on theories that were used to explain behaviour were premised on a psychodynamic model with three basic characteristics (McGrath & Margison, 2000; The Psychiatric Interview in Clinical Practice, 2005):

- ✓ Behaviour being regulated psychically at a sub-conscience level
- ✓ Behaviour that diverges from the prevailing norm being symptomatic of a disease or disorder
- ✓ Self-insight through analysis with a therapist can change behaviour

However, further research showed that this "lie on the couch" approach of talk therapy did not lead to long term behaviour change (Bandura, 2004). The 1960s saw a paradigm shift in which behaviour could then be viewed as a result of factors at a personal level, behavioural level, and environmental level and not necessarily as a result of psychodynamic proceses (Bandura, 2004). There was therefore need to have an approach to treatment that could consider content, location and change agent. Treatment content became action oriented and focused on changing the actual deviant behavior rather than on trying to find the psychological origins of the behavior. Mastery experiences were used to give people the skills and belief in themselves to adopt healthier behaviors. Treatment occurred in the settings where the behavior occurred – at home, school, workplace and community rather than in a therapst's office. For example, teachers were trained to assist in reducing problem behaviors in the school setting and peers or role models who had overcome the problem behavior themselves were also change agents (Bandura, 2004). Although both approaches were very different, research done on phobias showed that both were equally as effective. Since both approaches worked, it was apparent there was some underlying mechanism connecting them. It was Albert Bandura in the late 1970 who proposed Self-Efficacy Theory as the unifying mechanism (Bandura 1977, 2004).

IV. THEORETICAL CONSTRUCTS

An individual's ability and confidence to successfully accomplish a certain task or something is what defines Self-efficacy. Defined both as a theory by itself, as well as being a construct of Social Cognitive theory, Self-efficacy theory suggests that belief of being able to accomplishing or failing to accomplish a certain task is what determines an individual's willingness to try or attempt to do the task. According to the theory, whereas people in possession of a strong sense of efficacy believe they can accomplish even the most difficult tasks given that they would look at the difficulties as challenges that can be mastered, those people with a low sense of efficacy would view such challenges as threats and therefore not attempt to perform them (Bandura, 1994). The theory introduces the idea that the perception of efficacy is influenced by four factors:

MASTERY EXPERIENCE

The resolve to attempt to do something successful is what leads to mastery experience. It is the mastery experience that boosts self-efficacy because people are more likely to believe they can do something new if it is similar to something they have already done well (Maliski, Clerkin & Litwin, 2004). For instance, workshops, training programs, internships, and clinical experiences are usually held to develop mastery skills among learners.

The advancements in mobile phone technology have seen individuals move from using basic phones to very sophisticated smart phones without any formal trainings being conducted.

VICARIOUS EXPERIENCE

Being able to observe and learn from equal others is also an important contibutor to developing self-efficacy. Watching an individual of equal calibre achieve a given task creates the desire in an individual observing or wanting to try to accomplish such a task.

Conversely, observing someone like you fail has potential to detract or threaten self-efficacy towards attempting that similar task. The more one associates with the person being watched, the greater the influence on the belief that one's self can also accomplish or not accomplish the behavior being observed.

If applied to technology, any new innovation can have successful implementation based on the feedback from the users. If the users have had bad experiences and speak about

these bad experiences to their peers, there is a chance for poor uptake of the new innovation. MPESA sold itself because it provided a platform for all but most importantly the unbanked populations. Today, it does not matter what social class you belong to, the MPESA platform is easy to use and convenient for all. Employers use the platform to pay employees and millions are transferred from an individual to business basis every day. The growth of MPESA has been due to the vicarious experience as is explained in the theory.

VERBAL PERSUASION

The other factor that influence self-efficacy is verbal or social persuasion. When people are persuaded verbally that they can achieve or master a task, they are more likely to do the task. Having others verbally support attainment or mastery of a task goes a long way in supporting a person's belief in himself or herself. For example, if a fellow soccer player put it to fellow team mates that they lost a game because they were all lousy players, this does not help much in improving self-efficacy, but if he was to say they lost because they needed more practice, this would motivate players to put in more hours and effort in practice (Brown, Maluoff & Schutte, 2005).

We have seen many elderly populations adapt and master the use of MPESA. In most instances, family members who had already mastered in the use of the platform may have been the same that persuaded their older family members to take up the use of the platform.

