DIGITAL LIBRARY ADOPTION AND THE TECHNOLOGY ACCEPTANCE MODEL: A CROSS-COUNTRY ANALYSIS

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ABSTRACT
In this article, we examine, through the framework of the Technology Acceptance Model (TAM), some of the features that inform user acceptance of a digital library system implementation at agricultural universities in two developing countries: Kenya and Peru. This is a study not only examining factors contributing to adoption of this offline digital library, but also a cross-site comparison, meant to examine the functionality in the developing world of a theoretical model developed in and based on conditions in the developed world. As we unravel predictors of technological acceptance of a digital library implementation in the developing world, we simultaneously investigate a broader question: not just questions regarding improved research in the developing world, but on it as well.

We analyze data from both sites on overall measures of perceived ease of use and perceived usefulness (two constructs of the TAM), and on individual measures making up the overall measures. We found the TAM to work well in describing factors that affect usage of digital libraries in developing countries, with perceived usefulness as the main predictor of intent to use this system (The Essential Electronic Agricultural Library, or TEEAL), and with relevance as the major constituent driver of perceived usefulness. Overall, we also found particular predictors of perceived usefulness and perceived ease of use that are consistent across cultures (relevance, trust, and ease of access), while other constructs (social norm, domain knowledge, visibility, and self-efficacy) demonstrated predictive power in only one setting. While post-hoc analyses gave several clues as to drivers of these differences, this study cannot definitively address what causes differences in predictive power between sites. What is clear, however, is that application of the TAM to IT implementation in developing countries must be guided more by the specificities of local circumstances than by the performance of the TAM in highly-developed countries.

1. INTRODUCTION
The growth of a state’s scholarly production and scientific knowledge can be viewed as a crucial factor in the processes of development (Lewison, 2003; Stephan et al., 2004; Zhang, 1992). In building a community and tradition of academic investigation and leadership, engagement with, learning from, and contribution to international scholarship is quite important (Holdom, 2005; Kitua et al., 2000): a closed system of scholarship, wherein a nation’s scholarly community learns only from itself without synthesizing knowledge from foreign scholars is naturally less dynamic and nuanced than an open system (Rowlands, 2003). The traditional avenues of academic knowledge-sharing, namely the distribution of peer-reviewed and other scholarly journals, are in a state of upheaval right now, as it is becoming increasingly apparent that high journal subscription rates have cut off much of the developing world from access to international scholarship (Kirsop and Chan, 2005). Various alternative knowledge distribution efforts have been initiated (see Kirsop and Chan, 2005). This paper investigates one of these initiatives, The Essential Electronic Agricultural Library (TEEAL), a digital library containing searchable articles from 149 journals. We examine, through the framework of the Technology Acceptance Model (TAM; Davis, 1989), some of
the features that inform user acceptance of digital library system implementation at sites in two developing countries: Kenya and Peru.

This study looks at two issues simultaneously. First, we examine factors contributing to adoption of this offline digital library, a tool which can potentially help the dispersal of global knowledge – particularly that of developing world researchers – and create a more vibrant global knowledge community. In doing so, we test a model long accepted and applied in the developed world – the Technology Acceptance Model (TAM) – in a developing world context. This study, then, is also a cross-site comparison, meant to examine the functionality in the developing world of a theoretical model developed in and based on conditions in the developed world. As we unravel predictors of technological acceptance of a digital library implementation in the developing world, we simultaneously investigate a broader question: not just questions regarding improved research in the developing world, but on it as well.

1.1 Background on Scholarly Journal Distribution

International scholarship has traditionally been distributed through the system of scholarly journal publication. While researchers and scholars conduct research and analyses, using resources of their own or other sponsoring institutions, their output is traditionally distributed by these academic journals. Many of these journals are published by large for-profit publishing houses, the interests of which lie more in profit margins than in principles of scholarly dissemination. In recent years, journal subscription prices have risen in a manner that is disproportionate to a rise in costs (Bergstrom, 2001).

In this way, profits are made by the large publishing houses that are acting as the intermediary between the author and the reader, and access to scientific research can be limited as a result. The high subscription rates for many journals put them out of reach for libraries and individuals in developing countries (McLellan, 2004; Smith, 2003). The effect of this system is that researchers in developing nations are often unable to purchase even the very journals in which they have been published. At the same time, scientific knowledge published in many journals is simply not accessible to whole nations worth of researchers (Smith, 2003).

Various efforts have been made in recent years to ameliorate the situation, ranging from discounted subscriptions to consortia licensing to open access archiving and publishing initiatives (for a fairly comprehensive analysis of the benefits and drawbacks of many of these efforts, see Kirsop and Chan, 2005). One of the more recent contributions to the field have been digital library initiatives involving differential licensing of already-published academic material. The most well-known of these efforts have been the Health InterNetwork Access to Research Initiative (HINARI) and the Global Online Research in Agriculture (AGORA) (see Aronson, 2002; Katikireddi, 2004; Ochs et al., 2004 for descriptions, explanations, and analyses of both). While both have experienced some measure of success, both HINARI and AGORA require access to the internet in the institutions in which they are operating. This can be problematic in certain countries where internet access may be expensive, unreliable or even non-existent.

