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Toward a Model of Interactions of Technology Adoption Factors vis-à-vis Socio-Economic Development Issues in Sub-Saharan Africa

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INTRODUCTION

While there has been considerable research on innovation adaptation and diffusion especially in the rapid growth area of Information Technology, most has focused on developed countries (Mathieson et al., 2001; Straub, 1994; Gallivan, 2001). Most of this research presumes that technology is readily available, and the onus of accepting or rejecting it resides with the end user. However, this assumption falls short of realities in developing countries in general, and Sub-Saharan Africa in particular. Countries in this region lag behind the rest of the world in basic socio-economic factors such as income, education, health, productivity, etc., pertinent to the day-to-day use of modern technologies. To the vast majority of potential users, adoption is not about choice, since adequate technology does not exist.

Several theoretical frameworks have been used to explain innovation adoption and diffusion. Among them are the theory of planned behavior, theory of reasoned action, diffusion of innovations, social cognitive theory, technology acceptance model, etc. (Gallivan, 2001). An area of innovation adoption and diffusion that has received considerable attention, especially in Information Technology, is research that predicts whether individuals will accept and voluntarily use a given technology. One of the most referenced models in this research stream is the Technology Acceptance Model (TAM). TAM proposes that successful adoption (acceptance) of technology is dependent on its usefulness and its ease-of-use (Davis, et al., 1989).

Researchers have studied TAM from various perspectives. One perspective looks at the influence of perceived user resources (Mathieson, et al., 2001). The perceived user resource model accounts for the user's perception of the relevance or adequacy of technologies. Pursuing this extension of the TAM framework, we desire to analyze situations where technologies are inadequate or unavailable. Such situations are reminiscent of Sub-Saharan Africa. For example, out of the 630 million people in the region, a paltry 150,000 or 0.0002% had Internet dialup access in the year 2001 (Jensen, 2001); the Internet dialup access in the U.S. for the same period stood at almost 30% (ITU, 2001). Statistics from the same period showed that telephone and PC density for Sub-Saharan Africa were only 0.74% and 0.1%, compared to 70% and 42% respectively in the U.S. (ITU, 2001). To help understand possible reasons for these discrepancies, we seek to address the following questions:

(1) What are the pre-cursors necessary in understanding technology adoption in Sub-Saharan Africa?
(2) How do socio-economic development factors interact with these precursors?

We posit that exposure to technology is a necessary precondition to possible acceptance or rejection—much as exposure to an educational setting precedes willingness (ability) or unwillingness (inability) to learn. Although this assumption seems obvious, it is important to recognize it explicitly in the context of Sub-Saharan Africa, given the inadequate technological infrastructure in the region. From our discussions, it would seem reasonable that we cannot simply extrapolate the existing technology diffusion or adoption experiences from the developed nations of the world to apply to Sub-Saharan Africa. While the study is partly a third generation extension of the original TAM model presented by Davis (Davis, et al., 1989), we focus on developing a model that seeks to shed some light on the dynamics that come to play in order to gain a better understanding of the situation in Sub-Saharan Africa.

In this paper, technology adoption includes, but is not limited to, Internet diffusion or the diffusion of Information and Communication Technology (ICT). Part of the motivation here comes from the realization that, given the globalization of the world economy, Sub-Saharan Africa is expected to play greater roles than it has in the past.

We seek to add to the discussions by building a model that shows some factors or forces that tend to constrain the exposure of this potentially viable region to technological development, which results in its limited adoption of technology. However, there are some socio-economic factors that seek to encourage private investors and policy makers to invest in the requisite infrastructure and modern technology, which in turn could lead to an enhancement to adoption of technology, ceteris paribus.

The rest of this paper is organized as follows. First, we discuss the precursors to the technology adoption for Sub-Saharan Africa. Second, we present a brief review of the perceived user resource model—a version of the Technology Acceptance Model. We then discuss the socio-economic development factors and their possible interactions with technology in Sub-Saharan Africa. Our convolution of these and other related research streams yields a new model that may have greater relevance to Sub-Saharan Africa.

Precursors to Technology Adoption for Sub-Saharan Africa

As stated earlier, there are many factors that affect the observable level of technology adoption in Africa that are absent in the original TAM model. It could be argued that factors such as culture, standard of living, and education would have different consequences on technology innovation and adoption in the African context. One such technological innovation is telecommunications and related technologies.

It is a universally accepted notion that modern telecommunications infrastructure is a key enabler of socio-economic development. The belief is that technological infrastructure serves as a catalyst to improvements of various telecommunications-related technologies. With regards to basic telecommunications infrastructure, Africa wavers behind the rest of the world very badly. It is estimated that the city of New York alone has more telephone lines than the whole continent of Africa (Mbarika, et al., 2002). One of the pertinent observations made

in a Panos Institute study was that poorly developed telecommunications networks and other technological infrastructure represent a major constraint to the adoption of telecommunications technologies in the least developed countries of Africa (The Panos Institute, 1998). As far back as 1985, Sir Donald Maitland presented a report to the Independent Commission on World Telecommunications Development in which he emphasized the fundamental importance of telecommunications infrastructure for the economic and social development of all nations.

