PART I

Digital Transformation

CHAPTER 1

The Eco-System of Firm Technology Adoption

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Introduction

In a not too distant future, most products and services are likely to be digitized (Hollebeek and Macky 2019). Meanwhile, business processes get digitized largely due to the digital sophistication of customers and the lower costs and efficiency associated with digitized operations (Tiago and Veríssimo 2014). Many firms have therefore moved their operations to the digitized world where innovative technologies are used for business operations. The kinds of technologies adopted include big data mining (Wu et al. 2014); cloud computing (Zhang et al. 2010); social media (Rigby 2011); networking (Kaplan and Haenlein 2010); cyber security (Von Solms and Van Niekerk 2013); and mobile app/technologies (Barrett et al. 2015). This phenomenon however disrupts many industries (Christensen and Raynor 2003), and in some cases, creates large losers who are unable to reinvent themselves back into the business environment.

The adoption of such innovations, according to Rogers (1962, 2010), happens at the individual level where attitudinal and perceptual factors relate directly to adoption; firm level where internal and industry environmental characteristics relate directly to adoption; and at the societal level where collective macro-level actions relate directly to adoption. Individuals as well as organizations exist within a society and interact. An uncharted question is how these various actors relate to each other as the firms adopt the innovations for business processes. For instance, how do firms ensure that the technologies adopted are sustainable in the eco-system and are more profitable in the long

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term? What are the most important factors that must be fixed for a sustainable and inclusive adoption of digital innovations?

The purpose of this paper is to present the Firm Technology Adoption Model (F-TAM), an eco-system model for examining the adoption of an innovation at the small-to-medium-scale enterprise (SME) level in a developing country context. Specifically, the study reports the influence of personal factors, firm-level factors, and societal-level factors, as well as how these factors serve as an eco-system for adoption of an innovation at the firm level. This novel view of examining adoption establishes the link between firms, individuals, and society for a sustainable business operation in the digitized era. The contribution of this chapter is to highlight the relevance of an eco-system-oriented perspective of engendering the sustainability of digital technologies that firms adopt and, by extension, corporate sustainability in the digitized era.

The conclusions made here are relational propositions that can be tested in any digitized context. The findings will help business owners to appreciate how individual actions as well as societal actions affect the eco-system of innovations and firm adoption decisions, as well as channel their energies to factors that ensure sustainability of their innovation adoption even beyond 2025. Society and governments can focus on the actions, policies, and activities that ensure sustainability of the digitized world. Researchers can embark on a series of studies to validate the report of this study.

In the subsequent sections, the main research questions are listed, the research methods used are summarized, a summary of findings are presented and discussed, conclusions are drawn, contributions of the paper to theory as well as industry practice are provided, and, finally, limitations of the work and recommendations for future research are shown.

Context and Background of Study

History of Innovation Studies

The study of innovations and their adoption originates from Tarde (1903), who is regarded as the founding father of diffusion studies. Current studies on innovation however are rooted in the works of Rogers (1962) and Schumpeter (1987). While Rogers (1962, 1995, 2010) focused on the adoption and diffusion of innovation, Schumpeter (1987) focused on what an innovation is and its effect on organizational performance.

Theories and models such as Theory of Reasoned Action (Fishbein and Ajzen 1975) and Diffusion of Innovations (Rogers 1962) have been the backbone with which researchers have examined the adoption of innovations at the individual level until the emergence of technology-specific models such as the Technology Adoption Model (TAM) (Davis et al. 1989) and Integrated Model of Technology Acceptance (ITMA) (Venkatesh et al. 2002). At the firm or organizational level, there had not been any new theory or model since Rogers' (1962) Diffusion Theory until the 1990s when Tornatzky, Fleischer, and

Chakrabarti (1990) and Goodhue and Thompson (1995) proposed the Technology, Organization and Environment Framework (TOE) model and Task–Technology Fit (TTF) model, respectively. At the societal level, the only notable theory development since Rogers' (1962) Diffusion Theory was in 2004 when Bajaj and Leonard (2004) developed the Culture Policy and Technology (CPT) Framework for examining society-wide technology adoption. The theories and models listed above have been the dominant ones used to date.