The Essential Electronic Agricultural Library (TEEAL)\(^1\) (referred to as a “Library in a Box”) is a searchable CD-ROM packaging of essential agricultural and bioscience journals and scholarly works, made available to universities in low-income countries at very inexpensive rates. The TEEAL package contains digital versions of the contents of 149 journals, published by over 60 publishing companies, as well as a powerful search engine designed to scour the database. These journals were selected as the “most essential”

\(^1\) Developed by Cornell University’s Albert R. Mann Library, with financial support from the Rockefeller Foundation
agricultural and bioscience journals by 600 international scientists. Content begins in 1993 and updates are available annually. As it currently stands, the newest articles in the TEEAL database will be at least one year old, as updates take place once a year and reflect the scholarly production of the previous year. Today there are TEEAL sets in use at over 150 institutions in over 70 countries. Host institutions are in charge of the implementation and support of the TEEAL system.

2. THEORETICAL FRAMEWORK

We chose to look at acceptance of TEEAL through the Technology Acceptance Model (TAM) because it is a widely used and accepted model in the developing context that has been under-tested under different development conditions. Since the introduction of the TAM by Davis (1989), the empirical evidence and research across hundreds of studies strongly suggest that TAM is a valid framework and reliable predictor of IT adoption (Agrawal, 1999; Davis et al., 1989; Hu et al., 1999; Venkatesh, 1999, 2000). Almost all of this research has been done, however, in the developed world. With its underpinnings anchored in the social psychology theory of reasoned action (Ajzen and Fishbein 1980), TAM theorizes that a person’s intention to adopt a particular IT is guided and determined by two distinct beliefs – perceived ease of use (PeoU) and perceived usefulness (PU). Perceived ease of use is defined as the extent to which a potential IT user perceives or believes that the use of that IT system will be free of effort (Thong et al., 2002). Perceived usefulness in turn is defined as the extent to which a potential IT user believes that the use of that IT system will enhance that user’s job performance (Thong et al., 2002). Further, TAM theorizes that perceived usefulness has a direct and positive affect on perceived intention to use, while perceived ease of use has an indirect and direct positive affect on a user’s intention to adopt an IT, or perceived intention to use. Perceived ease of use directly affects perceived usefulness and, therefore, perceived ease of use both indirectly and directly drives perceived intent to use (Thong et al., 2002). A representation of the TAM model is in Figure 1.

Figure 1. Illustration of the Technology Acceptance Model (TAM)

Although TAM has been widely accepted in IT and information systems technology acceptance research, the original TAM model has been challenged for different reasons and within different contexts. Later research by Venkatesh and Davis (1996) proposed a TAM2 framework which recognizes that perceived usefulness and perceived ease of use are influenced by environmental differences, such as variations in subjective and social norms. The framework provides space for the independent variables that drive perceived ease of use and perceived usefulness. It has benefited from numerous TAM-related studies that have strengthened the findings around TAM, including that perceived usefulness is generally a
much stronger predictor of perceived intent to use than perceived ease of use (Subramanian, 1994).

Consistent with TAM2, later research found that TAM does not always hold across cultures due to cultural differences: Straub et al. conducted one of the first studies of TAM functionality outside of the North American context (1997). They compared performance of the model in Japan and Switzerland with its performance in the United States, all with airline employees using new software in their jobs. They found that the model retained predictive power in Switzerland but did not function well in the Japanese setting. The authors suggested cultural differences as a reason for this cross-cultural differentiation. They note that these differences might involve Hofstede’s (1980) four cultural dimensions (power-distance, uncertainty avoidance, individualism, and masculinity) but they did not attempt to measure any degree of explanatory cultural difference in the study.

While the Straub et al. (1997) study revealed cultural differences in TAM functionality, they didn’t test the model outside of the highly developed world. TAM has also been directly challenged as an appropriate model for developing countries and ICT adoption (Anandarajan et al., 2000). Anandarajan et al. tested the TAM model in technology (in this case, microcomputer) adoption amongst 88 employees at six Nigerian banks. The study found that social pressure was much more important than any other measures, including perceived usefulness and perceived ‘enjoyment’ in their sample. The finding lead them to question the effectiveness of TAM in societies that are more collectively oriented and less individualistic than in most of the highly developed world, and particularly in North America where much of the instrumental TAM research has been based.

Others suggest that perceived ease of use may actually serve as a more robust predictor of technology acceptance in environments in the developing world. Research involving WebCT, for example, found that perceived ease of use was the stronger predictor of intent to use WebCT, not perceived usefulness (Brown, 2002). Specifically, the Brown research concluded that user characteristics of self-efficacy and computer anxiety and technology characteristics of ease of finding and ease of understanding (due to the language of instruction issues) were the main predictors of perceived ease of use, with perceived ease of use serving as the main predictor of perceived intention to use.

As these studies suggest, while the TAM is fairly well accepted in the developed context, there is far from a consensus on whether and how the TAM functions in the developing context. This study aims to advance the literature by further testing the TAM in the developing world. This project also offers a chance to study the TAM in a new context: that of a digital library. As a digital library, TEEAL enjoys some unique IT characteristics beyond more traditional IT that have been the focus of many past TAM research analyses (Hong et al., 2002). In addition to a digital library’s overarching technological differences from a PC, email, or word processing system – namely the collection’s content, the services around the digital library, the architecture of the digital library and its distributed nature - digital libraries also most often serve a community of users involving a large number of diverse users with unique socioeconomic backgrounds and levels of education. Researching digital libraries, contrary to previous assumptions, is a social process involving a high degree of collaboration (Levy and Marshall, 1995). The conclusions of this study, then, are relevant to further research and practice dealing with both digital libraries and IT implementation in developing countries.

