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## Research Article

# Determinants of Geographic Information Technologies Intention and Adoption and Mozambique Institutions' Perspectives

<sup>1,2</sup>Nelson Amade, <sup>2</sup>Marco Painho and <sup>2</sup>Tiago Oliveira

<sup>1</sup>Universidade Católica de Moçambique (UCM), Beira, Moçambique, 1070 312 Lisboa, Portugal

<sup>2</sup>NOVA Information Management School (NOVAIMS), 1070 312 Lisboa, Portugal

## Abstract

**Background and Objective:** Many determinant factors are behind the adoption of geographic information technologies (GIT). In that sense institutions must evaluate and analyze these factors before deciding to operate with these technologies. The study seeks to investigate the drivers behind the adoption of GIT at two stages (intention and adoption) applied to a Mozambique context. **Materials and Methods:** Data were collected from 110 institutions belonging to Mozambique institutions. The data were analyzed by employing partial least square (PLS) and relevant hypotheses were derived and tested. The research model was estimated using Smart PLS 2.0 M3 software. **Results:** The results suggested that technology competence, security, competitive pressure are important drivers to explain the intention to adopt GIT. Financial concerns, government policies, donor pressure and intention to adopt are important drivers to explain adoption of GIT. The donor pressure is the only driver that is statistically significant in both intention and adoption of GIT. **Conclusion:** The findings offer valuable insights to managerial and decision makers in institutions. The combination of three theories, diffusion of innovation theory, technology organization and environment framework and the policy context add value to the research in a holistic approach.

**Key words:** Geographic information technology, adoption, technology organization, holistic approach, diffusion of innovation

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**Corresponding Author:** Nelson Amade, Universidade Católica de Moçambique (UCM), Beira, Moçambique, PhD candidate in NOVA Information Management School, 1070 312 Lisboa, Portugal Tel: (+258) 848042749

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**Data Availability:** All relevant data are within the paper and its supporting information files.

## **INTRODUCTION**

In recent decades institutions have become more open to opportunities that technologies are proposing and for that, many institutions around the world are adopting different types of technologies to improve efficiency, flexibility and offer security. Among the most exciting technologies developed, geographic information technologies (GIT) have gained attention based on their ability to support decision makers and provide the right tools for institutions to accomplish their goals<sup>1</sup>.

The introduction of new technology approaches in Mozambique such as GIT started recently and the government policies behind their implementation are still to be refined and disseminated<sup>2-6</sup>. Currently, the use of these technologies in institutions claims to be more targeting to competitiveness, donor imposition, need to find new opportunities to maximize efforts and increase the possibilities to reach the goals. For these reasons, it is important to understand the drivers behind the adoption of GIT. Some studies analyze GIT from the institutions' perspective<sup>7-15</sup> and some of these are of a qualitative nature and rely on technology use rather than adoption<sup>16-18</sup>. The reasons prompting institutions to adopt GIT differ from context to context and include factors such as the ability to have a disaster risk management system, improvements in education methods, competitive pressure, donor pressure, innovation, security, improvements in health system approaches, customer satisfaction and natural resources management<sup>7,13-15,19-26</sup>. To the best of the authors' knowledge, no published study has conducted a holistic evaluation of the stages that lead Mozambican institutions to adopt GIT (from intention to adopt GIT and GIT adoption).

Therefore, the literature suggests that an understanding of the African continent and the concept of GIT<sup>1</sup> may be a useful starting point for studying the drivers behind the adoption of these technologies in one of the African countries (Mozambique).

The African continent can be described by its size, natural resources and rapid population growth. Issues related to spatial planning and resources management become vital to the prosperity of the continent. Studies and initiatives (improvement of drought mitigation, planning rural water supply systems, tracing the spatial variation of diseases, determining and predicting electrical conductivity in soils, examining map geoservation areas and water resources and creating a geodatabase, among others)<sup>7,27-32</sup> involving government, private sector, non-governmental organizations

(NGOs) and donor pressure have been undertaken in various African countries involving the adoption and use of GIT as decision support tools.