While there may be some who subscribe to the notion that economic development precedes technological development, we are of the school of thought that believes in the converse. A glimpse into the future of what the socio-economic situation of countries would be like in the absence of the means of acquiring, manipulating, storing, and transporting information and knowledge rapidly demonstrates the absolutely essential role of general technological and telecommunications infrastructure in the 21st century (Kenney, 1995).

There are other factors that limit the adoption of technology in Sub-Saharan Africa. Hitherto, the under-developed countries of Sub-Saharan Africa have had to bear extra burdens in paying more for technology, relative to developed countries. For example, unlimited Internet access in the United States generally costs under $20 per month, while it takes Ghanaians $50 for a service that is not near as reliable (Petrazzini and Kibati, 1999). The fact that most Ghanaians and the rest of Sub-Saharan Africans earn only about $25 a month makes for an uphill task for acquiring (much less adopting) technology in what is considered to be the most economically disadvantaged region in the world. We believe that these and other reasons justify the need to develop a new TAM model that may be more relevant in capturing the adoption (or lack thereof) of technology in Sub-Saharan Africa.

The Influence of Perceived User Resources in Technology Adoption

As already pointed out, this paper is an extension of "The Influence of Perceived User Resources Model", which in turn is an extension of the original Technology Acceptance Model. Continuing along the genealogical lineage, TAM's roots come from the Theory of Planned Behavior (TPB), which came from psychological research in the area of the Theory of Reasoned Action (Mathieson, et al., 2001).

Unlike the theory of planned behavior, TAM was developed to study the decision-making processes of users as to whether or not to adopt some information technology in various settings. Certainly, TAM has had major contributions to the field of Information Systems. A major reason for TAM's popularity is its practicality (relative to TPB). It is more parsimonious than TPB. Unlike TPB in which every situation requires unique operationalization, calling for the development of customized instruments for behavioral, normative, and control beliefs, TAM does not require such. Also, TAM has less constructs than TPB, making it easier to apply when predicting IS usage (Mathieson, et al., 2001).

In spite of its relevance and practicality, TAM has some potential limitations. For example, TAM was based on studies in industrialized countries where technologies already existed. In essence, the developers inadvertently presumed that technology availability was a given. When it comes to Sub-Saharan Africa where technology availability is grossly inadequate, using the TAM model in its original form would be a stretch.

The relevance of the influence of perceived user resource model to this paper is that it already extends TAM to account for situations of the users' perceptions of the resources at their disposal. Although the theoretical discussions of this model will not be presented in this paper, a pictorial representation is shown in Figure 1. By focusing on resource issues, we believe that researchers, policy makers, and private investors can better delineate factors that managers may have some degree of control over. It also helps keep the construct distinct from previously created constructs that deal with perceptions of individual abilities such as self-efficacy and skill (Compeau and Higgins, 1995; Mathieson, et al., 2001). However, we need to account for the cases when the users have inadequate or unavailable resources in actuality. We also want to know what factors contribute to the perpetual inadequacy of modern technologies in developing countries, particularly Sub-Saharan Africa.

In the Mathieson model (Figure 1), perceived user resources is designated by "PR", which is the extent to which an individual believes that he or she has the personal and organizational resources needed to use an Information System. The perceived user resources include factors such as skills, human assistance, hardware, software, time, documentation, and money (Mathieson, et al., 2001). In actuality, the factor "PR" is made up of reflective and formative components. The reflective component measures an overall perception of resource availability, while the formative components measure the perceptions of individual resources, such as expertise, training, hardware, money, etc. Since these items capture different resources, they are not necessarily correlated (Mathieson, et al., 2001).

Socio-Economic Development and Technology Interactions

Another idea for this paper stems from observations of possible interactions between technology and socio-economic development in developing countries. It has long been recognized that the establishment of the Internet and other technological infrastructures in developing countries would provide a much-needed impetus for improved economic productivity, governance, education, health, and quality of life, both in absolute and marginal terms (Madon, 2000).

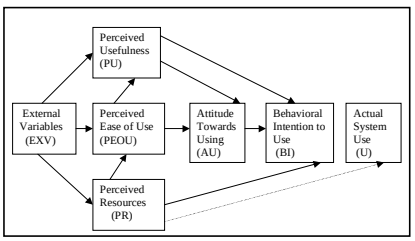
From our perspective, a model of technology diffusion that would be applicable to Sub-Saharan Africa should cover more factors. In addition to the development factors listed, other issues that conspire to make for poor technological infrastructures also have to be contended with. Among these are hunger, poverty, graft, lawlessness, apathy, bribery, corruption, tribal strife, and religious strife. For most of Africa, it is probably best not to approach TAM from the standpoint of studying only the processes that users go through in order to make the decision to accept or reject some technology. This is because the option is not volitional for the vast majority of potential users of technology in Sub-Saharan Africa.

From the foregoing, a more reasonable starting point would be to look at the factors that would affect the infusion of technology. Some of the factors that positively impact the infusion of technology by nation states are: education, health, democracy, economic productivity, pressure or desire to integrate into the world economy, the physical environment, roads, water supply, employment, social well-being, etc. (Madon, 2000).