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2 WebCT is a course management system enabling fairly complex interactions and collaborations across users involving digital content and communications use in South Africa
3. **RESEARCH QUESTIONS**

3.1 **Perceived Ease of Use**

Many studies of the past decade strongly suggest that perceived ease of use has a significant positive effect on behavioral intent to use, both directly and indirectly (Davis, 1989; Jackson et al., 1997; Venkatesh, 1999; Yi and Hwang, 2003). This study hypothesized that perceived ease of use of TEEAL would have a positive effect on the perceived intent to use TEEAL and the perceived usefulness of TEEAL.

H1a: Perceived ease of use would be a significant predictor of perceived usefulness of using the TEEAL system.

H1b: Perceived ease of use would be a significant predictor of perceived intent to use the TEEAL system.

3.2 **Perceived Usefulness**

As a constituent part of the TAM, perceived usefulness has been demonstrated in numerous previous studies to have a positive effect on the intent to use a digital library (Agarwal and Prasad, 1999; Davis, 1989; Hong et al., 2002; Hu et al., 1999; Jackson et al., 1997). Based on this research, this study hypothesized that perceived usefulness would have a positive effect on the intent to use TEEAL.

H2: Perceived usefulness would be a significant predictor of perceived intent to use TEEAL.

3.3 **TAM Model**

The technology acceptance model (TAM) has been empirically demonstrated to predict the adoption of information technology in a number of different studies, including digital library adoption (Agarwal and Prasad, 1999; Chau, 1996; Davis, 1989; Legris et al., 2003; Thong et al., 2002). This study predicted that perceived ease of use and perceived usefulness together would have a positive effect on intent to use TEEAL.

H3: Perceived ease of use and perceived usefulness will together be significant predictors of perceived intent to use the TEEAL system.

3.4 **External Factors Predicting Perceived Usefulness**

Perceived usefulness is widely considered the main predictor in the TAM, compared to perceived ease of use (see Subramanian, 1994). TAM2 theorizes that external factors are critical to the perceived usefulness and thus the predictive power of the TAM framework (Venkatesh and Davis, 1996).

3.4.1 **Visibility**

Visibility is defined as the degree to which a given system is known within an organization. Further, in the context of TAM, it has been demonstrated that the more a given system is visible to a member in the organization and the more it is visibly used by peers, the more likely the member is to use the technology or system (Karahanna et al., 1999; Thong et al., 2002). Based on these findings, this study expected to find a positive relationship between the degree of Visibility and the perceived usefulness of TEEAL.

3.4.2 **Social Norm**

Social norm is defined as a person’s perception that most people who are important to him think he should or should not perform the behavior in question (Fishbein and Ajzen, 1975). Past studies have found that the social norm (aka subjective norm) has a positive effect on the
intent to use a given technology. This study theorized that social norm would have a positive effect on the perceived usefulness of TEEAL.

### 3.4.3 Domain Knowledge
Domain knowledge is defined as the person’s knowledge of the respective discipline, domain, or area that is relevant to the database search. Past research has demonstrated empirically that persons with a higher level of domain knowledge were able to conduct searches and database queries more efficiently (without error) and more rapidly than novices (Marchionini et al., 1993; Thong et al., 2002). This study postulated that a positive relationship exists between domain knowledge and the perceived usefulness of TEEAL.

### 3.4.4 Trust in Content
Trust in content is defined as the degree of validity attributed by a user to a given database or set of knowledge content. Research relating to online transactions and informational knowledge in databases concludes that the level of trust attributed to a technology and its respective content has a positive relationship to the intent to adopt that technology (McKnight et al., 2002; Pavlou and Gefen, 2004). This study predicted a positive relationship between the trust in content and the perceived usefulness of TEEAL.

### 3.4.5 Relevance
Relevance is defined as the degree to which the information or knowledge can be integrated into the user’s actual work practices or applied to the user’s research areas (Kling and Elliott, 1994; Thong et al., 2002). The concept of relevance is embedded in the user’s performance evaluation of a given information retrieval system, such as a digital library or online database (Schamber et al., 1990; Spink et al., 1998; Wallis and Thom, 1996). This study predicted a positive relationship between a user’s determination of relevance and the perception of TEEAL’s usefulness.

In alignment with research around TAM2 (Venkatesh and Davis, 1996), these external factors were predicted to have a positive effect on the perceived usefulness of TEEAL.

H4: Visibility, social norm, domain knowledge, trust in content, and relevance of content will together be significant predictors of the perceived usefulness of TEEAL.

### 3.5 External Factors Predicting Perceived Ease of Use
In the context of developing countries, previous literature has suggested that perceived ease of use is the stronger predictor of intent to use (Anandarajan, 2000; Brown, 2002), although not enough research has been done to be conclusive. In alignment with research around TAM2 (Davis et al., 1996), this study predicted the following external factors would have a positive effect on the perceived ease of use associated with TEEAL.

#### 3.5.1 Computer Literacy
As a computer dependent system, the TEEAL database of agricultural research content requires at least a rudimentary knowledge of PC usage and related procedures. Several studies indicate that a positive relationship exists between previous computer usage/computer fluency and the adoption of a computer-dependent technology (Atkin and LaRose, 1994; Lin, 1998). Prior experience with the Internet also had a significant impact on the user’s perception of a digital library’s usability or perceived ease of use (Koohang and Ondracek, 2005). This study predicted a positive relationship between computer literacy and the perceived ease of use of the TEEAL system.
3.5.2 Level of Infrastructure
Level of infrastructure is defined as the facilities and services that exist to support a given technology. In the case of TEEAL, these include electricity, a stable computer, and a stable environment not subject to disruptions. Studies have shown that innovation requires a threshold level of infrastructure stability (Leonard-Barton 1987; Leonard-Barton and Deschamps 1988). This study therefore predicted a positive relationship between the level of infrastructure and the perceived ease of use of the TEEAL system.