The GIT can be described as all types of computer platforms and computer systems used in processing georeferenced information. These technologies include geographic information systems (GIS), desktop mapping systems, remote sensing systems (RSS), global positioning systems (GPS), as well as a vast range of hybrid platforms and sub-systems related to geographic information processing<sup>1</sup>.

Overtime, these technologies began to be introduced in Mozambique through institutions supported by the public policy approved in 2000 that encourages and proactively promotes the use of information and communication technology (ICT)<sup>3-6</sup> and through donor pressure.

The present research combines features of two models (diffusion of innovation (DOI) theory<sup>33-36</sup> and technology organization and environment (TOE) framework<sup>37,38</sup>) and the policy context, resulting in an integrated framework to explaining the drivers behind the GIT adoption. The DOI theory seeks to explain how new ideas spread through a social system<sup>39</sup> (institutions in the process of adopting a new technology face complex problems based on their organizational structure, which accommodates and aggregates a group of individuals with a set of procedures and norms). TOE framework explain show innovation processes occur in institutions. Therefore, this study presents an analysis of the drivers behind the adoption of GIT for a specific Mozambique institutions context.

## **MATERIALS AND METHODS**

Pilot interviews were conducted with 30 institutions in Mozambique in 2015, in order to test the questionnaire (accessibility of the questions, structure). The sample was assembled through a random drawing of institutions from public, private and non-government-organizations. The final sample included 110 institutions and the data were collected from people in those institutions operating with these technologies.

The proposed research model (Fig. 1) results from a combination of DOI theory, TOE framework and policy context. The policy context is introduced as a third element in order to enrich and explain the model, in light of the consideration that the variables donor pressure and government policies seem to be playing a key role in motivating organizations to adopt new technologies.

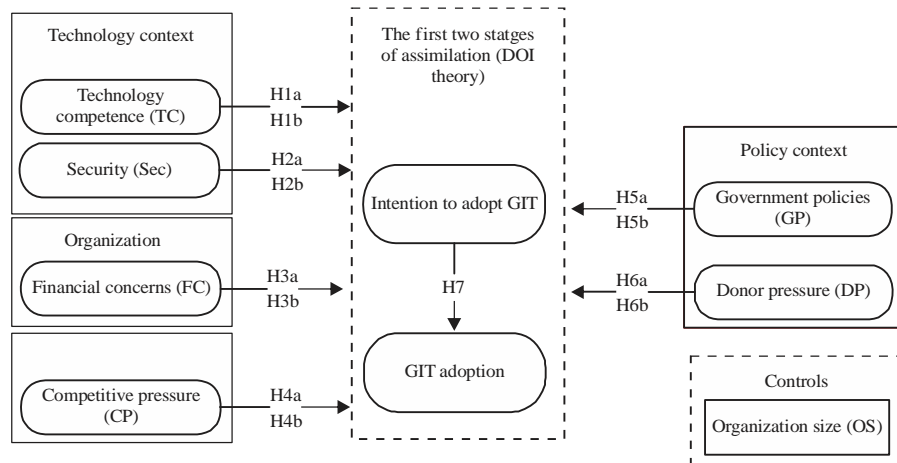


Fig. 1: A proposed research model of GIT

**Hypotheses on technology:** The technology context refers to the technological environment available in an institution including the assets. It includes the specialized human resources, infrastructure and all of the working procedures. Specialized human resources of an institution are all of the people that have the skills, knowledge and expertise to operate with the equipment (GIT)<sup>38,40,41</sup>. Hence, the technology competence strongly influences the intention and the adoption of GIT.

H1: Technology competence will positively influence GIT intention (H1a) and adoption (H1b).

In the technology context, security is considered the priority to the institution's well-being. A security leak is an incident in which the institution loses its information, personel records and/or sensitive data<sup>42</sup>. The lack of appropriate tools to deal with data in a secure and efficient way will discourage an institution to adopt GIT. Adopting these technologies will bring new initiatives toward data security to deal with the new data in a secure way. Hence, security is a significant driver.

