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Extended contextual validation of stakeholder approach to firm technology adoption: moderating and mediating relationships in an innovation eco-system

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Abstract

Purpose – The need for context-specific adoption models led to the development of the firm technology adoption model (F-TAM) model. Among small to medium-scale enterprises (SMEs); however, firm-level factors were rather insignificant in engendering SME level adoption of technological innovation. This study aims to examine the effect of firm size and other moderating and mediating factors on the relationships between personal, firm, societal and technological factors proposed in the stakeholder-oriented F-TAM among SMEs.

Design/methodology/approach – A research instrument was developed, reviewed by experts, and pilot tested with a sample of 25 respondents. Data were purposively collected from four hundred (400) SMEs and analyzed with partial least squares structural equation modeling (PLS-SEM).

Findings – The study discovered that employees, societal and technological factors moderate the relationship between firm factors of adoption and firm adoption. Without these moderating effects, firm factors of adoption would have been insignificant at the SMEs' level of organizational technology adoption. The study further discovered that firm size, as well as risk propensity, also affect the relationships proposed in the model.

Research limitations/implications – Data was collected on voluntary adoption from the most cosmopolitan area of a developing country. It, therefore, needs further contextual validation across the country and different countries.

Practical implications – The engagement of innovations in firms must be planned with employees and society as major stakeholders.

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Originality/value – The significance of this finding is the study's emphasis on an eco-system approach for examining the phenomenon of innovation adoption. To the best of the authors' knowledge, this study is the first to examine the effect of firm characteristics on is proposed eco-system of stakeholders.

Keywords F-tam, Innovation, Stakeholders eco-system, SMEs

Paper type Research paper

1. Introduction

The engagement of innovative solutions for sustainable business performance continues to be at the forefront of academic and industrial discourse. Such discussions have been in the areas of social innovation (Ahmed *et al.*, 2018), grassroots innovations (Parwez and Chandra Shekar, 2019), relational innovation (Pauget and Dammak, 2018) and eco innovations (Nicolai and Faucheux, 2015), among others. New digital technology innovations that are frequently adopted among SMEs for business marketing and strategic use include social media (Rigby, 2011) and mobile technologies (Ahmad, 2018). The engagement of these digital innovations has often been to achieve some sustainability (Bouglet *et al.*, 2012).

On a global scale, ongoing scholarly works regarding these digital technologies include studies on their adoption or rejection (Raffaelli *et al.*, 2019), late adoption (Jahanmir and Cavadas, 2018) and adoption effect on performance (Ferreira *et al.*, 2019). Although it is becoming common knowledge that the stakeholder approach to business solutions is more sustainable (Bouglet *et al.*, 2012), an obvious omission in the literature on the discussions around these innovations is the role of different stakeholders in any adoption unit (Doe *et al.*, 2017).

In Sub-Saharan Africa, the adoption of mobile technologies has generated industry and academic interest, with emphasis on antecedents (Maduku *et al.*, 2016), dimensions and trends (Attopley, 2016), impact and effects (James, 2016), policies for wider diffusion (Tagoe, 2016) a financial instrument (Soutter *et al.*, 2019), a tool for good governance (Asongu *et al.*, 2019), financial inclusion (Machasio, 2020) models of adoption (Doe *et al.*, 2018) and the contribution of their adoption to economic development (Asongu and Asongu, 2018). The focus on mobile innovations, particularly mobile money, is due to the realization that the adoption of mobile phones and their associated innovations defy the arguably slow rate of technology adoption in African countries (Doe *et al.*, 2017).

Given the varying results realized when earlier models were tested in the context of a developing country (Datta, 2011), which is largely due to significant differences between the structure of returns from innovation-related capital investments (Dewan and Kraemer, 2000), and the levels of human capital development and economic freedom (Owusu-Agyei *et al.*, 2020), the need for a context-specific model became imperative. This need led to the development of the firm technology adoption model (F-TAM) (Doe *et al.*, 2018). This model highlights the role played by different adoption units (Rogers, 1962), as stakeholders, in firm-level adoption. The model also treats the relationships between these levels of adoption (stakeholders), in addition to the technology itself, as an eco-system. Thus, the ecosystem of firm technology adoption, according to Doe *et al.* (2018), comprises of personal level factors, firm-level factors (internal and external), societal level factors and the technology (innovation) being adopted. The results for the statistical validation of the model (Doe *et al.*, 2019) challenged some propositions made in earlier models, such as the culture policy and technology framework, perceived electronic readiness model (PERM) and TOE models that raised issues for further debate.

Although employee factors lead to firm adoption, the firm-level factors of adoption do not. On the other hand, societal factors do not lead to firm adoption if employee factors do not mediate them; this is an observation that is worth investigating thoroughly.

Perhaps, an unexpected discovery made by the study is that technology characteristics do not necessarily influence employee factors, which partly challenges Rogers' (1962) diffusion theory. Another unanticipated relationship found was that technology characteristics led to firm adoption, which affirms Rogers' (1962) proposition.

The conflicting results of Doe *et al.* (2019) study raise further contextual issues worth being analyzed. For instance, how do technology characteristics lead to firm adoption when is it insignificant in influencing both employee factors and firm factors? Would the results be different if the sizes of firms were bigger, as reported a few decades ago by Kimberly and Evanisko (1981), because larger firms are more formalized than smaller firms? What other roles do the technological characteristics play in the suggested eco-system of firm adoption? This study, therefore, is an extension of an earlier study that validated the F-TAM model. Hence, it addresses the following research questions:

RQ1. Does the size of a firm affect the relationships posited in F-TAM?

RQ2. Do personal and societal factors moderate the relationships of F-TAM?

RQ3. How do the technological characteristics influence the suggested eco-system of adoption?

2. Literature review

2.1 Innovation

Innovation is the creation, adoption and use of any idea, material artifact, product, technology or process that is new to those adopting it (Gupta *et al.*, 2007). Innovations that are enabled by digital technologies, such as mobile phones and mobile money, are referred to as digital innovation (Yoo *et al.*, 2010) and are often disruptive (Christensen and Raynor, 2003).

2.2 Study context

Developing countries have low to middle income ($0–$3,255 per capita income), low growth rates and lack the domestic savings required to finance investments into growth enablers (Bannock *et al.*, 1992) such as technology. Per this description, Ghana is a developing country. The Ministry of Trade has categorized small to medium-scale enterprises (SMEs) in Ghana under micro-enterprises, which refers to organizations that use between 1 and 5 persons with total assets of less than $10,000; small enterprises, which use between 6 and 29 people with total assets of less than $100,000; and medium enterprises, which are organizations that use between 30 and 99 people with total assets of up to $1m (Mensah, 2004). The significance of this context for the study is that the digital divide, invariably a poverty gap (Zachary, 2002), is a noticeable phenomenon (Falch, 2004). The adoption of any technology is generally slow, which has triggered both industry and academic interest about what makes an innovation diffuse with ease in such a context.

2.3 Sustainable development

Sustainable development is defined as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report, 1987). For the discussion here, sustainable development (adoption) is operationalized as the adoption of innovations for business performance that seek to uphold the interest of all stakeholders such as the firm, customers, employees, government and society, both now and in the future. Sustainable development was previously seen as having an opposing interest to the basic business interest of innovation and profit but has been gaining momentum in business strategies over the past few decades (Bouglet *et al.*, 2012). This is due to the realization that with the firm's economic interest (profit through exchanges), the societal interest (ensuring access to healthcare, education, as well as good working conditions) and environmental interest (protecting biodiversity and natural resources) are best achieved if it is done with the stakeholder approach (Roscoe *et al.*, 2020). This sustainable development of an organization can also be achieved through the adoption of technological innovation (Yuan and Zhang, 2020). This view has been confirmed in a study of 75 low to middle-income countries (Omri, 2020).

Internal drivers of sustainability include reducing costs and waste while improving process efficiencies, boosting innovation and innovative practices, attracting and retaining more compliant employees and improving internal processes, amongst others. Literature has shown that these internal triggers can be achieved with the adoption of digital innovations (Doe *et al.*, 2019). External triggers of sustainability include improved customer satisfaction, improved relations with regulators, ethical behavior, improved access to the market and trust among others. These have also been shown to be achievable through the adoption of digital innovations (Doe, 2021). Therefore, to activate both internal and external sources of sustainability, the firm stakeholders become integral triggers

2.4 Stakeholder theory

The stakeholder theory (Freeman, 1984) opines that various individuals, groups and institutions interest affected by the existence of a phenomenon and are interested in sustainable solutions to the same. A stakeholder, as defined by Freeman (1984), is "any group or individual that can affect or is affected by the achievement of an organization's objectives." Their interest, therefore, must be factored into the development of any sustainable solution to the phenomenon (Atif, 2019) to avoid the pitfall of implementing sustainability strategies that render sustainable development an elusive goal (Gauthier, 2017).

As to who qualifies as potential or actual stakeholders, Mitchell *et al.* (1997) noted that firm stakeholders include persons, institutions, groups, organizations, society and even neighborhoods and the environment (Mitchell *et al.*, 1997). Comprehensive reviews of stakeholder definitions have been done by scholars such as Laplume *et al.* (2008), Miles (2011) and Miles (2017). These authors noted how various authors include the "environment" as a stakeholder in firm sustainable engagements. (Benn *et al.*, 2016). The F-TAM model operationalizes the stakeholders of firm technology adoption as the employees, customers, business partners and society. These are persons or institutions that can be seen and engaged in a tangible manner.

Stakeholders have been classified into primary and secondary stakeholders. Primary stakeholders, according to Clarkson (1995, p. 106), are the people or institutions whose continued participation is needed for the firm to survive as a going concern. These include employees, customers, suppliers and the general public (e.g. government and any policy, infrastructure, regulatory and enforcement agency). Indeed Mitchell *et al.* (1997) argue that primary stakeholders hold power that influences managerial decisions. Clarkson (1995, p. 107) classifies secondary stakeholders as persons "who influence or affect, or are influenced or affected by" the organization, but that their engagement is not necessary for the organizations survival. Examples include competitors, media, trade associations and special interest groups. Clarkson (1995) noted, however, that while there is no contractual or transactional relationship with these groups, they can cause significant disruption to the firm due to their influence on customers, the industry in which the firm operates and shaping opinions (Clarkson, 1995). The F-TAM model classifies employees, the firm dynamics (internal and industry) and society as primary stakeholder groups, as shown in the model. Competitor actions (secondary stakeholder); however, captured under "industry factors" due to the influence of competitive actions on the nature and scope of an industry as a whole, as suggested by Clarkson (1995).

Bhatt and Singh (2020) emphasize the need to identify these actors and their interactions to facilitate an understanding of factors that facilitate or impede the adoption of a technology by a firm with an actor-network model. The influence of these stakeholders on each other in the firm adoption of technology and the context within which these stakeholder influences impact the whole eco-system of adoption is, therefore, worth examining. For instance, for bigger firms, there are contextual differences in structure and availability of more firm-level resources than in smaller firms. Does this contextual difference of the firm as a stakeholder impact the relationships in the eco-system of the stakeholders? This gap is a knowledge gap that has been unexplored and is examined in this study.