3.5.3 Librarian Assistance
Studies have shown that the adoption of technology is dependent largely on the support environment around that technology, and the help available from others (Buyukkurt and Vass, 1993; Igbaria, 1994; Westcott, 1985). The availability of such help is a precondition to the perception of a technology’s ease of use. This paper theorized that librarian assistance would have a positive effect on users’ perceptions of the ease of TEEAL usage.

3.5.4 Ease of Access
Ease of access is defined as the degree of ease experienced by a user in locating the TEEAL system. Perceived accessibility was determined to be a major factor in the repeat usage of information sources and technologies (O’Reilly, 1982) and the selection of specific information channels (Hardy, 1982). Thus, we predicted a positive relationship between the degree of ease of access and the perceived ease of use in using TEEAL.

3.5.5 English Literacy
TEEAL is an electronic database of agriculture-related research publications written in the English language. The greater the person’s experience and mastery of the English language, the easier it will be for that person to search and find content sought. Studies have demonstrated that English literacy is directly related to Internet use in China (Du, 1999). This study theorized that a positive relationship exists between English literacy and the perceived ease of using TEEAL.

3.5.6 Self-efficacy
Self-efficacy is defined here as the degree of self-ability to conduct a search on a library database or digital library. Based on social cognitive theory (Bandura, 1977), computer self-efficacy has been demonstrated to influence the usage of a system (Compeau et al., 1999; Hill and Smith, 1987). Prior research has found a positive relationship between computer self-efficacy and general computer usage (Igbaria and Iivari, 1995). Information science and library researchers have noted the impact of computer literacy on increasing usage of information retrieval systems (Jacobson and Fusani, 1992). Based on this research and that of Thong et al. (2002), we theorized that self-efficacy would have a positive relationship to TEEAL’s perceived ease of use.

Based on research with TAM2 (Davis et al., 1986), these external factors were predicted to have a positive effect on the perceived ease of use as the use relates to TEEAL.

H5: Computer literacy, level of infrastructure, librarian assistance, ease of access, English literacy, and self-efficacy will together be significant predictors of TEEAL’s perceived ease of use.

4. Method
4.1 Participants
A TEEAL User Study was conducted in concert with the Mann Library, with financial assistance from the Rockefeller Foundation. As part of this study, surveys were administered
to over 1000 TEEAL users and potential users (current non-users) at 16 institutions in Africa, Latin America, and Asia. These institutions were chosen for participation because they had used the TEEAL program for over 3 years. At each institution, a librarian was in charge of administering the sample to a random selection of library users drawn from those entering the library, including both those who used TEEAL in their research and those who do not. This paper is based on the results of these surveys from two of these institutions: Universidad Nacional Agraria La Molina in Lima, Peru, where 151 surveys were completed; and Egerton University in Njoro, Kenya, where 223 surveys were completed. The response rate was 79%. Two institutions were chosen for analysis so as to allow an in-depth and nuanced examination of the unique elements that can support or derail digital library implementation in diverse locations. These two institutions were chosen for analysis because they represent unique and different environments. La Molina, for instance, has more consistent electricity, and more pervasive and reliable internet access than does Egerton. The samples also naturally represent different social norms and cultural backgrounds.

The final population sample at Egerton University in Kenya consisted of 182 males and 41 females. Fourteen percent of the respondents in this sample were professors, 33% were graduate students, 19% were researchers, and 8% were undergraduates. The population sample at La Molina in Peru consisted of 94 males and 57 females. Twenty-one percent of the respondents in this sample were professors, 33% were graduate students, 5% were researchers, and 27% were undergraduates.

4.2 Measures

Internal reliability was satisfactory for all measures (Cronbach’s α > .70 for each multi-item construct). Table 1 presents the mean summed frequency of scores on the constructs at both Egerton University (Kenya) and Universidad La Molina (Peru).

4.3 Procedure

This study was conducted on a purposive sample of TEEAL users and non-users in the selected institutions. Potential participants were asked by local library staff to take part in a voluntary survey about use of the TEEAL system. Information sheets were also given out along with the survey. If they wished to participate, respondents were asked to fill out an 86 question survey. If respondents were non-users, they were asked to skip particular sections of the survey. Anonymity was assured for participants.

4.4 Analysis

Six regression analyses were conducted on the data from the two agricultural institutions. Three bivariate linear regression analyses and one multiple regression analysis were conducted to measure the applicability of the TAM model to this digital library initiative. These analyses tested the hypotheses that perceived ease of use and perceived usefulness could predict intention to use, both separately and together, as well as the hypothesis that perceived ease of use could predict perceived usefulness. Two more multiple regression analyses were conducted to test the best predictors of perceived ease of use and perceived usefulness.

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3 These may not add up to the same total N due to skipping of questions, rounding of percentages, and answers of “other”.