A major idea that runs across all of the earlier models is that behavioral intention to adopt will lead to the adoption and use of an innovation. While this idea is true in developed countries due to the availability of infrastructure (Dewan and Kraemer 2000; Pohjola 2001) and emphasis on the role of science in human behavior (Hofstede 2003), the same cannot be said of most developing countries suffering from major infrastructural paucity and divergent socio-cultural emphasis on human behavior (Amoako et al. 2014). Thus, between behavioral intention to adopt and actual adoption is the socio-economic gap of poverty, cultural closeness, resource challenges, and low e-readiness. The result is that these earlier models have realized mixed results when they are tested in developing country contexts (Datta 2011), and therefore do not particularly explain why an innovation is so adopted.

Another omission observed in the scientific literature is the role of the innovative eco-system as an integrating network of interrelated actors that stimulate adoption on any particular level. For instance, the Technology, Organization and Environment (TOE) framework proposes that each of these factors will lead to adoption. The TOE framework places employees as part of the organization's environment. As an organization, however, there is the possibility that there will be personal-level adoption of an employee occurring before the organization itself. There is correspondingly an organization-wide adoption that can occur, as well as a societal-level adoption that occurs outside the organization. Within an organization, there are individuals; and organizations similarly exist within societies. This forms the social system (eco-system) mentioned in Rogers' (1962) definition of diffusion, within which adoption can occur at any level. Scientific literature is silent on the influence of each of these levels of adoption on others. Thus the influence of personal-level factors on other-level factors and vice versa is not established. The influence of organizational-level factors on other-level factors has not been established. Likewise, the influence of societal-level factors on other-level factors has not been established. How these three levels of factors interrelate to stimulate adoption at the firm level is also absent from the scientific literature. For the attainment of corporate sustainability, how these factors interact needs to be explored because employees work within a firm environment, while firms also exist within a societal context. Thus there are both internal and external factors that can interact to promote or hinder the sustainability of any corporate strategy in the digitized era. How these factors interact needs to be explored.

Finally, after scrutiny of the earlier models, it appears that data used in developing the earlier models have been from socio-cultural and economic contexts of developed countries. A significant question that arises from this phenomenon is: if the model was developed from a developing country context, will the antecedents of adoption explain adoption behavior better?

To position this study into the international academic discourse, Boateng, Molla, and Heeks (2009) classified innovation studies into three categories. The first category is the potential and constraints frameworks, which include opportunities, assessment, and electronic readiness (e-readiness), as well as development frameworks. The second category is the adoption and diffusion frameworks, which include technological, managerial, organizational, cultural, environmental, and interactional considerations frameworks. The third category is the support and implementation frameworks, which include strategy, consumer behavior, design and development, service evaluation, public policy, knowledge, and learning. This study falls in line with the adoption and diffusion-related studies.

The Concept of Innovation

Rogers (1962, 1995) defines innovation in his Diffusion of Innovation Theory (DOI) as "an idea, practice, or object that is perceived as new by the unit of adoption". According to Rogers' (1962) definition, the perceived newness of the idea for the adopting unit is the point where the innovation occurs, and not the currency of the invention. The DOI theory focuses on understanding how, why, and the rate at which an innovation spreads in a social system (Rogers 1962).

Schumpeter (1934, 1974), on the other hand, defines innovation as the introduction of a new product, a new method of production, a new market, conquest of a new source of supply, and implementation of a new form or organization. This view of defining innovation is broad, capturing anything new in the organization, both internal or external. Schumpeter (1934) emphasizes the role of innovation in organizations and treats it as another factor of production, aimed at yielding higher profits. To Schumpeter (1974), therefore, innovation pertains (only) to a commercially exploitable novelty.