2.5 Adoption theories

At the personal level, the theory of reasoned action (Fishbein and Ajzen, 1975), theory of planned behavior (Ajzen, 1985) and decomposed theory of planned behavior (Taylor and Todd, 1995) have been used to study the adoption of innovations in general. When innovation is technology-related, the integrated model of technology acceptance (Venkatesh *et al.*, 2002), TAM (Venkatesh and Bala, 2008), unified theory of acceptance and use of Technology 1 and 2 (Venkatesh *et al.*, 2012) and dynamic use diffusion model (Shinh *et al.*, 2013) are used in studying it. The culture, policy and technology framework (Bajaj and Leonard, 2004) is used to study the societal adoption of technology. At the organizational level, the technology, organization and environment framework (TOE) (Tornatzky *et al.*, 1990), task-technology fit (TTF) (Goodhue and Thompson, 1995) and PERM (Molla and Licker, 2005) are used in studying organizational adoption. However, none of these models examines the effect of the connection between the different levels of adoption.

A new model that challenges the general orientation of positing the intention to adopt and fixing developing countries' contextual arguments is the F-TAM (Doe *et al.*, 2018). A contextual validation of the F-TAM (Doe *et al.*, 2019) recorded some relationships that affirm findings by earlier models and different relationships that demonstrate the significance of stakeholders and challenge the outcomes of other models. These reported relationships, in addition to other contextual issues, are explored below:

H1. Personal (employee) level factors lead to firm adoption.

This partly affirms the basis of the TOE framework (Tornatzky *et al.*, 1990), in which employee factors were lumped together with other organizational factors to influence firm adoption:

H2. Personal level factors lead to firm factors.

This is a relationship suggested by Rosli *et al.* (2012) and particularly implied in the TOE framework, where it was lumped together with firm factors. This links employee personal factors and other firm factors in Seet *et al.* (2020):

H3. Societal level factors influence personal level factors, as implied in Jahanmir and Cavadas (2018), and

H4. Influence firm-level factors.

A view reported by Kimberly and Evanisko (1981) and strongly proposed in a stakeholders approach to firm strategic moves by Bhatt and Singh (2020). However, societal factors do not necessarily lead to firm adoption, contrary to the relationship proposed in the TOE framework (Tornatzky *et al.*, 1990) and the PERM (Molla and Licker, 2005):

H5. Technological characteristics influence societal-level factors.

H6. Drive firm adoption.

Which affirms the assertions of Rogers' (1995) diffusion theory, but they do not influence employee factors or firm-level factors directly.

The insignificance of firm factors on firm adoption or any of the other categories of factors (Doe *et al.*, 2019) challenges the major position of other models (TOE, TTF and PERM), which suggests that firm factors of adoption, mostly indicated as firm readiness to adopt, will lead to adoption. If the F-TAM had put employee factors as part of firm factors, perhaps its results would have been the same and diminished the significance of employee factors. This apparent insignificance of firm factors leads to an examination of other moderation and mediation factors.

Doe *et al.* (2019) posit:

H7. That societal factors probably moderate the relationship between firm factors and firm adoption.

H7. While personal level factors possibly moderate the relationship between firm factors and firm adoption.

Again,

H9. The technological characteristics are suspected of moderating (strengthen) the relationship between firm factors and firm adoption.

These proposed effects, which were not anticipated in earlier models, are inevitable if firm-level factors are to remain relevant in the eco-system of firm adoption. Following the findings of Kimberly and Evanisko (1981), we investigate whether:

H10. The size of firm moderates the relationships F-TAM proposes.

In Doe *et al.* (2019):

H11. Personal level factors are suggested to probably mediate the relationship between societal level factors and firm adoption

H12. Finally, we investigate whether societal factors fully mediate the link between technological characteristics and firm-level factors.

H12. Whether societal factors fully mediate between technological characteristics and personal level factors.

If these assumptions are proven, they would be novel discoveries concerning the relationship between personal, firm and societal level factors, which would, in effect, make this study an extension of the validated F-TAM.

3. Methodology

Question Items in the research instrument were either adapted from relevant studies or crafted and taken through the evaluation process. Authors checked for the length of the question and grammar, simplicity, social desirability, double-barreled questions as well as and question order (Leeux *et al.*, 2008). Furthermore, the instrument was pilot tested with a sample size of 25 respondents. The pilot test sample of 25 samples was chosen as a middle ground between various pilot study sample size suggestions of 15 to 35 (Fowler, 1995), 25 to 75 (Converse and Presser, 1986), 10 to 25 (Sheatsley, 1983) and 20 to 50 (Sudman, 1983). The Cronbach's alpha values obtained from the pilot test were firm adoption (0.836), personal factors (0.874), firm internal factors (0.942), firm external factors (0.927), societal factors (0.937) and technological factors (0.901) (Nunnally and Bernstein, 1978). The instrument was therefore found to be valid and reliable in testing SMEs for the F-TAM of technology adoption at the firm level. Due to the unavailability of a sample frame, four hundred (400) SMEs were purposively sampled from the Greater Accra Region of Ghana, as the authors focused only on firms that had adopted mobile money technology. The significance of collecting data from this context (SMEs in Ghana) is that the digital divide invariably a poverty gap, which is a noticeable phenomenon among SMEs in developing countries (Doe *et al.*, 2017). Thus, the adoption of any technology is generally slow, which has triggered both industry and academic interest in what makes an innovation diffuse with ease and sustainably in such a context (Maduku *et al.*, 2016; Attopley, 2016; James, 2016; Tagoe, 2016; Soutter *et al.*, 2019; Asongu *et al.*, 2019; Machasio, 2020; Doe *et al.*, 2018). Therefore, data from a developing country context for this model is relevant.

There are over 635,695 SMEs in Ghana, with approximately 175,920 of them in Greater Accra alone (Ghana Statistical Service, 2017). Either way, an adequate sample size would be 384, using Yamane (1967) formula. Thus, 400 SMEs are representative. The sample size also meets the criteria proposed by Barclay *et al.* (1995) for analysis purposes, using partial least squares structural equation modeling (PLS-SEM). They propose 10 times the number of structural paths directed at a particular construct in the inner model. In this case, firm adoption had the highest number of predictors – 25; therefore, the minimum sample is 250.

PLS-SEM; SmartPLS Release: 3.2.7 (Ringle *et al.*, 2005) was used for the data analysis. Hair *et al.* (2019) argued that PLS-SEM is the appropriate tool to use when the analysis is concerned with testing a theoretical framework from a prediction perspective; the structural model is complex and includes many constructs, indicators and/or model relationships; the path model includes one or more formatively measured constructs; when distribution issues are a concern, such as lack of normality; and when research requires latent variable scores for follow-up analyses. These conditions are all present in this study.

Except for firm adoption, other constructs were measured reflectively because the individual items were similar and correlated well, such that the deletion of some items did not significantly affect the definition of the construct. The underlying construct and model indicators are suggested and have positive and desirably high intercorrelations (Coltman *et al.*, 2008).

4. Data analysis

4.1 Descriptive statistics

Twenty-six primary constructs were examined in this study and are shown in Table 1.

All 26 variables had a mean of approximately 4 (agreed) except one variable under personal factors and one other variable under internal factors. All measurement constructs were statistically significant at $p < 0.01$ (or $p < 0.05$). That is, the *t*-values were all greater

Constructs	Mean	SD	t	p
Firm level adoption of MoMo innovations	4.082	0.497	43.498	0.00***
Perceived ease of use	4.001	0.547	36.597	0.00***
Perceived usefulness	3.875	0.616	28.388	0.00***
Perceived indispensability	3.315	0.833	7.564	0.00***
Perceived social influences	3.636	0.768	16.552	0.00***
Trial feedback	3.785	0.620	25.332	0.00***
Employee self interest/self enhancement motives	3.571	0.770	14.825	0.00***
Technological readiness	3.733	0.728	20.116	0.00***
Managerial innovativeness	3.813	0.663	24.515	0.00***
Organizational readiness	3.821	0.630	26.055	0.00***
Strategic fit with operations	3.778	0.693	22.464	0.00***
Ease of support	3.477	0.837	11.401	0.00***
Organizational culture (firm propensity to take risk)	3.749	0.711	21.073	0.00***
Organizational partner requirement	3.751	0.683	22.004	0.00***
Competitive pressure	3.698	0.687	20.321	0.00***
Needs of customers	3.705	0.659	21.396	0.00***
Government championship	3.698	0.701	19.890	0.00***
Government policy	3.558	0.665	16.756	0.00***
Government regulation/laws	3.668	0.697	19.144	0.00***
Innovation infrastructure	3.911	0.689	26.456	0.00***
Opinion leadership	3.711	0.662	21.478	0.00***
Successive government commitment	3.695	0.649	21.427	0.00***
Flexibility	3.924	0.619	29.877	0.00***
Observability	3.828	0.651	25.430	0.00***
Complexity	3.600	0.679	17.683	0.00***
Relative advantage	3.843	0.672	25.090	0.00***

Note: ***Significant at $p < 0.01$

Table 1. Descriptive statistics for all constructs ($N = 400$)

than 1.96 using a 0.05 level of significance (Hair *et al.*, 2016). Therefore, all the attributes identified in this study are applicable to SMEs in Ghana. Refer to Figure A4 (Appendix A1) for demographic details of samples (Table 2).

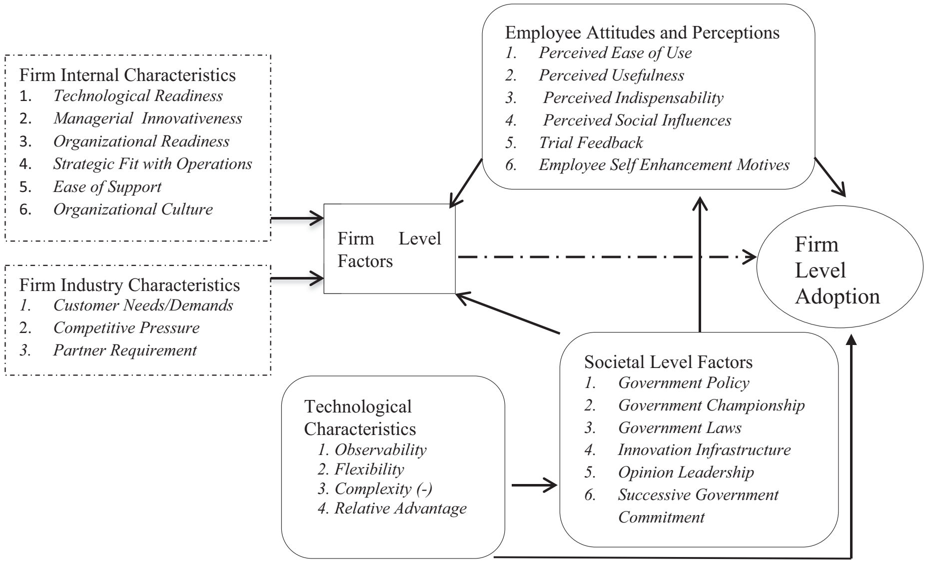
The Bivariate correlations analysis was used to examine the relationship between the 26 constructs of the study without controlling them; it showed that the correlations between the constructs were all positive and mostly significant.