The Electronic Journal on Information Systems in Developing Countries
http://www.ejisdc.org
Table 1: Descriptive Statistics for All Constructs for Egerton (Kenya) and La Molina (Peru)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Egerton Institute</th>
<th>La Molina</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N)</td>
<td>Mean</td>
</tr>
<tr>
<td><strong>TAM variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Ease of Use</td>
<td>190</td>
<td>8.55</td>
</tr>
<tr>
<td>Perceived Usefulness</td>
<td>174</td>
<td>8.61</td>
</tr>
<tr>
<td>Perceived Intent to Use</td>
<td>191</td>
<td>9.36</td>
</tr>
<tr>
<td><strong>Hypothesized Predictors of Perceived Usefulness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>187</td>
<td>7.15</td>
</tr>
<tr>
<td>Domain Knowledge</td>
<td>189</td>
<td>8.10</td>
</tr>
<tr>
<td>Visibility</td>
<td>189</td>
<td>7.48</td>
</tr>
<tr>
<td>Trust</td>
<td>190</td>
<td>9.09</td>
</tr>
<tr>
<td>Social norm</td>
<td>189</td>
<td>7.88</td>
</tr>
<tr>
<td><strong>Hypothesized Predictors of Perceived Ease of Use</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of Access</td>
<td>183</td>
<td>7.08</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>190</td>
<td>8.46</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>224</td>
<td>5.10</td>
</tr>
<tr>
<td>Librarian assistance</td>
<td>192</td>
<td>8.78</td>
</tr>
<tr>
<td>Computer Literacy</td>
<td>223</td>
<td>3.99</td>
</tr>
<tr>
<td>English Literacy</td>
<td>165</td>
<td>9.45</td>
</tr>
</tbody>
</table>

Note: Scores range from 1 – 10 for all variables except for Computer Literacy, which was measured on a six point scale.

5. RESULTS

Hypothesis 1a: Perceived Ease of Use will be a significant predictor of Perceived Usefulness of the TEEAL system

Stepwise linear regressions evaluating the prediction of Perceived Usefulness from Perceived Ease of Use were conducted separately for the Kenyan and Peruvian respondents, controlling for gender and age. For respondents at the Egerton University site (\(N = 171\)), positive perceptions of TEEAL’s ease of use was a significant predictor of positive perceptions of TEEAL’s usefulness, \(\beta = .52, p < .001\). Approximately 27% \((p < .001)\) of the variance of Perceived Usefulness was accounted for by its linear relationship with perceived Ease of Use for Kenyan respondents. Results at La Molina \((N = 84)\) were similar, \(\beta = .52, p < .001\), with approximately 26% \((p < .001)\) of the variance of Perceived Usefulness accounted for by its linear relationship with Perceived Ease of Use for Peruvian respondents. As hypothesized, respondents at both research sites with more positive perceptions of TEEAL’s ease of use tended to have more positive perceptions of TEEAL’s usefulness.

Hypothesis 1b: Perceived Ease of Use will be a significant predictor of Perceived Intent to Use the TEEAL system

Stepwise linear regressions between Perceived Ease of Use and Perceived Intent to Use TEEAL were conducted separately for the Kenyan and Peruvian respondents, controlling for gender and age. At Egerton University \((N = 186)\), Perceived Ease of Use was a significant predictor of Perceived Intent to Use, \(\beta = .33, p < .001\) with approximately 11% \((p < .001)\) of
the variance in Perceived Intent to Use accounted for by its linear relationship with Perceived Ease of Use. Results at La Molina \((N = 98)\) echoed this relationship, \(\beta = .42, p < .001\). Approximately 16\% \((p < .001)\) of the variance in Intention to Use was accounted for by its linear relationship with Perceived Ease of Use by the Peruvian respondents. These two linear regression analyses indicate that Hypothesis 1b was supported by the data in both Kenya and Peru.

**Hypothesis 2: Perceived Usefulness will be a significant predictor of Perceived Intent to Use TEEAL**

Stepwise linear regressions between Perceived Usefulness and Perceived Intent to Use TEEAL were conducted separately for the Kenyan and Peruvian respondents, controlling for gender and age. At Egerton University, Perceived Usefulness was a significant predictor of Perceived Intent to Use, \(\beta = .60, p < .001\), accounting for approximately 36\%, \((p < .001)\), of the variance in Perceived Intent to Use. This relationship was particularly strong at La Molina, \(\beta = .74, (p < .001)\), where Perceived Usefulness accounted for approximately 55\% \((p < .001)\) of the variance in Perceived Intent to Use. These two analyses indicate strong support for Hypothesis 2 in both research locations.

**Hypothesis 3: Perceived Ease of Use and Perceived Usefulness will together be significant predictors of Perceived Intent to Use the TEEAL system**

Stepwise multiple regression analyses were conducted separately for the Kenyan and Peruvian respondents, controlling for gender and age, At Egerton University \((N = 170)\), the multiple regression model was significant, \(R^2 = .37 (p < .001)\), but Perceived Usefulness was the only significant and strong predictor of Perceived Intent to Use at the Egerton location, \(\beta = .62, p < .001\). Perceived Ease of Use was not a significant predictor of Perceived Intent to Use \(\beta < .01, p = .97\). The regression model was also strong at La Molina \((N = 84)\), \(R^2 = .55, p < .001\), with Perceived Usefulness again the only significant predictor of Perceived Intent to Use, \(\beta = .71, p < .001\). Perceived Ease of Use did not significantly contribute to variance in Perceived Intent to Use when analyzed in a model with Perceived Usefulness, \(\beta = .07, p = .76\). Hypothesis 3, then, was only partially supported by the data in both locations. While both multiple regression models were significant, Perceived Usefulness was shown to be the only significant predictor of Perceived Intent to Use in both research locations.