H2: Security fears will negatively influence intention to adopt GIT (H2a) and GIT adoption (H2b).

**Hypotheses on organization:** The organization context refers to the resources available to support the adoption of an innovation<sup>43-47</sup>. It refers to the ability of the institution to accept or refuse the adoption and implementation of an innovation. Good financial balance in an institution can contribute to the decision about implementing GIT.

Hence, financial concerns will determine the way that GIT will or will not be adopted.

H3: Financial concerns will positively influence GIT intention (H3a) and adoption (H3b).

**Hypotheses on environment:** Competitive pressure is recognized as an adoption motivator and driver in the innovation adoption literature<sup>48</sup>. Adopting new technologies is a wise decision that institutions can consider when dealing with market pressure. Adopting GIT, institutions can obtain greater advantages, new procedures, flexibility, improving production and response time to market needs. Hence, competitive pressure will help institutions to improve their standards.

H4: Competitive pressure will positively influence GIT intention (H4a) and adoption (H4b).

**Hypotheses on policy:** Government policies in general refer to a group of policies that drive the procedures related to technology adoption. The authority and the vision of the government encourage institutions to implement a technology and continue innovating. When government supports and motivates a specific approach to GIT, institutions will be more willing to adopt GIT<sup>3,5,6</sup>. Hence, government policies will motivate institutions to introduce new technologies approaches.

H5: Government policies will positively influence GIT intention (H5a) and adoption (H5b).

As in many African countries, Mozambique's economic activities are financially supported by international organizations and developed countries' aid programs<sup>49,50</sup>. Many of these programs have technology requirements for implementation, including in some cases of GIT. It is thus reasonable to expect donor pressure to have an impact on the use of GIT in organizations.

H6: Donor pressure will positively influence intention to adopt GIT (H6a) and GIT adoption (H6b).

**Hypotheses on DOI:** The technology acceptance model addresses the way new technologies are faced according to users' perceptions within a working environment and hypothesizes that beliefs influence attitudes leading to intentions<sup>51</sup>. Institutions having the intention to adopt GIT will multiply the possibilities for technology adoption, hence,

H7: Intention to adopt will positively influence GIT adoption.

**Data collection:** To evaluate the theoretical constructs in a questionnaire and apply that evaluation to the target group of Mozambican institutions, the research followed several steps. First, the questionnaire was created in English and revised by a group of university staff. As the questionnaire was administered in Mozambique, where the formal language is Portuguese, it was then translated from English to Portuguese with support of university staff. To ensure the accuracy of the translations, a professional translator was asked to translate from English to Portuguese and vice-versa. The questionnaire items were created based on published studies (Appendix A) and the authors' motivation. All constructs were measured using a seven-point scale ranging from "strongly disagree" to "strongly agree". To test the instrument, a pilot study involving 30 organizations was conducted in Mozambique and the results showed that the scales, the approach and the translation were effective.