At the same time, there are some factors that apply mostly to Sub-Saharan Africa that tend to erode significant investments in modern technological infrastructures, without which the noted desirable goals remain unrealizable. These factors include: lack of vision, self-centeredness (graft), investments in obsolete or hand-me-down technologies, bribery and corruption, lawlessness, military and civilian dictatorships, apathy, colonial master-plans, religious and tribal strife, minimal efforts to provide the populace with the basic amenities in life (e.g., water, roads, electricity, healthcare, education, employment), etc.

While it is true that most of Sub-Saharan Africa is so far behind when it comes to technology, and that it needs to go through incremental development, one could not realize sustainable developments by flooding the continent even with the best and latest technologies. This

Figure 1: Influence of Perceived User Resource Model Extension From TAM



[Adapted from Mathieson, et al., 2001]

is especially true when the vast majority of the population is grappling with the day-to-day problems of poverty, hunger, and survival. A reasonable starting point would be to invest in technologies that alleviate hunger, poverty, and improve basic health. These technologies would include farm equipments that would empower farmers to move from the centuries-old method of using hoes to till the lands. Providing the populace with these and other basic needs mentioned above would then allow them to move to higher levels in their hierarchy of needs. When one has electricity, television, telephone, etc., then his or her horizon might extend to other matters such accepting or rejecting some technology. Prior to that, the "save" button in graphical user interface means nothing in the person's mental model.

We recognize that there are pockets on the continent that already have modern technologies. However, these are extremely few, and mostly limited to the urban elite. For the vast majority of the urban dwellers, technology is too expensive. Given that most of the IT infrastructures link mostly the major cities, it is out of reach to the rural communities who make up about 70% of the region's population (Mbarika, et al., 2002). We feel that substantive development will continue to elude Africa until the factors (mentioned above) that curtail improvements in technology are addressed. Until this is achieved, the conventional Technology Acceptance Model would be of limited applicability in studying IT adoption in Sub-Saharan Africa. It is in light of this that we offer what we believe is a more appropriate model.

The Revised TAM: Accounting for Actual Technology Available

An extension of TAM model that accounts for the availability (or lack thereof) of information technology is given in Figure 2. The new model incorporates the linkages between factors of national development and technological infrastructure. In the new model, we explicitly recognize the fact that in actuality, most potential users of technology (for the most part future) in Sub-Saharan Africa do not have the technologies needed at this time. Further discussion of the model is given below.

The "Actual Technology Available" in the figure refers to the technology that is in place and available for use. This would include related items such as computers, telecommunications networks, Internet, etc.

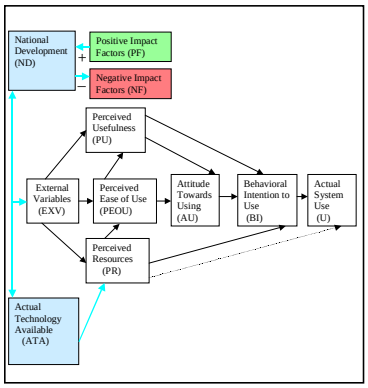
Two types of factors labeled "positive impact forces" and "negative impact forces" respectively impact the object labeled "National Development". Examples of positive impact forces include: health, democracy, good governance, economic productivity, social well-being, the physical environment, roads, water and power supply, education, employment, pressure or desire to integrate into the world economy, etc. (Meso and Duncan, 2000). The negative impact forces include: lack of vision, bribery and corruption, lawlessness, military and civilian dictatorships, investments in obsolete or hand-me-down technologies, apathy, colonial master-plans, religious/tribal strife, minimal efforts to provide the populace with the basic amenities in life (e.g., water, roads, electricity, healthcare, education, employment), etc. (Meso and Duncan, 2000).

As noted in the diagram, there is a two-way interaction between "National Development Factors" and "Actual Technological Infrastructure Available". We suggest that the chicken-and-egg analogy applies here. Our belief is that technology provides the initial jolt in the positive feedback loop between the two. Ceteris paribus, the initial technology results in enhancement in national development, which in turn provides resources and need for more (and perhaps even better technology). The positive cycle could then keep feeding on itself. It should be noted that for a region that is essentially agrarian, the initial technology would be farming-related technology.

CONCLUSION

The contribution of this study has been to enhance our understanding of the interactions that come to bear between socio-economic development needs and factors generally innate to Sub-Saharan Africa that manifest to impede technological adoption in the region. We have argued that Sub-Saharan Africa has some factors that do not show up in the conventional Technology Acceptance Model, whose premise was based on settings that are essentially applicable to industrialized nations. By extending the influence of the perceived user resource model, which in turn was developed from the original TAM literature (Davis, et al., 1989; Mathieson, et al., 2001), and borrowing from ideas espoused in socio-economic development literature (e.g., Madon, 2000), we developed an extended model that accounts for technology availability. This new model enhances our understanding of technology adoption within the context of Sub-Saharan Africa. Furthermore, the model could be applicable to other developing regions of the world.

Figure 2: The Revised TAM: Accounting for Actual Technology Available



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