**Hypothesis 4: Visibility, social norm, Domain Knowledge, trust in content, and Relevance of Content will be significant predictors of the Perceived Usefulness of TEEAL**

Stepwise multiple regression analyses were conducted separately for the Peruvian and Kenyan respondents to evaluate the hypothesized relationships among variables, controlling for gender and age. Table 2 shows the standardized beta weights and significance level for each independent variable, as well as the total variance explained for each significant predictor variable for respondents at both research sites.

Hypothesis 4 was partially supported by the data gathered at both research sites. The multiple regression model derived from the Kenyan data incorporating the hypothesized variables was quite strong, \(R^2 = .62, p < .001\), but Visibility was not a significant predictor of Perceived Usefulness. Relevance was the strongest predictor, accounting for 43\% of the variance in Perceived Usefulness.
The multiple regression model was also strong for the Peruvian data, $R^2 = .66$, $p < .001$, but different predictors were significant. Domain Knowledge and social norm were not significant predictors of Perceived Usefulness while Visibility was a significant predictor. However, Relevance was again shown to be the strongest predictor, accounting for 57% of the variance in Perceived Usefulness.

### Hypothesis 5: Computer Literacy, level of infrastructure, librarian assistance, Ease of Access, English Literacy, and self-efficacy will together be significant predictors of TEEAL’s Perceived Ease of Use.

Stepwise multiple regression analyses were conducted separately for the Peruvian and Kenyan respondents to evaluate the hypothesized relationships among variables, controlling for gender and age. Table 3 shows the standardized coefficient and significance level for each independent variable, as well as the total variance explained for each significant predictor variable for respondents in both research locations.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Egerton</strong> ($N = 167$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>.66***</td>
<td>.50***</td>
<td>.38***</td>
<td>.37***</td>
</tr>
<tr>
<td>Social norm</td>
<td>.36***</td>
<td>.31***</td>
<td>.30***</td>
<td>.26***</td>
</tr>
<tr>
<td>Domain Knowledge</td>
<td>.30***</td>
<td>.26***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust</td>
<td>.16**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>.43***</td>
<td>.53***</td>
<td>.60***</td>
<td>.62**</td>
</tr>
<tr>
<td><strong>La Molina</strong> ($N = 83$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>.76***</td>
<td>.54***</td>
<td>.54***</td>
<td></td>
</tr>
<tr>
<td>Trust</td>
<td>.35***</td>
<td>.33***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visibility</td>
<td></td>
<td>.14*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>.57***</td>
<td>.64***</td>
<td>.66*</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05, ** p < .01, *** p < .001

Excluded variables: Visibility; Gender and Age controlled; Excluded variables: Social norm, Domain Knowledge; Gender and Age controlled.
Table 3: Summary of Stepwise Regression Analyses (Standardized Beta Weights) for Predicting Perceived Ease of Use at Egerton and La Molina

<table>
<thead>
<tr>
<th>Variable</th>
<th>Egerton(^a) (N = 154)</th>
<th>La Molina(^b) (N = 88)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \text{Step 1} )</td>
<td>( \text{Step 2} )</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>.50***</td>
<td>.40***</td>
</tr>
<tr>
<td>Ease of Access</td>
<td>.26**</td>
<td>.26**</td>
</tr>
<tr>
<td>( \text{Adj. } R^2 )</td>
<td>.25***</td>
<td>.30**</td>
</tr>
</tbody>
</table>

\(^a\)Excluded variables: Computer Literacy, infrastructure, librarian assistance, English Literacy; Gender and Age controlled;  
\(^b\)Excluded variables: Computer Literacy, infrastructure, librarian assistance, English Literacy, self-efficacy; Gender controlled.

6. DISCUSSION

The current study examined digital library acceptance in two research institutions in the developing world and produced a number of interesting findings. The major hypotheses of the study were supported. The TAM model appears to work well in describing factors that affect usage of digital libraries in developing countries, with Perceived Usefulness performing over and above Perceived Ease of Use as a significant predictor of Perceived Intent to Use. Along with the general utility of the TAM model, this study uncovered some site-specific or culture-specific findings that suggest the need for a nuanced approach to IT implementation in developing countries, especially for researchers or practitioners guided by the TAM.

6.1 TAM Model: Perceived Usefulness and Perceived Ease of Use

This study found that both perceived usefulness and perceived ease of use predicted perceived intention to use, when examined individually, in accordance with the original TAM (Davis, 1989). Consistent with later research based on the TAM2 updates to the model (Subramanian, 1994), perceived usefulness was the stronger predictor, since it was the only significant predictor of intent to use in both samples when both variables were in the equation. This study, then, adds to the literature supporting both the original model and the updates that TAM2 made to the original model.

Perceived ease of use, however, served as a predictor of intent to use only indirectly, in its function as a predictor of perceived usefulness. This is similar to the findings of Legris et al. (2003), who found perceived ease of use to have both direct and indirect effects on the intent to use a technology. The weaker predictive power of perceived ease of use may have to do with the environment in which we have applied TAM. Prior research involving TAM has been done almost exclusively in the developed world; very little research has been done applying TAM to IT implementation in developing countries. One study that has done so found perceived ease of use to be a predictor of technology adoption superior to perceived usefulness (Brown, 2002), findings opposite ours. While Brown’s study theorized that ‘abstractive’ thinking in South Africa, as in much of the developing world, may have been the cause of this disparity with TAM research in the developed world, other factors may be involved. For example, Brown’s study involved the course management system WebCT and surveyed only student users. In the case of TEEAL and other digital libraries, the primary
user is typically an advanced user with a solid domain knowledge who actively seeks a cause and effect relationship in the texts and other technologies. What is clear above all is that applying TAM to IT implementation in developing countries requires acknowledgement of the diverse conditions in which ITs are used, both between different developing countries and between developed and the developing countries.