4.2 Data suitability/quality test

The nonresponse bias, common method variance (CMV) bias, sample size adequacy and the normality test are essential for SEM.

4.2.1 Nonresponse bias. Data were collected under conditions of anonymity with a high response rate (95%) (Ledden *et al.*, 2011). We compared the mean values of the questionnaire scale items between early respondents and late respondents and found no significant difference between the two categories (Lings and Greenley, 2010). Therefore, nonresponse bias was not a problem encountered with this data.

4.2.2 Common method variance bias. To test for CMV, Harman (1967) recommends exploratory factor analysis (EFA) with the extraction of only factors with less than 50%. EFA was conducted on the data with the extraction of only one factor, which shows that the factor accounts for 23.9% variance. Hence, CMV bias was not found in this data.



Source: Doe *et al.* (2019)

Figure 1.
Revised firm technology adoption model

4.2.3 Sample size adequacy. The 400 responses obtained from the SME survey meet the PLS analysis recommendation proposed by Barclay *et al.* (1995). They propose 10 times the number of items in the most complex construct or 10 times the number of structural paths directed at a particular construct in the inner model. In either scenario, the sample size of 400 is adequate for PLS-SEM.

4.2.4 Normality diagnostics. Normality tests of skewness, kurtosis, Kolmogorov–Smirnov tests and Shapiro–Wilk test were done. Thirty-two items in the questionnaire scale had kurtosis $> \pm 1.0$, whereas 17 items had skewness $> \pm 1.0$. Kolmogorov–Smirnov tests for normality showed $0.222 < \alpha < 0.329$; $p < 0.01$ for all items. Also, Shapiro–Wilk test of normality showed $0.776 < W < 0.895$; $p < 0.01$ for all items. These results imply that the data violate multivariate normality assumptions, consequently affirming the appropriateness of PLS-SEM usage.

4.3 Measurement model analysis

In the measurement of PLS model analysis, firm adoption was modeled as a formative construct (instead of reflective) due to the different strategies used by the SMEs. Furthermore, three items, "CO2", "CO3" and "CO4", were reverse coded for consistency with the other items under technological characteristics. All 25 lower-level constructs in the model were measured as reflective constructs.

4.4 Analysis of constructs

We analyzed the convergent and discriminant validity of the reflective constructs (Hair *et al.*, 2016).

Table 2. Discriminant validity of reflective constructs (square root of AVEs in diagonal-bold) – Fornel and Larcker criterion

Constructs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1 Firm Level Adoption	***NA***																									
2 Perceived Ease of Use	0.37	***0.75***																								
3 Perceived Usefulness	0.41	0.37	***0.76***																							
4 Perceived Indispensability	0.29	0.22	0.33	***0.75***																						
5 Perceived Social Influences	0.17	0.15	0.24	0.50	***0.77***																					
6 Trial Feedback	0.22	0.25	0.24	0.36	0.42	***0.77***																				
7 Employee Self Interest	0.36	0.18	0.41	0.51	0.47	0.45	***0.75***																			
8 Technological Readiness	0.25	0.15	0.24	0.46	0.46	0.44	0.52	***0.74***																		
9 Managerial Innovativeness	0.17	0.17	0.16	0.36	0.42	0.44	0.46	0.48	***0.74***																	
10 Org. Readiness	0.28	0.18	0.23	0.43	0.44	0.52	0.51	0.58	0.44	***0.77***																
11 Strategic Fit with Ops.	0.25	0.20	0.23	0.41	0.51	0.56	0.54	0.50	0.50	0.57	***0.75***															
12 Ease of Support	0.30	0.22	0.35	0.49	0.41	0.30	0.54	0.45	0.32	0.41	0.43	***0.79***														
13 Organizational Culture	0.30	0.24	0.30	0.37	0.36	0.31	0.43	0.43	0.46	0.39	0.44	0.46	***0.72***													
14 Org. Partner Requirement	0.19	0.09	0.24	0.47	0.49	0.35	0.47	0.49	0.38	0.47	0.43	0.59	0.49	***0.77***												
15 Competitive Pressure	0.18	0.15	0.27	0.41	0.45	0.43	0.52	0.43	0.43	0.47	0.51	0.42	0.47	0.48	***0.76***											
16 Needs of Customers	0.23	0.19	0.26	0.44	0.41	0.34	0.39	0.39	0.39	0.38	0.40	0.43	0.51	0.54	0.55	***0.75***										
17 Govt. Championship	0.13	0.21	0.18	0.46	0.46	0.41	0.40	0.35	0.43	0.35	0.43	0.41	0.46	0.51	0.47	0.47	***0.75***									
18 Government Policy	0.26	0.20	0.23	0.37	0.43	0.28	0.32	0.39	0.34	0.30	0.29	0.41	0.36	0.35	0.37	0.43	0.41	***0.75***								
19 Govt. Regulation/Laws	0.34	0.23	0.28	0.35	0.39	0.40	0.43	0.29	0.34	0.40	0.44	0.34	0.39	0.28	0.40	0.43	0.33	0.55	***0.74***							
20 Innovation Infrastructure	0.15	0.19	0.11	0.19	0.26	0.26	0.20	0.29	0.27	0.28	0.25	0.19	0.27	0.26	0.32	0.38	0.32	0.45	0.52	***0.78***						
21 Opinion Leadership	0.17	0.08	0.24	0.34	0.44	0.24	0.37	0.38	0.31	0.39	0.41	0.46	0.39	0.52	0.46	0.50	0.46	0.55	0.46	0.47	***0.71***					
22 Successive Govt Commit.	0.21	0.19	0.15	0.33	0.47	0.42	0.37	0.36	0.46	0.38	0.49	0.30	0.42	0.39	0.53	0.46	0.54	0.50	0.51	0.53	0.58	***0.81***				
23 Flexibility	0.18	0.21	0.20	0.21	0.32	0.32	0.20	0.19	0.18	0.25	0.29	0.22	0.29	0.23	0.36	0.39	0.45	0.42	0.38	0.51	0.45	0.53	***0.76***			
24 Observability	0.18	0.16	0.17	0.26	0.41	0.43	0.26	0.26	0.31	0.37	0.48	0.36	0.37	0.41	0.47	0.45	0.47	0.43	0.45	0.46	0.50	0.58	0.60	***0.79***		
25 Complexity	−0.12	−0.21	−0.23	−0.34	−0.45	−0.36	−0.38	−0.36	−0.32	−0.35	−0.45	−0.41	−0.39	−0.48	−0.48	−0.39	−0.38	−0.33	−0.37	−0.34	−0.47	−0.46	−0.31	−0.44	***0.79***	
26 Relative Advantage	0.33	0.28	0.28	0.33	0.40	0.42	0.46	0.33	0.38	0.41	0.43	0.42	0.42	0.44	0.51	0.48	0.50	0.46	0.50	0.47	0.44	0.58	0.49	0.57	−0.48	***0.77***

Note: All correlations are positive and mostly significant

4.4.1 Convergent validity. For convergent validity, Hair *et al.* (2016) recommend a minimum Cronbach's alpha of 0.6 for an exploratory study, as well as minimum composite reliability and average variance extracted (AVE) estimates of 0.7 and 0.5, respectively. Also, Chin (2010) recommends that each of the item loadings of the reflective constructs should be $x \geq 0.60$ (Table A2).

In this regard, initial loadings showed that three out of 23 items were below 0.60 for personal factors, two out of 24 items loaded below 0.60 for firm internal factors, two out of 14 items loaded below 0.60 for firm external factors, two out of 27 items loaded below 0.60 for societal factors and four out of 16 items loaded below 0.60 for technological characteristics. All items with loadings below 0.60 were delete, and the model was re-run to obtain acceptable loadings (Hair *et al.*, 2016). See Table A2 (Appendix 1) for details.

4.4.2 Discriminant validity assessments. Discriminant validity could be done using the Fornell–Larcker criterion, item cross-loadings and Heterotrait–Monotrait ratio (HTMT) criterion (Hair *et al.*, 2016). However, Henseler *et al.* (2016) contend that cross-loadings of indicators explain 0% of discriminant validity while Fornell–Larcker and HTMT criterions explained 20.82% and 97%–99% of discriminant validity, respectively. We, therefore, examined the discriminant validity of reflective constructs using the Fornell–Larcker and HTMT criteria.

4.4.3 Discriminant validity – Fornell–Larcker criterion. From Table 3, the square root of the AVE estimate for each of the 25 reflective constructs is greater than the inter-construct correlations between them (Fornell and Larcker, 1981). Thus, each construct is distinct and differs from the other measurement constructs. Hence, discriminant validity has been met.

4.4.4 Discriminant validity – Heterotrait–Monotrait ratio. Although Henseler *et al.* (2016) provided three HTMT criteria; HTMT specificity ratio of 0.90, HTMT specificity ratio of 0.85 and HTMT inference score ranging from -1 to 1 ($-1 < \text{HTMT} < 1$) as an indication of distinctiveness, they argued that HTMT0.85 is the most conservative criterion, HTMT inference is the most liberal while HTMT0.9 lies in between the two extreme categories. We adopted the 0.9 ($\text{HTMT}_{0.9}$) for assessing the discriminant validity (Teo *et al.*, 2008) and found that none of the correlations exceeded 0.9 (refer to Table 3); therefore, confirming the discriminant validity of the 25 reflective constructs in the model.

4.5 Testing for multicollinearity of formative scale measure – firm adoption of mobile money innovations

The multicollinearity test for formative indicators (items), recommended by authors like Hair *et al.* (2014), was conducted on the five items under firm adoption of mobile money innovations construct. An examination of the variance inflation factors (VIF) indicated that multicollinearity does not exist because all items had VIF < 5, as shown in Table 4.

4.6 Structural equation modeling

4.6.1 Analysis of structural model. Because the structural model involved second level constructs, they were modeled as a second-order formative construct with six first-order reflective indicators (personal factors), nine first-order reflective indicators (firm-level factors), six first-order reflective indicators (societal factors) and six first-order reflective indicators (technological characteristics) (Hair *et al.*, 2016). A correlation matrix of the five high-level constructs (Table 5) shows a significant (strong) positive correlation between all constructs ($p < 0.01$ in all cases).

The result of the structural model following the application of PLS-SEM shown in Figure 2 presents the regression weights, and variance explained in the endogenous constructs based on the study's conceptual framework.