The Organisation for Economic Co-operation and Development (OECD) defines innovation in the Oslo Manual (2005) as "the implementation of a new or significantly new product (goods or service), process, new marketing method or a new organizational method in business practice, workplace organization or external relations". The OECD views innovation as a process of activities that involves scientific, technological, organizational, financial, and commercial steps, which actually leads to or is intended to lead to improvement in the workplace.

In this chapter, innovation is defined as the adoption of any new artifact, concept or idea, process, product or service, technology, method, or structure previously unused by the adopting unit. It is essential to establish the differentiation between an innovation and an invention. An invention is the creation of

a new artifact, concept/idea, process, product/service, technology, method, or structure (Kuznets 1962); thus innovation is precipitated by inventions. Adoption of an innovation, on the other hand, invariably results in a behavioral change; and for that reason, earlier models which studied adoption, employed behavioral change theories such as Theory of Reasoned Action and Theory of Planned Behaviour. A digital innovation is enabled by digital technologies that leads to the creation of new forms of digitalization (Yoo et al. 2010). Digital innovations often change the structure of industries and are largely disruptive (Christensen and Raynor 2003). A disruptive innovation creates new markets and value, disrupts existing industry structure, and displaces established market leaders, products, and alliances with new ones (Christensen and Raynor 2003).

Diffusion and Adoption of Innovation

Rogers (2010) differentiates between adoption and diffusion of an innovation. Diffusion is the process by which an innovation is communicated among the members of a social system over time. Fichman (2000) defines diffusion as "the process through which a technology spreads across a population of organizations". Although Fichman's (2000) definition seems to focus only on organization, it is still consistent with Rogers' (2010) definition in that the organization is a social system. The technology referred to in Fichman's (2000) definition is broadly referred to as innovation in Rogers' (2010) definition. From the Theory of Diffusion (Rogers 2010), four essential issues are identified for diffusion to occur. These are the innovation itself, communication of the innovation, time, and social system (context of adoption).

Innovation: Rogers (1962) posits that the characteristic of the innovation makes the innovation diffuse faster or lower. In his argument, an innovation that gives an advantage to its users is triable, flexible to use, observable and compatible with users, and is easily adopted, therefore diffusing faster.

Communication: The channel of communication is a system by which users exchange information. According to Rogers' (1962) diffusion, the faster a communication system is, the quicker the diffusion of innovation that is communicated through that channel. Between the mass communication channels and interpersonal communication channels, Rogers (1962) posits that the interpersonal channel is more important due to the influence of opinion leadership. Tarde (1903) had conceptualized this interpersonal communication process as social imitation of something new by members of a community.

Time: This aspect of the innovation diffusion process accounts for the time lag between when an innovation is first adopted and when it is replaced by a new innovation. This chronicles adopter categorization, which ranges from innovators, early adopters, early majority, late majority, and laggards within the social system of diffusion. Thus, while some members of the same social system are first to adopt an innovation as a result of venturesome disposition, others adopt the innovation only if non-adoption can cause them to be extinct.

Social System: A social system is a group of interconnected units jointly engaged in problem-solving to accomplish a common objective (Rogers 1962). The diffusion of an innovation occurs only when a social system accepts the innovation and shares information about the innovation within the system and with other systems. Rogers (1962) argues that social systems that are based on a positive attitude to change, value for advanced technology and a skilled labor force, respect for education and science, and emphasis on rational relationships rather than emotional relationships are prone to adopting innovations. Rogers (1962) further argued that potential adopters' decisions concerning adoption are based on rationality embedded in culture and the context of adoption rather than persuasion. This is uncharacteristic of most African societies (Amoako et al. 2014) where cultures are less likely to plan for long-term infrastructure that can accommodate the use of innovation (Hoyer and MacInnis 1997).

Adoption of an innovation, on the other hand, is an individual process of how the adopting unit becomes aware of an innovation, takes interest in the innovation, evaluates the innovation, tries the innovation, and finally adopts or rejects the innovation.

At the awareness stage, the adopting unit becomes aware of innovation. The awareness may have come to them through the opinion leadership within the social system or through the commercial promoters of the innovation.