Most of us have family members we support financially and MPESA made it easier for us to transfer money even to the most remote areas. Money transfer became easy and made it cheaper to move money between individuals, family members and businesses. Verbal and social persuasion in this case was what promoted the MPESA platform because it was easy to sell the benefits to the rest of the family members due to the multiple advantages.

SOMATIC AND EMOTIONAL STATES

The physical and emotional arousal states that occur when someone contemplates doing something provide clues as to the likelihood of success or failure. Wheareas feelings of stress, anxiety, worry, and fear all negatively affect self-efficacy and can lead to a self-fulfilling prophecy of failure or inability to perform, positive feelings are more likely to lead to accomplishment of a task (Pajares, 2002; Bandura & Adams, 1977). For example, fear of pain associated with dentists and anxiety prevents people from making dentist appointments. Also, fear of discrimination or stigma prevents asthma patients from using or carrying inhalers which are detrimental in their continued asthma care.

Assume you were in a situation where you urgently needed some money, say to pay for police cash bail over a petty trafic offence yet you did not have the money in cash or there was no bank and a friend sent through some money via MPESA, this would arouse positive emotions. This could arouse happiness, a feeling of relief and liking towards MPESA. Such a situation can make you want to always have and use MPESA and maybe even recommend it to others.

V. APPLICABILITY OF THE THEORY TO THE AFRICAN CONTEXT

The use of cultural leaders as role models to change or against certain retrogressive behaviours such as stopping wife inheritance is a good example of vicarious experience. We see our marathon runners also used in advertisements to lure us to buying items but to the youth, these are individuals just like them that have made it in life and are successful. That is why we have many young marathoners coming up because of being able to identify with the winners coming from their villages. In thinking about professional careers, many youth or young adults growing up see their relatives (fathers, uncles, siblings and aunts) that are in particular professions like teaching, lawyers and others with a degree and at some point working on their second or third degrees. These successful relatives end up being role models and motivators to these young adults who are so impressed by their relatives as they grow up. One of the most successful companies in Kenya is Safaricom. Mr. Bob Collymore the company's Chief Excutive Officer (CEO) is seen as a public figure and has been the face behind the success of Safaricom and the MPESA platform. He has a lot of influence in the way people perceive any systems that Safaricom launches and because of their previous success with MPESA, it becomes easier to influence the use of any new systems. This is a good example of his influence to vicarious experience in this theory.

Somatic and emotional states have been a hinderance to care and treatment of HIV due to stigma and fear of discrimination. Counsellors use verbal persuasion to encourage the patients to adhere to medication and appointments and after months of going through the treatment, they master the process and this is evidenced through change in behaviour.

VI. LIMITATIONS OF THE SELF-EFFICACY THEORY

Just as you can learn positive things through mastery experiences, you can learn negative activities as well. Criminals become criminals because of learning from their peers and criminal leaders use the same model to make the criminals good at what they do. The criminal leaders in this case are the change agents. While this theory can be used to make positive behavior change, it can also be used to influence negative behavior. Corruption in Kenya has become worse because it starts from the leaders and trickles down to the bottom. The leaders are the change agents and positive change would need to start from the top for it to make it to the bottom.

VII. STRENGTHS OF THE SELF-EFFICACY THEORY

Self-efficacy theory is one that is very relevant and can be used from the time a baby starts learning. It is through vicarious experience that one can learn how to tie their shoes, brush their teeth, eat with a fork, etc. Children observe their parents and older siblings and copy what they do. From doing

it over and over again, one gains mastery experience of doing things and can only get better at it. Each of the four factors mentioned in the self-efficacy theory plays a key role in an individual's success or failure in whatever they do. The influences that have made us successful in any part of our lives could be associated with at least one, several or all of the factors of self-efficacy.

VIII. THE SELF-EFFICACY THROUGH TECHNOLOGY THEORY

mHealth innovations are meant to communicate key health information messages with expected outcome. The innovators however are most likely neither communication experts nor health/medical experts and often do not think about the content being shared in the platforms. In aiming at effectiveness of any technological solution for health, it is important to think about the success of the development and how likely it is that the innovation will be adopted.