Constructs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1. Firm Level Adoption	NA																								
2. Perceived Ease of Use																									
3. Perceived Usefulness		0.58																							
4. Perceived Indispensability		0.31	0.48																						
5. Perceived Social Influences		0.19	0.33	0.71																					
6. Trial Feedback		0.39	0.35	0.54	0.58																				
7. Employee Self Interest		0.26	0.59	0.69	0.68	0.67																			
8. Technological Readiness		0.21	0.34	0.62	0.64	0.67	0.70																		
9. Managerial Innovativeness		0.28	0.25	0.54	0.64	0.78	0.69	0.77																	
10. Org. Readiness		0.25	0.35	0.63	0.63	0.80	0.74	0.86	0.73																
11. Strategic Fit with Ops.		0.29	0.33	0.57	0.70	0.82	0.74	0.69	0.78	0.85															
12. Ease of Support		0.31	0.48	0.63	0.61	0.44	0.72	0.60	0.46	0.59	0.58														
13. Organizational Culture		0.36	0.41	0.51	0.58	0.52	0.63	0.63	0.78	0.59	0.65	0.64													
14. Org. Partner Requirement		0.15	0.36	0.67	0.73	0.57	0.70	0.73	0.68	0.74	0.66	0.83	0.80												
15. Competitive Pressure		0.23	0.42	0.60	0.65	0.68	0.75	0.63	0.70	0.73	0.74	0.63	0.75	0.79											
16. Needs of Customers		0.31	0.41	0.66	0.62	0.52	0.58	0.59	0.66	0.60	0.60	0.63	0.81	0.89	0.89										
17. Govt. Championship		0.27	0.28	0.64	0.65	0.57	0.56	0.50	0.67	0.54	0.59	0.62	0.70	0.81	0.69	0.70									
18. Government Policy		0.29	0.36	0.57	0.66	0.45	0.49	0.58	0.58	0.49	0.47	0.63	0.56	0.63	0.62	0.70	0.63								
19. Govt. Regulation/Laws		0.35	0.47	0.51	0.57	0.63	0.64	0.42	0.58	0.61	0.65	0.48	0.61	0.49	0.63	0.68	0.51	0.88							
20. Innovation Infrastructure		0.31	0.19	0.28	0.35	0.38	0.27	0.41	0.44	0.39	0.36	0.28	0.47	0.43	0.48	0.58	0.42	0.70	0.80						
21. Opinion Leadership		0.17	0.35	0.49	0.67	0.39	0.52	0.55	0.55	0.60	0.60	0.65	0.62	0.82	0.75	0.77	0.72	0.89	0.69	0.71					
22. Successive Govt Commit.		0.27	0.21	0.45	0.62	0.63	0.51	0.51	0.78	0.56	0.69	0.43	0.66	0.63	0.78	0.69	0.70	0.74	0.76	0.73	0.86				
23. Flexibility		0.31	0.31	0.31	0.41	0.47	0.30	0.30	0.35	0.37	0.42	0.32	0.51	0.40	0.57	0.62	0.59	0.65	0.62	0.77	0.72	0.74			
24. Observability		0.25	0.24	0.37	0.56	0.66	0.41	0.41	0.56	0.56	0.71	0.49	0.61	0.66	0.72	0.68	0.66	0.66	0.69	0.65	0.77	0.82	0.88		
25. Complexity		0.34	0.32	0.47	0.63	0.54	0.53	0.51	0.54	0.55	0.64	0.56	0.60	0.73	0.74	0.60	0.60	0.57	0.56	0.52	0.71	0.68	0.47	0.68	
26. Relative Advantage		0.43	0.43	0.46	0.55	0.64	0.66	0.49	0.65	0.63	0.65	0.60	0.68	0.72	0.79	0.76	0.70	0.73	0.80	0.70	0.71	0.85	0.75	0.84	0.74

Note: HTMT 0.9 criteria showing that all correlations are less than 0.9 (Henseler *et al.*, 2016)

Table 3. Discriminant validity of reflective constructs – Heterotrait–Monotrait ratio (HTMT) criterion

Before concluding a structural model, Hair *et al.* (2014) recommend assessing the structural model for collinearity issues as well as assessing the path co-efficient, level of *R*-squared (R^2), size of *f*-square (f^2) and predictive relevance of *Q*-square (Q^2).

4.6.2 Assessment of the structural model for collinearity issues. Collinearity was tested using the VIF (Hair *et al.*, 2014). From Table 6, all the VIFs were lower than five. Therefore, the five high level-constructs models do not present a collinearity problem.

4.6.3 Assessment of path coefficients. Regression weights were used to assess the path coefficients and bootstrap *t*-values to determine the significance of hypothesized structural paths (Tortosa *et al.*, 2009). The bootstrap *t*-values performed using 5,000 sub-samples (Tortosa *et al.*, 2009) showed that six of the nine hypothesized direct paths were statistically significant (that is $t > 1.96$) (two-tailed test) (Table 7).

The hypotheses test results in Table 7 above confirm that, in the context of the study, *H1* – personal level factors lead to firm adoption ($\beta = 0.480$, $t = 4.900$, $p < 0.01$); *H2* – personal level factors lead to firm factors ($\beta = 0.524$, $t = 12.19$, $p < 0.01$); *H3* – societal level factors influence personal level factors ($\beta = 0.646$, $t = 14.265$, $p < 0.01$); *H4* – societal level factors influence firm-level factors ($\beta = 0.410$, $t = 7.633$, $p < 0.01$); *H5* – technological characteristics influence societal factors ($\beta = 0.592$, $t = 14.660$, $p < 0.01$); *H6* – technological characteristics influence firm adoption ($\beta = 0.165$**, $t = 1.984$, $p < 0.05$) are all supported.

4.6.4 Assessment of the level of R-square. For research involving human behavior, the R-square values of 0.02, 0.13 and 0.25 could be interpreted as weak, moderate and substantial, respectively (Cohen, 1988). From Table 9, R-square values of 0.206, 0.707, 0.382 and 0.350 were obtained for firm adoption, firm-level factors, personal level factors and societal level factors, respectively. The four *R*-squares obtained exceed the moderate level, which shows good explanatory power.

4.6.5 Assessment of the effect sizes (f-square). We examined the effect sizes (f^2) of each of the exogenous constructs in the model to determine the magnitude of their effect on the endogenous construct (Table 8). Concerning the effects of the threshold (f^2) recommended by

Table 4. Multicollinearity assessment of firm adoption of MoMo innovations (showing VIF values)

Firm adoption items	VIF
My firm has officially adopted mobile money technology for business purposes	1.308
Our employees know how to process mobile money payments	1.387
Our employees know that mobile money is acceptable in the firm	1.347
Our customers are able to make payment with mobile money	1.198
We are able to pay our suppliers with mobile money	1.091

Note: VIF<=5 is acceptable (Hair *et al.*, 2014)

Table 5. Correlation matrix for high level constructs

High level constructs	1	2	3	4	5
Firm level adoption	1				
Personal level factors	0.368***	1			
Firm level factors	0.278***	0.776***	1		
Societal level factors	0.246***	0.617***	0.733***	1	
Technological characteristics	0.276***	0.334***	0.416***	0.592***	1

Note: ***Correlation is significant at 0.01 level of significant

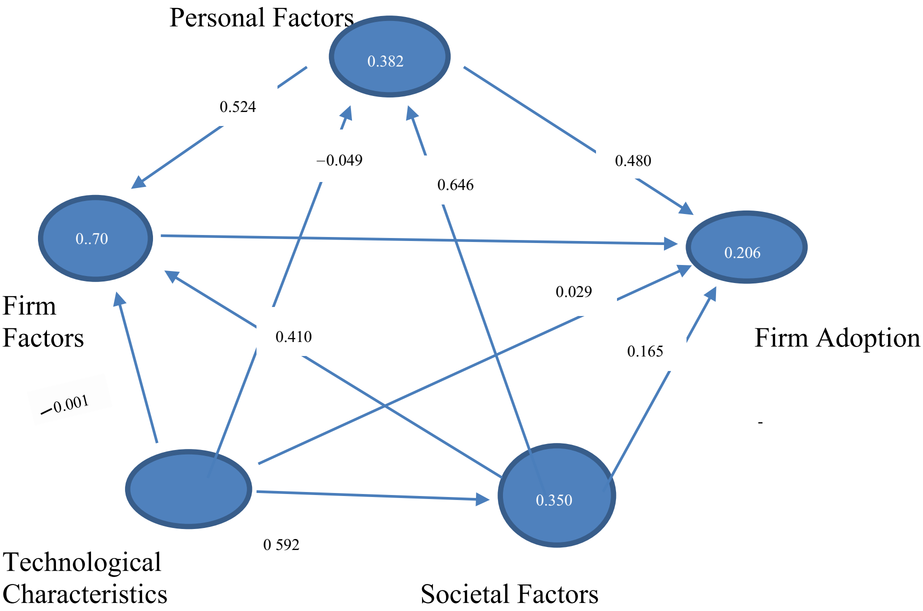


Figure 2. Structural model showing regression weights

High-level constructs	Firm adoption	Firm-level factors	Personal level factors	Societal level factors
Firm adoption				
Firm level factors	3.410			
Personal level factors	2.554	1.619		
Societal level factors	2.788	2.214	1.539	
Technological characteristics	1.543	1.543	1.539	1.000

Note: VIF<=5 is acceptable (Hair *et al.*, 2014)

Table 6. Collinearity assessment of the inner structural model (showing VIF values)

Propositions	Structural path	Path coefficient	*t*-value (Bootstrap)	Proposition results
P1	Personal Level Factors Firm Adoption	0.480***	4.900	Supported
P2	Personal Level Factors Firm Level Factors	0.524***	12.190	Supported
P3	Societal Level Factors Personal Factors	0.646***	14.265	Supported
P4	Societal Level Factors Firm Level Factors	0.410***	7.633	Supported
P5	Technological Characteristics Societal Level Factors	0.592***	14.660	Supported
P6	Technological Characteristics Firm Adoption	0.165**	1.984	Supported

Notes: ***Significant at $p < 0.01$; **significant at $p < 0.05$

Table 7. Structural path results

Cohen (1988) and Hair *et al.* (2016), we found that personal factors (f^2=0.11) and technological characteristics (f^2=0.02) had small effect sizes on adoption. Personal factors had a large effect size on firm factors (f^2=0.58). On the other hand, societal factors had a medium effect (f^2=0.26) on firm factors. Societal factors (f^2=0.44) had a large effect size on personal factors. Finally, technological characteristics (f^2=0.54) had a large effect size on societal factors. However, firm-level factors and societal level factors had no effect size on adoption. Similarly, technological characteristics had no effect size on either firm-level factors or personal level factors.

4.6.6 Assessment of the predictive relevance Q-square. We used Stone–Geisser's (Q^2) cross-validated redundancy, a blindfolding procedure in PLS, setting an omission distance of seven as a criterion for the predictive relevance of the model. The general rule of thumb is to have a Q^2 value above 0 to show predictive relevance (Chin, 2010). Q^2 values of 0.06, 0.69, 0.37 and 0.34 (Table 8) were obtained for adoption, firm factors, personal factors and societal factors, respectively, which indicate predictive relevance.