At the interest stage, the individual collects specific information about the innovation, its usefulness, ease of use, and consequences of adoption. This enables the adopter to move to the next stage of evaluation based on the known characteristics of the innovation.

At the evaluation stage, the individual determines the value of the innovation and decides whether to try it. This determination is arrived at as a trade-off between costs incurred and potential benefits expected, effort and outcome, advantage over competing innovations, among other factors.

At the trial stage, the adopting unit takes the innovation into experimental use for the first experience. This purchase is usually on a limited scale where the adopter seeks to overcome perceived risks of full-scale adoption.

At the adoption stage, the innovation is engaged into full-scale use and is given a favorable response by members of the society. The adoption stage registers the rejection of innovation if the trial use is unfavorable.

Adoption Eco-system

An eco-system is a multifaceted, dynamic, evolving system of parts that constantly interact, and adapts, sometimes in unexpected ways (Gobble 2014). The eco-system can be a business eco-system, innovation eco-system, start-up eco-system, etc. The eco-system view of adoption has been prompted by researchers on innovation eco-system (Gobble 2014; Adner 2006; Groth et al. 2015) who emphasize the need to examine innovation as a member of a system of parts that contributes toward the success of the innovation. This view is

adapted in examining adoption at the firm level. Thus the adoption eco-system is operationalized in this study as the interaction of factors at the different levels of adoption and the technology itself.

These articles posit that for any adopted technology to be sustainable (long-term adoption and profit yielding) at the firm level, personal-level factors (human attitudes), firm-level factors (firm preparedness), and societal-level factors (government and society contribution toward its adoption) must all interplay to ensure real sustainability of the technology adopted. Otherwise the technology is either dropped along the way or fails to yield the essential benefits sought.

Developing Country Contexts

The World Bank (worldbank.org; cited on 20th July 2019) defines a developing country as a low-to-middle-income ($0–$3995 per-capita income) country with low standards of living and low access to goods and services. Bannock et al. (1992) similarly define a developing country as a country that has not yet reached the stages of economic development characterized by neither growth of industrialization nor a level of national income sufficient to yield domestic savings required to finance investment for further growth. A relevant emphasis of Bannock et al.'s (1992) definition is that developing countries lack the required domestic savings to finance investment that is necessary for further growth and infrastructure to support adoption of future technologies. Within this developing country context is the issue of the digital divide, that is, the unequal access of technological innovations, which is invariably a poverty gap (Fuchs and Horak 2008).

SMEs in Developing Countries

The world bank classifies firms with less than 300 employees as SMEs. The African Development Bank also views all firms with less than 50 employees as SMEs. These classifications may see some variations within countries. For instance, the Ministry of Trade in Ghana defines micro-to-medium-sized enterprises as any organization that employs between 1 and 5 persons to be a micro enterprise, 6 to 29 people with total assets less than $100,000 as a small enterprise, and 30 to 99 people with total assets of up to $1 million as a medium enterprise (Mensah 2004).

In developing countries, small businesses represent over 90% of business units and are hailed to be the backbone of the private sector in any economy (Bannock 2005). It is worth noting that SMEs account for 50% to 60% of total employment (Kennedy and Hobohm 1999), stimulate local and regional development, promote an entrepreneurship culture, and develop other business-related skills (Albaladejo 2002). In a developing country context where governments lack the needed resources to provide basic amenities like

roads, water, electricity, employment, and infrastructure, SMEs become particularly important in national development agendas. Therefore, their empowerment is a relevant issue worth examining. An area of SME empowerment is to promote the adoption of sustainable innovation among SMEs.

Corporate Sustainability

Corporate sustainability has been operationalized as "meeting the needs of a firm's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities, etc.), without compromising its ability to meet the needs of future stakeholders as well" (Dyllick and Hockerts 2002). Siebenhüner and Arnold (2007) argued that a sustainability-oriented company is one that makes changes to include the use of resource-efficient technologies, sustainability reporting schemes, and providing sustainable goods and services to its customers. Internal drivers of sustainability include reducing costs and waste while improving process efficiencies; helping to boost innovation and innovative practices; attract and retain more compliant employees; helping to manage risks, intangible assets, and internal processes; increasing productivity and product quality; among others. External triggers of sustainability include improved customer satisfaction, improved relations with regulators and ease of access to permit, ethical behavior, improved access to the market, trust, among others.