#### Appendix A

Constructs	Measurement items	Source
Technology competence	TC1: The technology infrastructure of my company is available to support GIT* TC2: My company is dedicated to ensuring employees are familiar with GIT TC3: My company has good knowledge of GIT TC4: My company has a GIT training program	Chan and Chong <sup>35</sup>
Security (Sec)	How do you perceive the risk that ... Sec1: The confidentiality and security of your business data are not guaranteed when adopting GIT solutions? Sec2: In case of damage, present liability law is still unclear about who will bear the damage? Sec3: The GIT provider will exploit contractual loopholes (i.e., incomplete contracting) to the detriment of your company?	Benlian and Hess <sup>52</sup>
Financial concerns (FC)	FC1: The organization has a certain amount of money to invest in GIT. (1-Strongly disagree, 7-Strongly agree,...) FC2: GIT operating budget as percent of total budget (#) FC3: Percentage of GIT operating budget supported by other institutions (i.e. donor) (#)*	Zhu <i>et al.</i> <sup>33</sup>
Competitive pressure (CP)	CP1-Our organization thinks that GIT has an influence on competition in their field of activity CP2-Our organization is under pressure from competitors to adopt GIT CP3: Some of our competitors have already started using GIT	Oliveira <i>et al.</i> <sup>45</sup>
Government policies (GP)	GP1: The government has a policy on technology adoption GP2: The government policies are implemented and followed GP3: My organization is under the government policies GP4: Technology adoption is one of the government pillars	IST-Africa Consortium <sup>6</sup>
Donor pressure (DP) (i.e., World bank, USAID)	DP1: Donors encourage implementation of GIT DP2: Donors recommend implementation of GIT DP3: Donors require implementation of GIT DP4: Donors keep the organization innovating	IST-Africa Consortium <sup>6</sup> and Stubbs <i>et al.</i> <sup>49</sup>
Intention to adopt GIT	GITi1: My company intends to use GIT if possible GITi2: My company collects information about GIT with the possible intention of using it GITi3: My company has conducted a pilot test to evaluate GIT	Chan and Chong <sup>35</sup>
GIT adoption	GITa1: My company invests resources to adopt GIT GITa2: Business activities in our company require the use of GIT GITa3: Functional areas in my company require the use of GIT	Chan and Chong <sup>35</sup>

Table 1: Mozambique institutions questionnaire results (early and late respondents and testing possible biases)

Constructs	Early respondents (n = 82)		Late respondents (n = 28)		Kolmogorov-Smirnov test
	Mean	SD	Mean	SD	
Technology competence (TC)	3.816	1.856	3.611	1.803	0.603
Security (Sec)	3.875	1.486	4.362	1.474	0.179
Financial concerns (FC)	4.966	2.988	4.887	3.505	0.818
Competitive pressure (CP)	3.995	1.494	3.822	1.762	0.584
Government policies (GP)	4.541	1.504	4.805	1.559	0.346
Donor pressure (DP)	4.435	1.732	4.325	1.843	0.818
GIT initiation (GITi)	4.796	1.432	4.473	1.765	0.624
GIT adoption (GITa)	4.469	1.738	4.255	1.732	0.782

Table 2: Sample characteristics (n = 110) of industry and organization size

Industry	n (sample size)	Percentage
Agriculture	13	12
Environment	10	9
Trade	1	1
Construction	4	4
Education	28	25
ICT	7	6
Industrial production	1	1
Economic development	8	7
Natural resources	8	7
Services	4	4
Health	9	8
Transport and communications	4	4
Other	13	12
<b>Organization size (number of employees)</b>		
Micro (1-9)	11	10
Small (10-49)	35	32
Medium (50-249)	42	38
Large (> 250)	22	20

The questionnaire was implemented online. An email containing a complete explanation of the research purpose and relevance was then sent to Mozambican public, private and NGO organizations. The institutions' details including the contact persons were obtained from the yellow pages of Mozambique, official government websites and persons working in this area. To increase content validity, an explanation of GIT was included in the questionnaire to enable individuals who were not familiar with the topic to answer the questionnaire. To increase response rate, all respondents were invited to provide their email addresses to have the opportunity to receive the findings of the study. The data were analyzed by employing partial least square (PLS) and relevant hypotheses were derived and tested.

Data were collected during the second semester of 2015. A total of 110 valid responses (82 early respondents and 28 late respondents) were obtained by the end of the period from a universe of approximately 2000 organizations. Non-response was attributed to diverse issues, including invalid email addresses, inbox full, lack of updated emails and lack of appropriate persons to respond to the questionnaire, among others.

**Statistical analysis:** The Kolmogorov-Smirnov (K-S) test was used to compare the sample distributions of the two groups (early and late respondents)<sup>53</sup>. The information reported in Table 1, indicates that the sample distribution of the two groups did not differ significantly, pointing to an absence of non-response bias. The common method bias was examined using Harman's one-factor test. It reveals that the first factor explains 32.8% of the variance, i.e., none of the factors had variance more than the 50% threshold value. Consequently the common method bias was not a serious concern. The results of the study were obtained through the variance-based technique, using partial least square (PLS) because: (i) Some of the items in our data are not distributed normally ( $p < 0.01$  based on Kolmogorov-Smirnov test), (ii) The research model has not been tested before and (iii) PLS estimation requires 10 times the largest number of structural paths directed at a particular construct in the structural model<sup>50</sup>. The sample meets the requirements for using PLS. The research model was estimated using Smart PLS 2.0 M3 software<sup>51</sup>.