4.7 The moderated models

Three moderated models were built to find answers to the *H7* (Figure 3), *H8* (Figure 4) and *H9* (Figure 5). These are s follows:

a. Moderating effect of societal factors on firm-level factors and adoption – the R-square of the structural model increased by 3% from 0.206 (Figure 2) to 0.233 (Figure 3), following the introduction of societal-level factors as the moderator. As summarized in Table 9, the interaction effect is statistically significant (β = 0.134, t = 3.098, $p < 0.01$). Therefore, societal factors strengthen the relationship between firm-level factors and firm adoption. *H7* is, therefore, supported. See Figure A1 (Appendix 1) for further moderating observations.

b. The moderating effect of personal factors on firm-level factors and adoption – the R-square value of the main structural model increased by 1% from 0.206 (Figure 2) to 0.216 (Figure 4) following the introduction of personal/employee factors as a moderator. As summarized in Table 9, the interaction effect is marginally significant (β = 0.086, t = 1.700, $p < 0.01$). Consequently, personal factors strengthen the relationship between firm-level factors and firm adoption, lending support to *H8*. See Figure A2 (Appendix 1) for further moderating observations.

c. The moderating effect of technological characteristics on firm-level factors and adoption – the R-square value of the main structural model increased by 2% from 0.206 (Figure 2) to 0.226 (Figure 5) after the introduction of technological characteristics as a moderator. As summarized in Table 9, the interaction effect is marginally significant (β = 0.12, t = 2.242, $p < 0.05$). This result implies that technological characteristics strengthen the

Table 8. Predictive accuracy (R^2), predictive relevance (Q^2) and effect sizes (f^2)

Constructs	R^2	Q^2	Firm adoption	Firm level factors	Personal level factors	Societal level factors
Firm adoption	0.206	0.059				
Firm level factors	0.707	0.686	0.01(None)			
Personal level factors	0.382	0.372	0.11 (Small)	0.58 (Large)		
Societal level factors	0.350	0.342	0.01 (None)	0.259 (Medium)	0.44 (Large)	
Technological characteristics	_	_	0.02 (Small)	0.00 (None)	0.00 (None)	0.54 (Large)

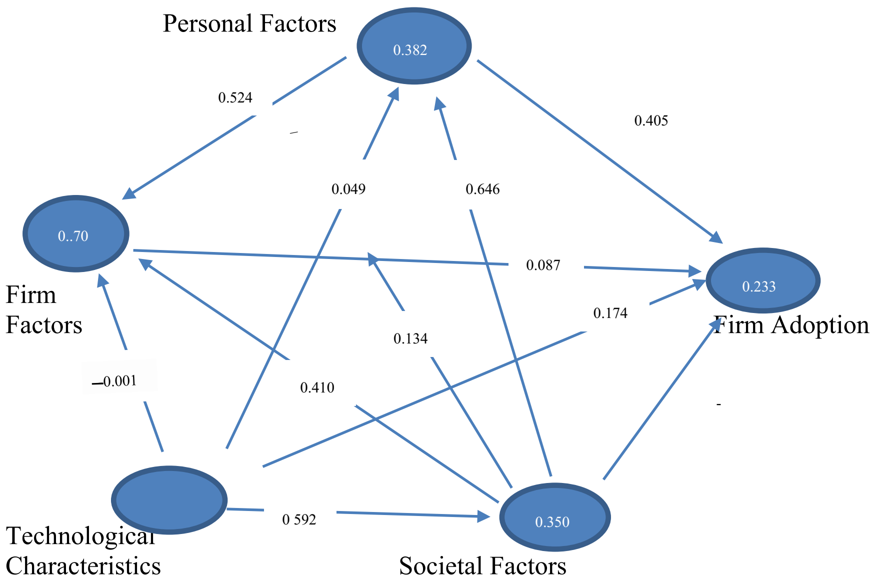


Figure 3. The moderating effect of society-level factors on the relationship between firm level factors and firm adoption

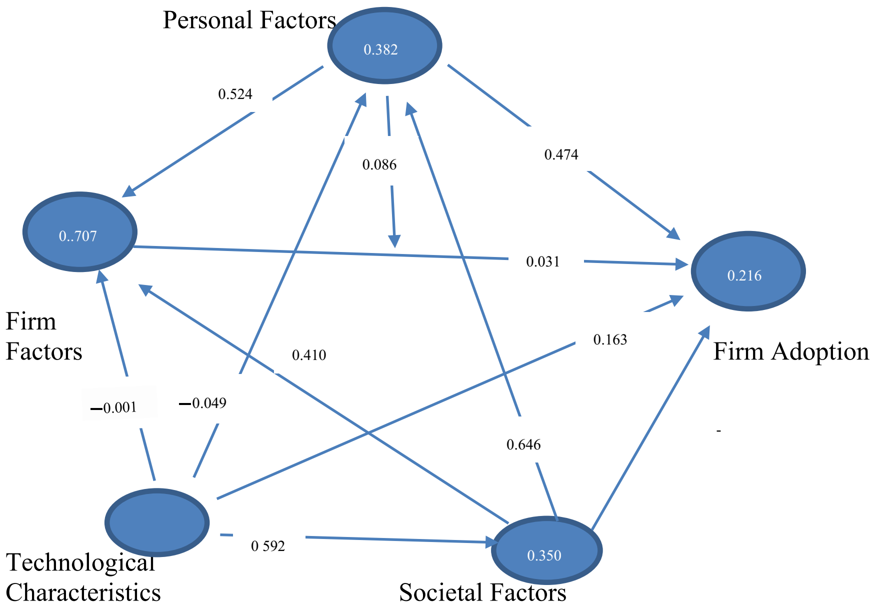


Figure 4. The moderating effect of personal level factors on the relationship between firm level factors and firm adoption

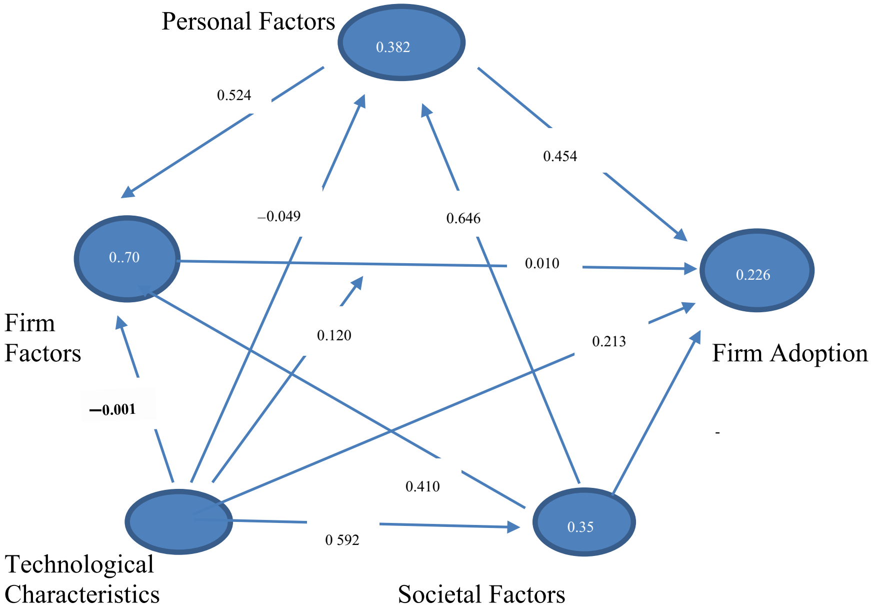


Figure 5.
The moderating effect of technological characteristics on the relationship between firm level factors and firm adoption

Table 9.
Moderation test results

Proposition	Relationship	Path coefficient	Std. Error	*t*-value (Bootstrap)	Hypothesis results
H7	FirmLF*SocietalLF Adoption	0.134***	0.043	3.098	Supported
H8	FirmLF*PersonalLF Adoption	0.086*	0.052	1.700	Supported
H9	FirmLF*Technological Adoption	0.12**	0.054	2.242	Supported

Notes: ***Significant at $p < 0.01$; **significant at $p < 0.05$; *significant at $p < 0.10$

relationship between firm-level factors and firm adoption. See Figure A3 (Appendix A) for further moderating observations.

d. Moderating Effects of Firm Size on F-TAM – the moderating effect of firm size on the F-TAM was investigated using multi-group analysis (PLS-MGA) techniques (Hair *et al.*, 2017). Using Ghana's Ministry of Trade categorization of SMEs (National Board for Small Scale Industries, NBSSI, 1990), we realized 235 micro firms (employee size of between 1 and 5), 143 small firms (employee size of between 6 and 29) and 22 medium firms (employee size of between 30 and 99). The 22 medium firms were added to the small firms because the minimum required sample size for multiple group analysis is 40 (Barclay *et al.*, 1995). See Table 10 for the results.

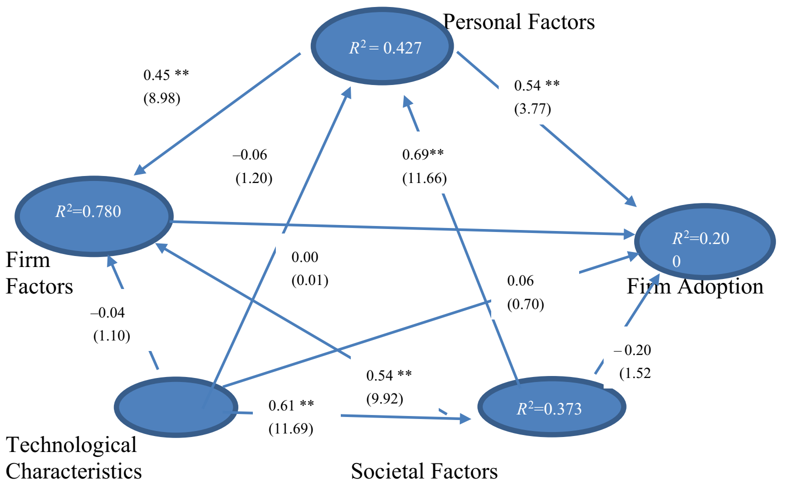
In both categories, a significant relationship was obtained for five of the relationships. However, the effect of technological factors on firm-level adoption was significant among the small and medium scale firms but not among micro firms. The effects of personal factors on firm-level factors, technological characteristics on firm-level adoption and technological characteristics on firm-level factors are stronger among small and medium scale firms than

Table 10. Multi-group results

Paths	Micro (*n* = 235) β	Micro (*n* = 235) *t*	Size Small and Medium (*n* = 165) β	Size Small and Medium (*n* = 165) *t*	Absolute value of path difference
Firm Level Factors → Firm Level Adoption	0.00	0.01	0.04	0.32	0.05
Personal Level Factors → Firm Level Adoption	0.54**	3.77	0.39**	2.82	0.14
Personal Level Factors → Firm Level Factors	0.45**	8.98	0.65**	7.99	0.19*
Societal Level Factors → Firm Level Adoption	−0.20	1.52	−0.03	0.31	0.16
Societal Level Factors → Firm Level Factors	0.54**	9.92	0.15*	1.90	0.39**
Societal Level Factors → Personal Level Factors	0.69**	11.66	0.58**	7.54	0.11
Technological Characteristics → Firm Level Adoption	0.06	0.70	0.26*	2.29	0.20*
Technological Characteristics → Firm Level Factors	−0.04	1.10	0.07	1.33	0.11*
Technological Characteristics → Personal Level Factors	−0.06	1.20	0.01	0.15	0.07
Technological Characteristics → Societal Level Factors	0.61**	11.69	0.54**	8.14	0.07