6.2 Predictors of Perceived Usefulness

What is particularly interesting in this light is that the predictors of perceived usefulness, the strongest predictor of intent to use in this study, varied depending on research site. Although relevance and trust in content were significant predictors of perceived usefulness at both research locations, there were variations in other significant predictors. At Egerton University only, social norm and domain knowledge were significant predictors, while visibility was significant only at La Molina.

Relevance as a strong and significant predictor in both countries is consistent with the design of the TAM. Perceived usefulness is defined according to the original TAM (Davis, 1989) as ‘the extent to which a potential IT user believes that the use of that IT system will enhance that user’s job performance’ (italics added; Thong et al., 2001). Given that the users of TEEAL are researchers seeking agriculture knowledge, it is likely that TEEAL’s content is directly relevant to the user’s job performance, i.e., the ability to apply agriculture knowledge from TEEAL to research, teaching, or practice involving agriculture. Qualitative data from TEEAL users suggests similar emphasis on relevance: one of the most common complaints of TEEAL non-users and low-users was the absence or poor representation of their specific research areas in the database.

Trust in content was a significant predictor of perceived usefulness in both research locations, although not as strong a predictor as relevance. This result may relate to the prior familiarity users have with a significant portion of the content available in the TEEAL digital library of agricultural content. As researchers in the domain of agriculture, it seems likely that users have significant exposure to the content and therefore have a level of trust built on this previous exposure. In a study by Gefen and Straub (2000), trust was found to be the primary determinant of a customer’s return to a given online or e-vendor in the context of online transactions or e-commerce within the TAM framework. Different from an online transaction which involves the exchange of funds and is therefore objectively high stakes, TEEAL involves content that can be applied or integrated into studies, research, teaching, and real-world projects. Given the high degree of predictive power around relevance and usefulness in the adoption of TEEAL, it is likely that the use of TEEAL and the application of its content

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4 Brown’s study involved the course management system WebCT in South Africa and theorizes that the unique ‘abstractive’ manner of thinking in African culture severs ‘conception from action,’ in contrast to traditional Western culture with its typically associative ‘cause and effect’ thought processes. While respondents in our study at Egerton University in Kenya may fit into Brown’s “African abstractive thinking” model, it is unclear whether respondents from La Molina University in Peru could be described in a similar fashion. Findings from neither Kenya nor Peru supported Brown’s conclusions. Part of the disparity may stem from Brown’s sample; in his study, only student users were surveyed. In our study, students, researchers, and faculty instructors were surveyed. The greater levels of research and world experience of those surveyed in this study versus the Brown study may indicate that Brown’s reasoning behind the prediction power of perceived ease of use is not always valid in developing countries traditionally associated with abstractive thinking. In the case of TEEAL and other digital libraries, the primary user is typically an advanced user with a solid domain knowledge who actively seeks a cause and effect relationship in the texts and other technologies.

5 Both open-ended interviews at a selection of sites and written comments returned along with the questionnaires were collected.
knowledge is comparable to the end goals of users of a high stakes transaction. If true, this finding indicates that TEEAL meets a key requirement (namely: relevance) for returning users and repeat usage longitudinally.

Unlike relevance and trust, social norm and domain knowledge were significant predictors only at Egerton, while visibility was significant only at La Molina. Specific local cultural differences may account for these different patterns, although sample-specific factors also may be involved. For example, in La Molina, there were more undergraduates in the sample than at Egerton, and those undergraduates were younger those at Egerton. Particularly with respect to domain knowledge, this may have been a factor, as shown by post-hoc tests. Sample-specific factors did not account for the social norm results, suggesting that the influence of social norms may in fact be culturally specific, and stronger in Kenya.

The predictive value of visibility at La Molina may be due to the finding that the average level of visibility was significantly lower there than at Egerton. If visibility is generally low, it makes sense that there would be a strong correlation and strong predictive power in the relationship between Visibility and Intent to Use.

6.3 Predictors of Perceived Ease of Use
While perceived ease of use was found to be a weaker predictor than perceived usefulness of intent to use in this study, perceived ease of use still contributed indirectly through its effect on perceived usefulness. With respect to external factors predicting perceived ease of use, only ease of access was a significant predictor in both research locations. Clearly, if access is difficult, using TEEAL will be difficult as well, as borne out by the research literature.

There also were site-specific predictors. For example, self-efficacy predicted perceived ease of use only at Egerton, while the age of respondents was a significant predictor of perceived ease of use only at La Molina. Again, both could be due to cultural differences between the locations, or due to sample- or population-specific differences. The appearance of age in the La Molina regression model, while representing only 8% of the variance, may indicate the importance of age when a sample is heavily skewed towards younger respondents. At La Molina, where more than half of the respondents (57.4%) were

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6 Approximately one third (33.5%) of respondents at La Molina were aged 18 – 24, while an additional 23.9% were aged 25 – 30; almost half of the respondents were under 30 years of age. In the Egerton sample, on the other hand, the 18-24 age group made up only 1% of the overall sample. The reason for this difference in sample age is most likely due to difference in the population from which the sample was taken. Qualitative research data from Egerton University suggests that the low appearance of respondents under 24 years of age in the sample - and the low appearance of undergraduates - is reflective of the TEEAL-using population at that institution. At Egerton University, TEEAL is housed in a library used almost exclusively by graduate students and professors. Therefore, the population from which this sample was taken (potential and current TEEAL users, which here means members of the university community in contact with this particular library) contains very few undergraduates or young people.