The profiles of the sample and size of responding organization are shown in Table 2.

## RESULTS AND DISCUSSION

The measurement model was analyzed first in order to assess reliability and validity, followed by the structural model.

**Measurement model:** The results of the measurement model are shown in Table 3 and 4, including the construct reliability, convergent validity, indicator reliability and discriminant validity. The construct reliability was tested using the composite reliability coefficient, which is greater than 0.7<sup>50</sup>. Furthermore, the indicator reliability was evaluated taking into consideration that the loadings should be greater than 0.7<sup>51,53</sup>. As seen in Table 3, the loadings are greater than 0.7, indicating good indicator reliability. To test the convergent validity, the average variance extracted (AVE) should be greater than 0.5<sup>54</sup>. The discriminant validity of the constructs was assessed using

Table 3: Sample results-PLS loadings and cross-loadings

Construct	Items	TC	Sec	FC	CP	GP	DP	GiTi	GiTa
Technology competence (TC) (CR = 0.910)	TC2	0.891	0.310	0.553	0.501	0.254	0.343	0.519	0.557
	TC3	0.898	0.287	0.495	0.436	0.177	0.320	0.527	0.523
	TC4	0.846	0.253	0.447	0.386	0.204	0.267	0.422	0.442
Security (Sec) (CR = 0.837)	Sec1	0.371	0.717	0.159	0.216	0.128	0.177	0.225	0.156
	Sec2	0.297	0.883	0.247	0.281	0.066	0.204	0.371	0.261
	Sec3	0.102	0.777	0.112	0.028	-0.029	0.144	0.280	0.093
Financial concerns (FC) (CR = 0.855)	FC1	0.579	0.234	0.923	0.637	0.408	0.414	0.505	0.636
	FC2	0.376	0.148	0.802	0.504	0.239	0.228	0.254	0.460
Competitive pressure (CP) (CR = 0.883)	CP1	0.484	0.132	0.597	0.813	0.382	0.403	0.427	0.523
	CP2	0.417	0.290	0.615	0.899	0.381	0.426	0.527	0.540
	CP3	0.394	0.170	0.499	0.823	0.380	0.339	0.491	0.501
	CP4	0.335	0.166	0.433	0.690	0.298	0.364	0.280	0.298
Government policies (GP) (CR = 0.895)	GP1	0.135	0.041	0.372	0.327	0.785	0.276	0.177	0.080
	GP2	0.205	-0.054	0.287	0.369	0.814	0.182	0.223	0.155
	GP3	0.159	0.137	0.230	0.313	0.782	0.305	0.289	0.175
	GP4	0.262	0.072	0.405	0.444	0.912	0.418	0.317	0.293
Donor pressure (DP) (CR = 0.930)	DP1	0.312	0.196	0.425	0.490	0.364	0.936	0.545	0.502
	DP2	0.333	0.219	0.392	0.428	0.285	0.951	0.558	0.513
	DP3	0.413	0.230	0.367	0.475	0.371	0.920	0.553	0.517
	DP4	0.136	0.112	0.112	0.190	0.306	0.673	0.382	0.233
GIT initiation (GiTi) (CR = 0.834)	GiTi1	0.351	0.195	0.267	0.439	0.362	0.502	0.758	0.479
	GiTi2	0.496	0.429	0.439	0.450	0.236	0.528	0.904	0.626
	GiTi3	0.490	0.250	0.394	0.423	0.166	0.354	0.702	0.423
GIT adoption (GiTa) (CR = 0.889)	GiTa1	0.674	0.144	0.710	0.626	0.264	0.504	0.606	0.848
	GiTa2	0.343	0.187	0.392	0.432	0.093	0.362	0.515	0.837
	GiTa3	0.390	0.275	0.483	0.401	0.215	0.437	0.522	0.873