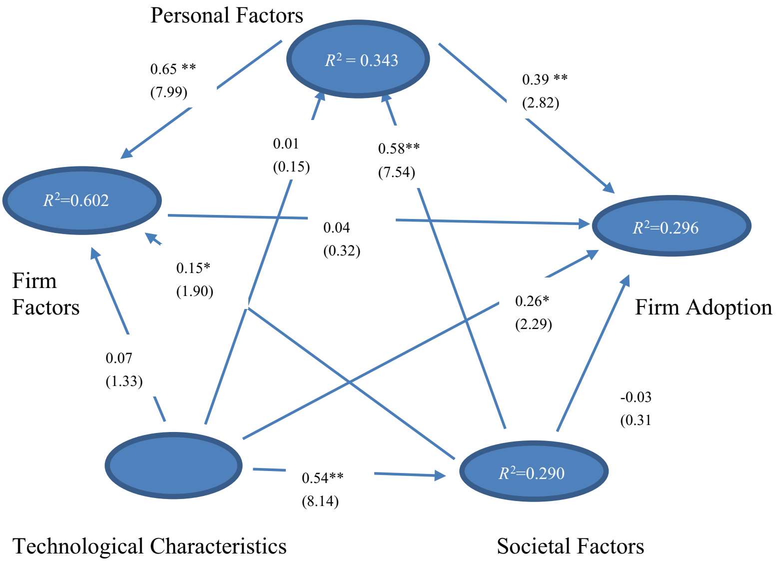
Notes: **Significant at $p < 0.01$; *significant at $p < 0.05$

among micro firms. The relationship between societal and firm-level factors is stronger among micro firms than among small and medium firms (Figures 6 and 7). Therefore, *H10* is supported in this context and affirms the relevance of the F-TAM as a context-sensitive model.*e. Moderating effect of risk propensity* – to examine further contextual issues that may affect the relationships posited in the model, we tested for the effect of risk predisposition on the model using multi-group analysis (MGA). We measured risk disposition with the level of decision-making. Thus, there were 179 owner/managers who were regarded as having high-risk propensity and 221 employees who were regarded as having low-risk propensity (Table 10).
We found that level of risk predisposition affects the relationship between employee factors and firm adoption. Specifically, the relationship between personal (employees) level factors and firm



Notes: Statistically significant at 0.01 level of significance; (t-value in parenthesis)

Figure 6. SEM standardized path coefficients for micro firms



Notes: Statistically significant at 0.01 level of significance; (t-value in parenthesis)

Figure 7.
SEM standardized path coefficients for small and medium firms

adoption is more significant among employees (β = 0.59**), who have a lower risk predisposition, than among owner-managers (β = 0.45**) who have higher risk predisposition. Thus, employees are more likely to adopt the innovation once the personal level factors are significant enough to result in firm adoption, irrespective of whether they are in big firms or small firms. However, owner managers' adoption is less likely to be dependent on these personal factors.

We also found that the level of risk predisposition affects the relationship between technology characteristics and firm-level factors. Specifically, technology characteristics are more likely to affect firm-level factors where owner-managers (high-risk predisposition) are to use technological innovation to use a technological innovation than if the employee (low-risk predisposition) is to use the innovation.

4.8 Mediation effects

Using PLS-SEM, we followed Nitzl *et al.* (2016) prescription to test for three mediation effects.

(1) *The mediation effect of personal factors on societal factors and firm adoption* – from Table 11, personal factors fully mediate the relationship between societal factors and firm adoption. Hence, *H11* is supported. Therefore, contrary to an earlier proposition in Doe *et al.* (2019), societal factors indirectly affect firm adoption.

(2) *The mediation effect of societal factors on technological characteristics and firm-level factors* – from Table 12, societal level factors fully mediate the relationship between technological characteristics and firm-level factors. Thus, *H12* is supported. Therefore, contrary to an earlier proposition in Doe *et al.* (2019), technological characteristics indirectly affect firm-level factors.

(3) *The mediation effect of societal factors on technological characteristics and personal factors* – from Table 13, societal level factors fully mediate the relationship

between technological characteristics and personal factors. Thus, *H13* is supported. Therefore, contrary to an earlier proposition in Doe *et al.* (2019), technological characteristics indirectly affect personal factors.

5. Discussion

The findings of this study demonstrate some dexterity of the F-TAM model. First, micro firms are more likely to rely on societal factors as a stakeholder group to rally resources (firm-level factors) if the adoption of technological innovation is to be sustainable. However, small to medium firms that have a higher tendency to be structured and rely on strategic planning (Darnall *et al.*, 2010) are more likely to be influenced by the firm-level stakeholder influences that have been strategically created for adoption. For sustainability of digital technology; therefore, the size of the firm is a determinant of which of the stakeholders' influence is stronger.

We also observe that small to medium firms are more likely to rely on technology characteristics to adopt the innovation than personal level factors (stakeholder interests). Again, for sustainable adoption among small to medium firms, the characteristics of the innovation itself will be more influential in the proposed adoption eco-system that the

Exogenous variables (*x*)	Path coefficient "a"	Path coefficient "b"	Path coefficient "c"	Indirect effect (a*b)	SD (ai*bi)	*t*	Mediation Type	Proportion of Mediation
Societal Factors	0.646***	0.480***	−0.131	0.3101	0.0706	4.395	Full	NA

Note: ****t*-values are significant at 0.01 level of significance

Table 11. The mediation of personal factors on societal factors and firm adoption

Exogenous variables (*x*)	Path coefficient "a"	Path coefficient "b"	Path coefficient "c"	Indirect effect (a*b)	SD (ai*bi)	*t*	Mediation Type	Proportion of Mediation
Technological factors	0.592***	0.410***	−0.001	0.2427	0.0352	6.902	Full	NA

Note: ****t*-values are significant at 0.01 level of significance

Table 12. Mediation of society level factors on technological characteristics and firm level factors

Exogenous variables (*x*)	Path coefficient "a"	Path coefficient "b"	Path coefficient "c"	Indirect effect (a*b)	SD (ai*bi)	*t*	Mediation Type	Proportion of Mediation
Technological factors	0.592**	0.646***	−0.049	0.3824	0.0423	9.041	Full	NA

Note: ****t*-values are significant at 0.01 level of significance

Table 13. The mediation of society level factors on technological characteristics and personal factors

influence of employees as a stakeholder group. This may also be large because of the higher tendency to engage in strategic planning, in which they may have analyzed the technology characteristics before attempting to adopt the innovation.

The moderating effects of risk predisposition on the two relationships suggest that SMEs with higher risk predisposition are more likely to rely on structured or strategic factors created within the firm environment for sustainable adoption of innovation than employees as a stakeholder interest group. Thus, risk propensity can influence which stakeholder influence is stronger for adoption sustainability. Furthermore, technological characteristics lead to firm-level stakeholder influences among SMEs with higher risk propensity. On the other hand, SMEs with a low propensity to risk are more likely to rely on employee influences (stakeholder group) to adopt than the deliberately created factors within the firm environment. Literature has hinted that risk-aversion, often associated with bigger firms, reduces the probability of adoption of an innovation (Knight *et al.*, 2003). This means that smaller firms with less risk aversion will adopt a technological innovation than a larger firms. Our finding perhaps helps to clarify this phenomenon. Bigger firms perceive more risk aversion and therefore rely more on strategic planning to drive sustainable adoption of technology. Thus, firm pre-disposition to risk influences the dynamics of stakeholder significance. For small to medium firms; therefore, this results in a higher tendency to rely on strategic creations within the firm rather than the interest of employees' perceptions and attitudes as a stakeholder group.

Sustainable adoption, therefore, is much more achieved through the interactivity of stakeholder influence in the adoption eco-system. The eco-system view of adoption has been prompted by researchers on the innovation eco-system (Gobble, 2014; Adner, 2006; Groth, Esposito and Tse, 2015), who emphasise the need to examine innovation as a member of a system of parts that contribute for the innovation to succeed. This view has been demonstrated in this study.

6. Summary and conclusions

The study found that the size of a firm affects the relationships proposed in F-TAM. Risk propensity is also confirmed to moderate the relationships proposed in the model. Furthermore, two stakeholder group influences (societal and employees), as well as technological characteristics, were all found to moderate the relationship between firm-level stakeholder influences and firm adoption. Without these moderating effects, the firms drive (represented by internal preparations and industry dynamics) would have been insignificant in driving firm-level adoption. The mediating relationships are also confirmed. As a result, all thirteen hypotheses of the study are supported in the present context. Figure 8 below is a pictorial view of the findings.

The effects of these findings put together amply illustrate that the context or ecosystem of adoption, the central relevance of the F-TAM model and the diverse interrelationship of stakeholders in this eco-system are very significant for the sustainable adoption of a technology (innovation). Adoption is not a linear event that will occur simply by putting a set of factors together. The interaction between the various stakeholder groups is as follows:

6.1 Employees

The attitudes and influence of this stakeholder group can lead to technology usage in a firm even when the firm has not officially prepared itself nor sanctioned the adoption of the technology. This unofficial usage produces a subjective norm within the working environment, which leads to the emergence of other factors at the firm level, which management prepares the firm to adopt. During official adoption, the attitude of this

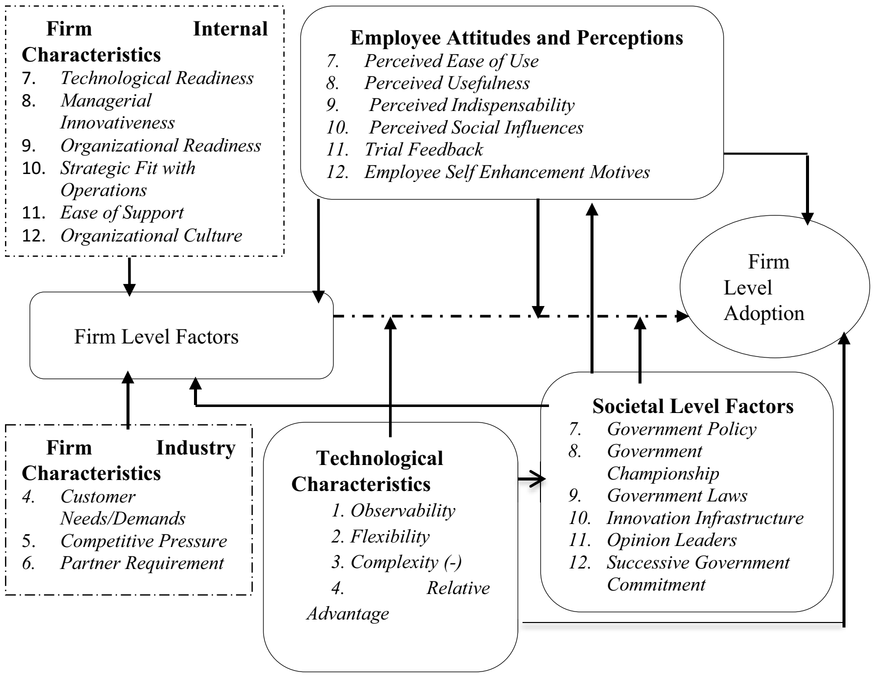


Figure 8. The final technology adoption model (F-TAM)

stakeholder group (employees) will also reinforce (moderation effect) the firm's effort to adopt. The only significant stakeholder group that precipitates employee influence, according to the F-TAM, is society. Thus, employees as a stakeholder group serve as a mediator between society and the firm adoption, as well as mediate between society and other firm-level stakeholders.