In interrogating the suitability and completeness of the current theoretical framework in explaining technological innovations we asked ourselves the following basic but critical questions:

- ✓ Who would be the targeted users of a given solution?
- ✓ What could be the problem aimed at by/through a given solution?
- ✓ What kind of solution could this be, deemed fit/relevant for the identified problem and population?
- ✓ How would the proposed solution be delivered?
- ✓ What could be the possible motivators/benefits identifiable from the targeted users that could influence the uptake and utilization of the solution?
- ✓ How could the motivators be emphasized through the solution?
- ✓ What could be possible barriers/risks to the uptake and utilization of the solution?
- ✓ What measures could be put in place to mitigate the identifiable barriers/risks?
- ✓ How replicable could be the proposed solution?
- ✓ What would be the measure(s) of success of a given innovation?

An analysis of these questions vis-à-vis the tenets of the two theories of diffusion of innovation and the self-efficacy theory as expounded early on in this paper reveals an apparent disconnect. Our findings suggest that whereas the diffusion of innovation theory is more focussed on the innovation itself, aspects of implementation and more on uptake of the innovation, the self-efficacy theory on the other hand is more focussed on the user's skills and abilities potentially gained from the innovation. However as the two theories stand, there exists no link. Figure 1 below is an illustration of how we conceptualise the two theories as they stand now.

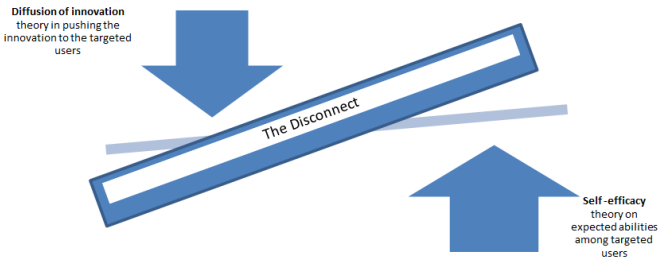

Figure 1: Illustration of both diffusion of innovation and self-efficacy theory as they are currently

The development of this new theory of Self-Efficacy Through Technology is based on the fact that most mHealth innovations are developed to change behaviour. The systems start off as innovations and they go through the diffusion process for them to be successfully implemented. Self-efficacy comes in at the point of determining the actual change in behaviour. By using the diffusion of innovation theory on itself, it pushes the product to the users without completely factoring in the actual change of behaviour by the user of the system. This is where we need to test the user experience through the self-efficacy theory. In most cases, by the time the new innovation impacts behaviour, it may go through a lot of changes and enhancements that are driven by the different experiences by the end users. This is where the self-efficacy experiences become relevant. The whole change process could take years and this is evidenced by several systems implemented in Kenya and all across Africa. A system could come up as new innovation, but after 3 years of trialability, it changes form and is no longer a new innovation but a full blown system having gone through several changes. In fact, it may completely change from what it was initially developed to do to becoming a new system doing functions completely different from the initial innovation. In merging the two theories of diffusion of innovation and self-efficacy we identify the following as key tenets of the Self-Efficacy Through Technology Theory. This new theory deviates from the diffusion of innovation theory by the fact that it suggests a multilinear, iterative process and not a unilineal approach. Every mobile health innovation has to at least follow through five key steps.

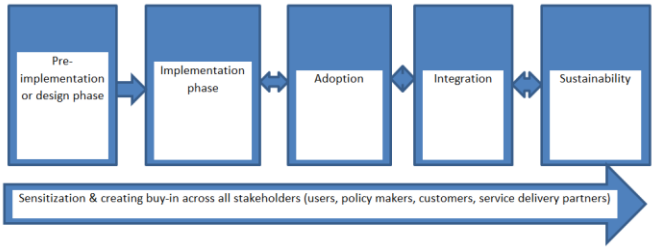

Figure 2: mHealth innovation for self-efficacy continuum

Each of these steps will have various activities based on the kind of innovation being developed. However, sensitization and creating of buy-in has to occur at all stages. This model suggests that there is need to do a lot of good work at design stage so that once implementation begins then it is very clear on what kind of innovation it is, its scope and objectives. Nonetheless, between implementation and sustainability it has to be a flexible process so that strategies can be refocussed to reflect lessons learnt. Throughout the

process, the system designer or implementer will find it necessary to refer to the ten questions suggested above. To accomplish the objective of this continuum the theory of Self-Efficacy Through Technology becomes eminent. The theory takes a strong practical approach and would be based on a number of tenets as detailed below:

INNOVATION IN HEALTH: We will use an example of mobile health innovation being used to communicate to clients, who could be patients, health care workers or with information that could be accessible to any health stakeholders. At the design phase an appropriate innovation has to be developed. The innovation has to take into consideration all the ten questions posed in this paper. That way, the innovation becomes relevant, sustainable and with ability to stimulate impact. During this stage both the system and content have to be standard and more importantly based on the user needs. The innovation comprising of both the system and content developed has to demonstrate the key characteristics that can both encourage diffusion of the innovation and create self-efficacy as follows:

- ✓ *Simplicity of use:* A given innovation must be so simple to use that once the users have access to it they make use of it without necessarily having to consult. A simple to use innovation guarantees high level of acceptability and adaptability.
- ✓ *Relative advantage/benefits:* An innovation has to demonstrate its potential benefits to the users. Most often than not this would be the first content that goes out to the targeted users so that they know why they should be part of this new innovation. This can also be done in the way you market the new product to the potential users or customers. The benefits and advantages of the new innovation have to be communicated to get the buy in of the intended user.
- ✓ *Mastery experience:* When an innovation is easy to use, and the intended users have been convinced that the innovation is of great benefit they would start to use the system or application (app). If there are any training tools provided on the innovations, the content has to be informative and one that passes practical knowledge and skills to the user.
- ✓ *Verbal Persuasion:* Many systems are developed and are deployed for use. Upon training or with any training tools developed, sometimes it takes verbal persuasion. This is sometimes done by trainers in face to face trainings, or through advertisements for the new innovation. The language used has to persuade and encourage the users to try out the innovation. In some instances, family members or friends that would persuade their relatives or friends to use the innovation by sharing the benefits they will get to experience.
- ✓ *Vicarious experience:* The people who use the innovation initially get to share their experiences. The success and failure of a new innovation can be dependent on the vicarious experiences for the first users. Feedback from peers becomes crucial but more important if an influential person in that community gets to appreciate the new innovations, then he/she becomes the spokesperson of the product. Use of role models in sharing their positive experience or promoting the innovation could have a positive effect in the adaptation of the innovation.
- ✓ *Somatic and emotional states:* Any time a system or app is used and ends up benefiting an individual or community, people get to share their positive experiences. A doctor that uses a mobile app to communicate with his patients and ends up with positive impact on the patients' health will most likely talk about the app to his peers. The patients' who experience the positive outcome may also talk about the app to potential patients. This positive feedback ends up creating a viral effect in the use of the innovation and more and more people get to use it.
- ✓ *Compatibility:* Before implementation it is important to look at the innovation and see whether it is compliant to standards, guidelines, and strategies in place, policies, legal framework and practices, social and cultural norms of a given setting. Some innovations cannot be a copy and paste. Countries have different policies and legal frameworks and cultures that could make an innovation irrelevant in some settings. If the systems or app is meant to communicate, it would be important to look at the content being shared. Translations can give content different meaning especially for language spoken in a different cultural environment.

PILOTING OF THE INNOVATION IN HEALTH: After the design stage, an innovation has to be tested to ascertain its suitability, relevance and ability to deliver on desired goals and objectives. Testing provides a good opportunity to learn so as to enhance the system and be able to take care of all the needs of the users before actual implementation.

IMPLEMENTATION OF THE INNOVATION IN HEALTH: With a well-developed innovation, one that has been tested and shown potential for intended goals, it is time to move into implementation. Sensitization becomes even more critical at this stage. Whereas easy to use mHealth innovations would be quickly taken up by targeted users still some level of training and strategies on how to provide technical support are required. During this stage observations are required on how best the innovation is delivering in terms of targeted goals among targeted populations. This calls for rigorous research to determine changes in behaviour. Self-efficacy tests have to be conducted among users pre-implementation, during implementation and post-implementation. This is the point at which the concept of the innovation is proven.

LEADERSHIP OF THE INNOVATION IN HEALTH: Once proven to be effective and acceptable, the next levels require strong leadership. When a strong leadership is convinced that a given innovation is necessary then its adoptability, integration and sustainability becomes easy. A strong leadership ensures high level of advocacy for the innovation and this would lead to gaining support in terms financing or purchase of the innovation from the private sector, national budgets or donors.

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