Table 4: Descriptive statistics, correlations and AVE of the sample

Construct	Mean	S.D.	TC	Sec	FC	CP	GP	DP	GiTi	GiTa
Technology competence (TC)	3.763	1.836	0.878*							
Security (Sec)	3.999	1.492	0.324	0.795*						
Financial concerns (FC)	4.946	3.111	0.571	0.229	0.864*					
Competitive pressure (CP)	3.951	1.560	0.505	0.237	0.668	0.810*				
Government policies (GP)	4.608	1.515	0.241	0.069	0.390	0.447	0.825*			
Donor pressure (DP)	4.407	1.753	0.355	0.222	0.390	0.470	0.375	0.878*		
GIT initiation (GiTi)	4.714	1.521	0.561	0.379	0.465	0.549	0.320	0.587	0.793*	
GIT adoption (GiTa)	4.414	1.731	0.581	0.229	0.648	0.591	0.236	0.521	0.651	0.853*

\*: The square root of the average variance extracted (AVE)

two criteria: Cross-loadings and the Fornell-Larcker criterion. For the cross-loading criterion the loadings of each construct should be higher than all cross-loadings<sup>50,53</sup>. To meet this criterion we eliminated 2 items (TC1 and FC3). Table 4 reports that the diagonal values (square root of AVE) are greater than off-diagonal values (correlation between constructs). Both criteria were therefore met, providing evidence of discriminant validity of the scales.

Table 3 and 4 report that construct reliability, convergent validity, indicator reliability and discriminant validity are satisfactory, recommending that the constructs are reliable and that it is feasible to test the research model.

**Structural model:** Assessing the results of the model, the path significance levels were estimated using bootstrap with 5000 resamples. The  $R^2$  criterion<sup>50</sup> is used to assess the

predictive capacity of the structural model and is the essential criterion for assessing the quality of the model. Examination of  $R^2$  (Fig. 2) shows that the model explains 54.4% of the variation in intention to adopt GIT and explains 62.3% of the variation in GIT adoption. This reveals that the conceptual model can be considered as substantial.

The analysis results can be summarized as follows. Technology competence (TC) ( $\beta = 0.270$ ,  $p < 0.01$ ), security (Sec) ( $\beta = 0.147$ ,  $p < 0.10$ ) and competitive pressure ( $\beta = 0.203$ ,  $p < 0.10$ ) are statistically significant in explaining intention to adopt GIT, thus confirming hypotheses H1a, H2a and, H4a. Financial concerns (FC) ( $\beta = 0.347$ ,  $p < 0.01$ ), government policies (GP) ( $\beta = -0.145$ ,  $p < 0.1$ ) and intention ( $\beta = 0.320$ ,  $p < 0.01$ ) are statistically significant in explaining the adoption of GIT, thus confirming hypotheses H3b, H5b and H7. Donor pressure (DP) ( $H6a = 0.367$ ,  $p < 0.01$  and