6.2 Firm-level stakeholders

This stakeholder group comprises internal preparedness promoted by management and industry dynamics. However, their influence is precipitated by society and employees. Among SMEs in general, these firm-level factors would be irrelevant without the moderating influence of personal, societal and technology factors. The evidence from this study shows that micro firms are unlikely to depend on these factors, while small to medium firms are more likely to depend on these factors. If this trajectory holds true, then this group of stakeholder influences is likely to be enough to lead to adoption among bigger firms.

6.3 Society

Because firms exist in a society, these macro stakeholder actions influence the availability of factors at the firm level (firm-level stakeholders), as well as employees attitudes and perceptions through a diffusion process. This macro stakeholder readiness and changes; however, do not lead directly to firm adoption. However, in the drive toward the adoption of technology, these macro stakeholder influences reinforce the firm's effort (moderation effect) to adopt. Within the suggested Eco-system (Doe *et al.*, 2019), this stakeholder influence mediates between technology characteristics and employee attitudes, as well as between technology characteristics and other firm stakeholders' group influences.

We conclude, therefore, that, for any adopted technology to be sustainable (long term adoption and profit yielding) at the firm level, the different stakeholders groups: employees (human attitudes), firm environment (firm preparedness and industry dynamics) and society (government and society contribution toward adoption), will all interact to ensure real sustainability of the technology adopted. The interaction will highlight which stakeholder group influence is more significant depending on firm size and risk propensity. Otherwise, the technology is either dropped along the way or fails to yield the essential sustainable benefits sought. Therefore, for each type of organization, the exact interrelationship needs to be tested with data from the exact context.

7. Theoretical and managerial implications

This study challenges the dominant idea of positing intention to adopt as the sole immediate antecedent of adoption, with all other factors leading to the intention to adopt. The stakeholder view emphasizes an interactively of various stakeholders and highlights trigger points for sustainable adoption. This study further argues that firm stakeholders' significance in the drive toward technological innovation is further dependent on size and risk propensity.

The insignificance of firm-level stakeholder influences is a phenomenon that is absent from earlier models largely because these models lump employee influence together with other firm-level stakeholder influences. Earlier models also did not examine adoption from the stakeholder interrelationship approach that this current study uses. Significantly, this paper contributes to theory by demonstrating the stakeholder interactive approach as an alternative, if not a better approach, to examining sustainable adoption behavior. For instance, depending on firm size, as well as propensity to risk, different stakeholder influences will become relevant in achieving a sustainable adoption behavior such that all stakeholder needs are met with respect to their expectation of the technology (innovation). This is what will engender the sustainability of the technology being adopted in the present context and ensure that variations in various stakeholder influences do not render the continuous use of the technology as obsolete. This finding is expected to set the pace for a new stream of studies to uncover whether earlier models would report the same findings if employees influence is decomposed from other firm-level stakeholders' influences. It also sets the pace for re-testing the earlier models at all levels with this eco-systems stakeholder approach.

Furthermore, the finding affirms employees as the most significant stakeholder group within the suggested eco-system (network of stakeholders) of firm adoption. This also challenges all models such as TOE and PERM that classify employees as part of firm factors and posit that firm factors will lead directly to firm adoption. Consequently, for the sustainability of firm technology adoption, all stakeholder interests must be aggregated before its significance can be uncovered.

This paper finally discovered that even among SMEs, firm size and risk propensity moderate the relationships posited in the F-TAM in general. Thus, the firm size and risk propensity have significant effects on the relevance of its stakeholders in igniting sustainable adoption behavior. These moderating effects posited in this model are obviously absent from all other adoption models that did not anticipate the interrelationship of adoption stakeholders in an eco-system view. Their relevance has been discovered in the F-TAM. These moderating relationships of different stakeholders' interactivity also support the emphasis on examining adoption at all levels from a stakeholder perspective.

For industry practitioners, the findings of this study provide a framework with which SMEs in developing country contexts can easily promote sustainable adoption of any innovation in the organization context. The interactive effect highlights where the emphasis needs to be laid to ignite adoption and the sustainability of the digitized technology. For instance, at the firm level, employee attitudes and perceptions, as well as the nature of the technology itself, are more important than other internal firm factors. With this model, igniting adoption is expected to be easier at the firm level. Thus, the proposed eco-system will enable managers to take a holistic view of the firm, toward sustainable technology adoption. The significance of these stakeholders also illustrates the essence of putting premium relevance on recruiting technologically savvy employees if the firm intends to adopt digital technologies sustainably. Furthermore, it illustrates the importance of monitoring government efforts to promote the adoption of innovations. In the case of micro firms, for instance, sustainable adoption will be assured when the macro-level stakeholders influence such as government, laws, policies and actions, are favorably disposed to encouraging these micro firms to adopt the technology. Where as in small to medium firms, sustainable adoption will be much more improved when the firm itself takes steps to create the internal readiness for adoption and address the needs of its industry stakeholders. The relevance of these stakeholders is that their interactivity will strengthen a firm's own efforts at sustainable adopting of an innovation. In fact, recent work by Barney (2018) extended the resource-based view to encapsulate a stakeholder dimension, recognizing the context in which decision-makers should work closely with key partners, such as customers and society in this current study, to be more sustainable in their strategic actions. Therefore, managers who seek to promote a sustainable technological innovation must closely examine the characteristics of the technology itself as it indirectly affects what employees perceive as usable and useful. Managers must likewise pay close attention to different stakeholder interests and influences. For micro-enterprises, employee stakeholder interest of perceived indispensability and self-enhancement motives must ostensibly feature in management decisions, as they feature as the major stakeholder group toward sustainable adoption. For small to medium scale enterprises, the use of strategic analysis of the technology characteristics will be useful. An analysis of risk propensity will also be useful. This should examine which stakeholder group is using the innovation in the firm. If it is employees, then their attitudes and perceptions of the innovations are more relevant than firm readiness. If it is managers, then the strategic firm readiness factors and the technology itself may be more essential.

In the digitized era where new technologies are rapidly churned out, what would make a corporate strategy sustainable in the changing environment must necessarily be identified. The ability of the firm to unlearn old technologies, adopt new technologies and adapt them to the changing digital environment is largely dependent on the employee stakeholder group, as shown in the study. SMEs in developing countries that understand the interaction effect of the different stakeholders are more likely to deploy more sustainable strategies that lead to sustainable corporate performance in the competitive digitized era than those that do not.

8. Limitations and future research

This study does not follow strictly the stakeholder classification of being primary stakeholders or secondary stakeholders, as proposed by Mitchell *et al.* (1997). Further studies, therefore, reclassify the stakeholders strictly into primary and secondary and measure how the secondary stakeholders influence the primary stakeholders.

In this study, purposive sampling (Straits and Singleton, 2017) was used. The downside of this sampling technique is that respondents do not represent the entire population. Given that the initial adopters of new technologies tend to be technology-savvy, and in most cases, owners/managers lead adoption, the findings of this study may be more tailored to technologically savvy SMEs. Again, the adoption is assumed to be a voluntary adoption process. When this model is applied to mandatory adoption, the results may vary. We recommend the application of this model in mandatory adoption situations.

The discipline of marketing posits with the marketing orientation (Kotler and Levy, 1969) that customer needs are placed at the heart of organizations' efforts to drive customer satisfaction and profit. If this is so, then the variable of "customer needs", as well as other industry factors, could probably lead to firm adoption. Perhaps if industry stakeholder groups are decoupled from internal organizational stakeholder groups, industry factors could lead to adoption. This needs to be explored in further studies.

Samples were taken from the most cosmopolitan Region of Ghana, Greater Accra. Thus, the findings of this study are expected to be generally applicable to all SMEs in developing country contexts. Apart from an extended study in other developing country contexts, the propositions in this study can also be subjected to a comparative test *vis-a-vis* other models that have been proposed to explain technology adoption or any other innovation at the firm level. The applicability to larger firms or firms in developed country contexts needs further research.

Finally, the moderating effect of employees and society stakeholders, technology characteristics, in addition to the dynamics of size and risk propensity on firm-level stakeholders, is likely to be significant for sustainable adoption in large firms. This calls for further studies.

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Further reading

Coad, A., Segarra, A. and Teruel, M. (2016), “Innovation and firm growth: does firm age play a role?”, *Research policy*, Vol. 45 No. 2, pp. 387-400.

Laukkanen, T. (2016), “Consumer adoption versus rejection decisions in seemingly similar service innovations: the case of the Internet and mobile banking”, *Journal of Business Research*, Vol. 69 No. 7, pp. 2432-2439.

Appendix

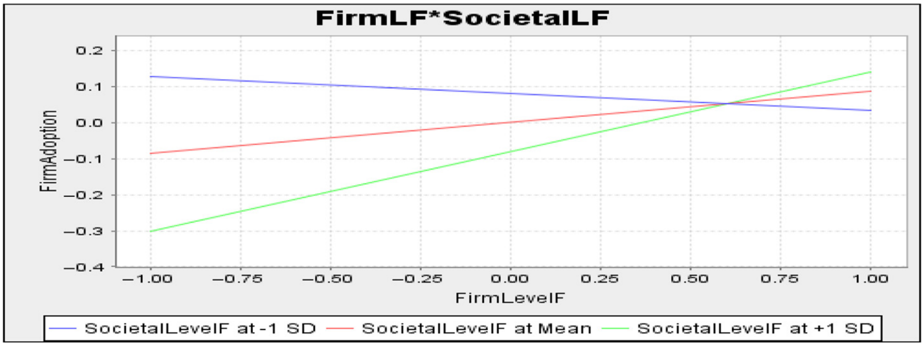


Figure A1. Moderating effect of societal level factors on firm level factors and firm adoption showing regression slopes

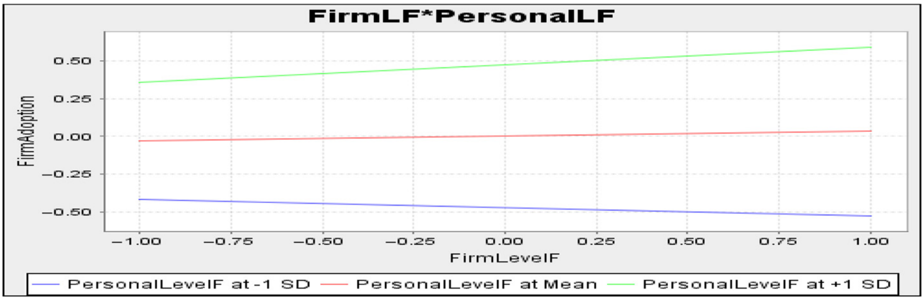


Figure A2. Moderating effect of personal factors on firm level factors and firm adoption showing regression slopes