7 Post-hoc ANOVAs, analyzing variance in Domain Knowledge by position and by research location found statistically significant variance in Domain Knowledge by position, \(F(7, 270) = 2.87, p < .01\). The effect was due to the significantly lower levels \((p < .01)\) of Domain Knowledge for Undergraduates \((M = 6.78, SD = 1.68)\) than for graduate students \((M = 7.95, SD = 1.94)\) and professors \((M = 8.28, SD = .1.53)\). Since the sample in Peru had significantly more undergraduate respondents (27.1%) than did the Kenyan sample (8.4%), it is not surprising that some different predictors were found.

8 A post-hoc ANOVA analyzing variance in Visibility by position and by research location found statistically significant variance by position, \(F (1, 270) = 7.80, p < .01\). The mean responses at La Molina \((M = 5.6, SD = 2.00)\) were significantly lower than responses at Egerton \((M = 7.48, SD = 2.30)\).
30 years of age or younger, those younger respondents found TEEAL to be more difficult to use. In the Egerton sample, on the other hand, where the 18-24 age group made up only 1% of the overall sample, age was negatively related to ease of use, the opposite finding of the La Molina sample. In the context of this older sample, then, the predictive power of age disappeared. Further research on the effect of age on perceived ease of use in a variety of samples is needed.

Sample-specific factors also may have contributed to the predictive power of self-efficacy in the Egerton sample. Post-hoc ANOVAs revealed that self-efficacy varied significantly by position, with undergraduates reporting significantly lower self-efficacy scores than professors or researchers, $F(7, 271) = 3.01, p < .01^9$. Since the La Molina sample had significantly more undergraduate respondents (28.4%) than did the Egerton sample (8.4%), it is not surprising that this had an effect on the prediction equation.

6.3.1 English Literacy
A final point to address is why English Literacy was not a strong predictor of Perceived Ease of Use at either research site. It would seem intuitive that proficiency in the English language would predict how easily one perceives the usage of a digital library containing articles written primarily in English. Furthermore, at least one previous study found English Literacy to affect technology use in China, regarding internet use (Du, 1999). In the current study, it may be that since English Literacy was so high for Egerton respondents ($M = 9.45, SD = .76$), residents of an English-speaking nation, it had no predictive value.

At La Molina, however, although responses to the English Literacy index were more varied ($M = 6.10, SD = 1.84$), this variable may simply pale in comparison to ease of access in predicting perceived ease of use for this site. English Literacy and Perceived Ease of Use were in fact significantly correlated at La Molina, but the effect size was low to moderate, $R^2 = .36, p < .01$, and was overshadowed in the regression model. It is also possible that respondents with lower levels of English Literacy may be less likely to use TEEAL, and therefore more likely to skip the portions of the survey that constitute perceived ease of use and other indices.

6.4 Future Research and Policy Implications
This study has found the TAM model to be of use in predicting technology acceptance in developing countries, with perceived usefulness more predictive than perceived ease of use with respect to intent to use. We have also found particular predictors of perceived usefulness and perceived ease of use that are consistent across cultures (relevance, trust, and ease of access), while other constructs (social norm, domain knowledge, visibility, and self-efficacy) demonstrated predictive power in only one setting. This study cannot definitively address what causes differences in predictive power between sites. Future research is needed to address whether such differences result from cultural, institutional, or sample-specific differences. What is clear, however, is that application of the TAM to IT implementation in developing countries must be guided more by the specificities of local circumstances than by the performance of the TAM in highly-developed countries.

The policy implications from this study are fundamental and rich with possibilities for future longitudinal research. The most basic finding is that perceived usefulness is the main predictor of the intent to use TEEAL, with relevance as the major constituent driver of perceived usefulness. As such, digital library support persons, administrators, and

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9 This effect was due to the significantly lower scores for feelings of self-efficacy by undergraduates ($M = 7.14, SD = 2.08$) than by graduate students ($M = 8.34, SD = 1.62$) and professors ($M = 8.69, SD = 1.45$).
coordinators should consider the active promotion of digital libraries in terms of their relevance and direct applicability to their user base: researchers, instructors, and students. Likely, this recommendation carries over to most digital library providers in developing (and developed) countries and adoption will increase if the usefulness is explicitly and specifically communicated to the particular user base and its unique profile.

A less obvious recommendation centers around the consistent importance of trust as a determinant of TEEAL’s repeat usage amongst its users. A set of users who share a common set of practices around a given process or technology have been described as ‘communities of practice’ (Lave and Wenger, 1991). A community of practice, or CoP, in the context of IT adoption and specifically digital library use has been demonstrated in numerous studies to be a critical factor in building a user’s trust in that technology and in the success of professional development around that process (Brown and Duguid, 2000; Chalmers and Keown, 2006; Levy and Marshal, 1995). Given the collaborative and social nature of research around a digital library (Bishop et al., 2003; Levy and Marshal, 1995), the two consistent predictors of perceived usefulness - relevance and trust - indicate that digital library users might benefit from a community of practice around the digital library in order to share in the specific practices relating to the content, the system, and the specific application of the digital library content for research, teaching, and real-world integration into agricultural practices.

BIBLIOGRAPHY