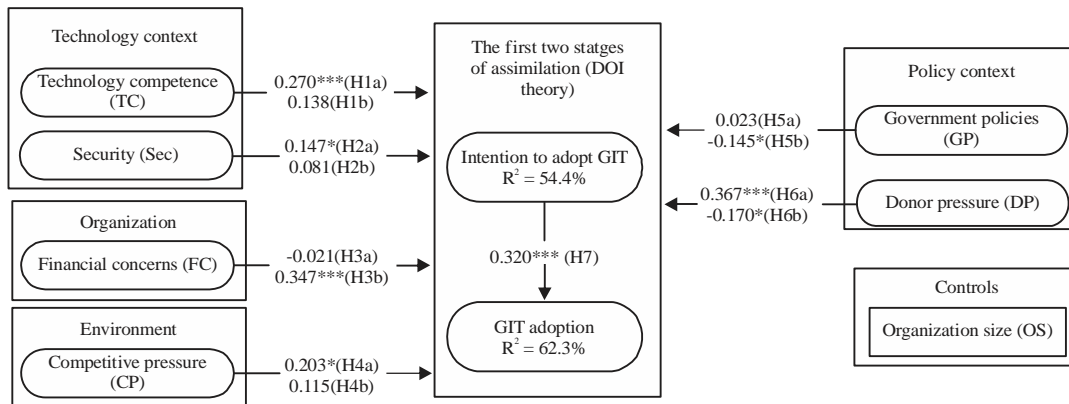


Fig. 2: Structural model results of research model for GIT in Mozambique context \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

H6b = 0.170,  $p < 0.1$ ) is statistically significant and is the only construct that explains both intention to adopt GIT and GIT adoption, thereby confirming hypotheses H6a and H6b. The model explains 54.4% of the variation in intention to adopt GIT and 62.3% of the variation in the GIT adoption.

The purpose of this paper was to understand the determinants that explain GIT in two stages of adoption (intention and adoption) in a Mozambique context. The empirical results generally support the model. The subsequent discussion into theoretical and managerial implications.

**Theoretical implications:** The study brings a threefold contribution: A new context, a new model and new findings.

While there are many theoretical studies of GIT, few of these have focuses on understanding the determinants behind GIT adoption in Mozambique.

With regard to a new model, the study builds upon the DOI theory<sup>39</sup> with a focus on decision stages. The study combined the DOI with the TOE<sup>38,40,41,48,54</sup> and added a new feature to the TOE framework, the policy context, which includes government policies and donor pressure. The model proposes that technology competence, security, financial concerns, competitive pressure, government policies, donor pressure and intention are determinants in explaining intention to adopt GIT in institutions. To the best of the authors' knowledge, this study is the first that seeks to understand the drivers behind the adoption of GIT in the Mozambique context using a research model that combines DOI theory, TOE framework and policy context as new input for the study.

Regarding new findings, the results show that technology competence, security, competitive pressure and donor pressure are important drivers to explain the intention to adopt GIT and that financial concerns, government policies,

donor pressure and intention are important drivers to explain actual adoption of GIT. The results reveal that to better understand GIT adoption it is convenient to estimate a model for a specific domain. This is one of the first efforts to provide concrete empirical support for the theories of GIT adoption in a specific context.

**Managerial implications:** Recognizing and understanding the determinants that lead institutions to adopt GIT will allow managers to make wise strategic decisions to expand their business and gain perceived benefits of adopting GIT, while at the same time identifying further training needs that may overcome barriers to strategic development. Based on the results of the study, managers will be able to set priorities regarding implementation of GIT in institutions. It should be emphasized that in the particular case of Mozambique the funding, restrictions and rules imposed by donor organizations will to a great extent determine the intention to adopt GIT and GIT adoption itself<sup>55</sup>. This creates a very special business environment in which the relationship between institution and client is greatly affected by a third party, the donor.

Government policies could encourage the adoption of these technologies, reducing the barriers to these initiatives and promoting feasible technology infrastructure and technical support for institutions.

## CONCLUSION

Understanding the determinants that leading Mozambique institutions to adopt GIT is crucial in a way that these technologies are spreading all over the country. Financial concerns, government policies and donor pressure mostly explain adoption of GIT. The donor pressure proved to



be the only construct that explains both intention to adopt GIT and the adoption of GIT. It would be interesting to have a future study that analyzes in depth the role of these variables as drivers of the adoption of these technologies.

### **SIGNIFICANCE STATEMENTS**

This study examines the drivers behind the adoption of GIT through a combination of three theories that can be beneficial for a specific Mozambique context. This study discovers that the donor pressure is the only construct that explains both intention to adopt GIT and the adoption of GIT. The study reveals that the most important constructs in explaining intention to adopt GIT are technology competence, security, competitive pressure and donor pressure. Thus, new theories can be combining to explain the drivers that leading institutions to keep using GIT at post adoption stage.

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