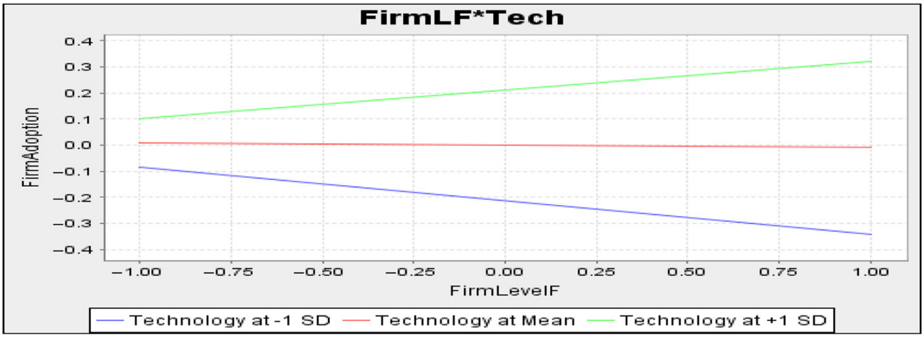
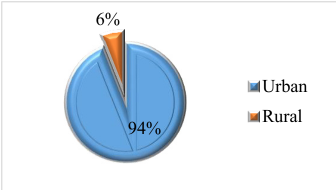


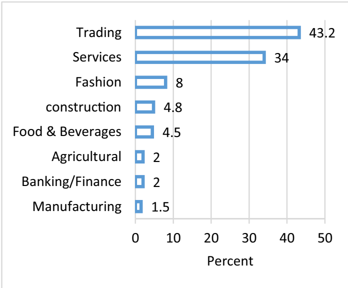
Figure A3. Moderating effect of technology factors on firm level factors and firm adoption showing regression slopes

SME business characteristics

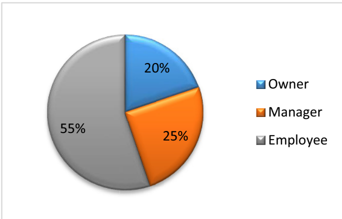
Variables	Frequency (n)	Percentage (%)
Type of business location		
Urban	376	94.0
Rural	24	6.0
Total	**400**	**100.0**



Variables	Frequency (n)	Percentage (%)
Sector of Operation		
Food & Beverages	18	4.5
Manufacturing	6	1.5
Agricultural	8	2
Services	136	34
Fashion	32	8.0
Construction	19	4.8
Microfinance/Banking	8	2
Trading	173	43.2
Total	400	100.0



Variables	Frequency (n)	Percentage (%)
Position of respondent		
Owner	79	19.8
Manager	100	25
Employee	221	55.2
Total	**400**	**100.0**



Variables	Frequency (n)	Percentage (%)
Percentage of Firm budget spent on adoption		
Between 1% & 3%	82	20.5
Between 3.1% & 5%	163	40.8
More than 5%	100	25.0
Don't know	55	13.7
Total	**400**	**100.0**

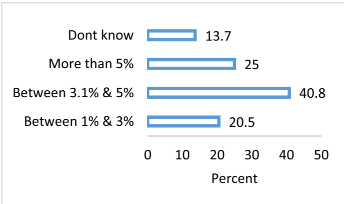


Figure A4. Respondents demographic details

Variable	*N*	Minimum	Maximum	Mean	SD
How long have your organization been in business(years)	383	2	25	6.45	4.196
Number of employee	385	1	103	9.66	16.726
Average turn over per year (GHC)	198	1,000	774,780	26,584.6	57,465.2
How long have your organization been using mobile money in your business	357	1	8	2.8207	1.45197

Table A1. Business characteristics-descriptive

High level construct	Low level construct	Initial, final no. of scale items	Item code	Loading	Cronbach's alpha	Composite Reliability	AVE
Firm adoption	Firm level Adoption of MoMo innovations	5,5	NA		Formative		
Personal factors	Perceived ease of use	4,3	PEOU2	0.651	0.611	0.789	0.556
			PEOU3	0.754			
			PEOU4	0.822			
	Perceived usefulness	4,3	PU2	0.790	0.621	0.799	0.572
			PU3	0.828			
			PU4	0.638			
	Perceived indispensability	4,4	PI1	0.740	0.738	0.835	0.561
			PI2	0.659			
			PI3	0.836			
			PI4	0.750			
	Perceived social influences	3,3	PSI1	0.624	0.693	0.814	0.597
			PSI2	0.851			
			PSI3	0.823			
	Trial feedback	4,3	TF2	0.817	0.663	0.808	0.586
			TF3	0.799			
			TF4	0.673			
	Employee self interest/ self enhancement motives	4,4	ESIEM1	0.670	0.740	0.836	0.562
			ESIEM2	0.752			
			ESIEM3	0.808			
			ESIEM4	0.761			
Firm internal factors	Technological readiness	4,4	TR1	0.693	0.727	0.826	0.544
			TR2	0.814			
			TR3	0.775			
			TR4	0.658			
	Managerial Innovativeness	4,3	MI1	0.770	0.619	0.780	0.544
			MI2	0.647			
			MI4	0.787			
	Organizational Readiness	4,3	OR2	0.782	0.665	0.811	0.589
			OR3	0.823			
			OR4	0.692			
	Strategic fit with operations	4,4	SFO1	0.725	0.738	0.835	0.558
			SFO2	0.774			
			SFO3	0.758			
			SFO4	0.731			
	Ease of support	4,4	EOS1	0.786	0.798	0.867	0.622
			EOS2	0.850			
			EOS3	0.849			
			EOS4	0.653			
	Organizational culture (firm propensity to take risk)	4,4	OC1	0.635	0.711	0.810	0.520
			OC2	0.784			
			OC3	0.817			
			OC4	0.629			
Firm external factors	Organizational partner requirement	5,3	OPR2	0.883	0.666	0.809	0.591
			OPR4	0.786			
			OPR5	0.613			
	Competitive pressure	4,3	CP2	0.788	0.649	0.807	0.583
			CP3	0.689			
			CP4	0.809			

(*continued*)

Table A2.
Reliability and convergent validity of reflective constructs

High level construct	Low level construct	Initial, final no. of scale items	Item code	Loading	Cronbach's alpha	Composite Reliability	AVE
	Needs of customers	5,3	NOC1	0.685	0.615	0.796	0.566
			NOC2	0.817			
			NOC3	0.749			
Societal factors	Government championship	7,4	GC2	0.786	0.772	0.834	0.562
			GC3	0.887			
			GC4	0.640			
			GC5	0.658			
	Government policy	4,3	GP1	0.816	0.631	0.796	0.568
			GP2	0.639			
			GP3	0.793			
	Government regulation/ laws	4,3	GRL1	0.741	0.610	0.788	0.554
			GRL2	0.714			
			GRL3	0.777			
	Innovation infrastructure	4,3	II1	0.732	0.683	0.825	0.612
			II2	0.836			
			II3	0.775			
	Opinion leadership	4,4	OL1	0.697	0.687	0.803	0.506
			OL2	0.730			
			OL3	0.777			
			OL4	0.633			
	Successive government commitment	4,3	SGC2	0.791	0.755	0.855	0.663
			SGC3	0.868			
			SGC4	0.781			
Technology Characteristics	Flexibility	4,3	F1	0.724	0.649	0.808	0.585
			F2	0.751			
			F3	0.815			
	Observability	4,3	OB2	0.828	0.716	0.833	0.627
			OB3	0.849			
			OB4	0.689			
	Complexity	4,3	CO2	0.701	0.701	0.828	0.619
			CO3	0.730			
			CO4	0.912			
	Relative advantage	4,3	RA1	0.773	0.670	0.817	0.598
			RA2	0.735			
			RA3	0.810			

Note: All item loadings are significant at 0.01 level of significance

Table A2.

About the authors

Joshua Kofi Doe hold a PhD from the Open University of Netherlands. He co-authored a paper that ushered the Eco-system oriented Firm Technology Adoption Model (F-TAM), a paper that won the "best paper award" at the 12th IADIS International Conference Information Systems 2019. He obtained his bachelors degree (first class) as well as masters of philosophy degree in marketing from the University of Ghana Business School. He worked in the tourism industry and spearheaded the establishment of a virtual office where marketing and transactions could be completed online. His research interest is in the application of technological innovation to marketing activities and the leveraging of these innovations for institutional growth and efficiency. He has two "best paper" awards to his credit. One from "the 12th IADIS International Conference Information Systems 2019"

and the other from "The 17th International Conference on Web Based Communities and Social Media 2020". Joshua Kofi Doe is the corresponding author and can be contacted at: dlas1274@yahoo.com

Prof Dr Rogier Van de Wetering is an Assistant Professor at the Faculty of Management, Science and Technology at the Open University (OU), the Netherlands. Rogier moved into academia after a decade of managing IT/business transformations in Deloitte's Strategy & Operations practice. He worked with a diverse client base in public sector including Universities and Academic medical centers. Dr Van de Wetering holds both a Master's Degree from Utrecht University and a PhD in Information Sciences and Medical Informatics. His research interests focus on understanding how organizations, specifically within healthcare, can gain organizational benefits and process improvements from Information Systems and Information Technology (IS/IT) alignment and IS/IT-enabled business transformations. Recently, he has become interested in the use of adaptive organizational models and enterprise architectures, complex adaptive systems, health IS/IT innovation, ecosystems and research valorization.

Prof Dr Ben Honyenuga is the Vice Chancellor and Chief Executive Officer of the Ho Technical University, in Ghana. Prior to that, he served as Dean of Students at the erstwhile Ho Polytechnic for two terms. Professor Honyenuga holds a Bachelor of Arts (Hons) in Social Sciences from Kwame Nkrumah University of Science and Technology; Masters in Public Administration from the University of Ghana Business School; Master of Philosophy from the Maastricht School of Management, Netherlands; and a Certificate in Management of Higher Education Institutions from Galilee International Management Institute, Israel. Prof Honyenuga obtained a PhD degree in Management from the Open University of the Netherlands, Heerlen (July 2015). Honyenuga's research focuses on Knowledge Management, Management Innovation, High Performance Organizations, African Business and Entrepreneurship.

Prof Johan Versendaal studied Computer Science at TU Delft and was awarded a PhD for his work on design methods and software architecture in interactive information systems. From 1991 to 1997 he worked at the Bureau for System Development (now known as Atos), specializing in workplace computerization and human factors. He then became development manager and product manager at Baan (now known as Infor). Since October 2008, he has been working as professor of Extended Enterprise at HU University of Applied Sciences Utrecht. Since June 2014 he has also held the title of special professor of e-business at the Open University in Heerlen, with a five-year tenure. Additionally, he is director of Breder Advice BV, an organization that advises healthcare providers, especially with regard to process design and automation. He has held this position since 2012. Johan Versendaal has authored and co-authored many publications. He is often invited to speak both in the Netherlands and abroad and he is a member of the international programme committees and organizational committees of a number of (scientific) conferences, including:

- European Conference on Information Systems (2009 and 2010), associate editor;
- the Bled eConference on eBusiness www.bledconference.org; and
- the International Conference on Enterprise Systems, Accounting and Logistics (ICESAL).