Digitized Environment

Issues of the digital business environment and its related studies date back to 1947 to the invention of the transistor, followed by the mainframe computers and virtual memory in the 1970s (Tilson et al. 2010), and digital record keeping and interconnectedness in the 1980s (Mahoney 1996). Following the rapid growth of internet connectivity in the 1990s (March et al. 2000), the digital revolution became truly global, spreading to the masses in the developing world. Current digitized technologies includes cloud computing, tablet computers and smartphones (Yoo et al. 2012), big data mining, social media (Rigby 2011), mobile app/technologies (Barrett et al. 2015), etc.

In the current digitized environment almost all other human activities are being digitized. Thus business interactions with stakeholders, such as customers, suppliers, government agencies, bankers, and insurance companies, are all being digitized. This is creating convergence of some activities on mobile devices and thereby increasing convenience, efficiency, as well as risks, while decreasing cost and time involved in performing the same activities. In this era, therefore, a sustainable corporate strategy is one that can address the complexities and challenges of navigating the adoption of different technologies more conveniently. This is where the firm needs an crucial understanding of what factors to lay emphasis on in order to engender an overall sustainable corporate strategy.

Methodology

This chapter investigates interrelated published studies that have spearheaded the proposal for this eco-system perspective of examining adoption of innovation. This chapter examines, in particular, the objectives of such studies, methods used in these studies, findings of each study, and then discussion of all findings in relation to how a sustainable innovative environment can be promoted. An author-centric approach to literature analysis (Webster and Watson 2002) is employed for the analysis. Each article is analyzed based on the contribution to the development of this novel view of examining firm innovation adoption (F-TAM). Papers are chosen based on their immediate improvement on the preceding stage of the research stream. Thus the chapter that makes the most immediate improvement of the model development process is examined at each stage of the analysis.

Summary of Findings

Doe, Van de Wetering, Honyenuga, and Versendaal (2017) sought to examine factors that stimulate firm-level adoption of mobile technologies at the personal level, firm level, and societal level, as well as how these factors interrelate to stimulate adoption at the firm level. Using a systematic literature review, Doe, Van de Wetering, Honyenuga, and Versendaal (2017) sampled articles from three and four-star ranked journals in the areas of innovations, information and communications technology, entrepreneurship, and small business management; and examined articles that had studied adoption of innovation at various levels of adoption. The authors used the modified form of the author-centric approach to literature analysis (Webster and Watson 2002), with the levels of adoption as provisional codes (Saldaña 2015). The data was reclassified with a concept-centric approach to qualitative data analysis with sub-coding techniques (Saldaña 2015). Causation coding (Miles et al. 2014; Saldaña 2015) and pattern coding were used in regrouping the sub-codes into major themes that depict the three levels of adoption. The constructs were displayed in a conceptual framework as artificial *ex-ante* artifacts (Venable et al. 2012) to be evaluated or validated as natural *ex-ante* artifacts (Venable et al. 2012), and were finally tested on the real adopters as natural *post-ante* artifacts (Venable et al. 2012). The findings of the study are described below.

At the Employees Personal level, factors that were found to have directly led to adoption include Perceived Usefulness (Vankatesh et al. 2003); Perceived Ease of Use (Vankatesh et al. 2003); Perceived Social Influence (Shinh et al. 2013); and Perceived Indispensability (Shinh et al. 2013). These are generally perceptual and attitudinal factors of an individual. With these variables, the study proposed that employees would adopt innovation by themselves whether they are in a firm setting or not, and whether it is sanctioned by an organization.

The Resource-Based View posits that the resources of a firm, including employees, shape the ability of the firm to be innovative and adaptive to innovations (Najaftorkaman et al. 2015) through subjective norm influence (Fishbein and Ajzen 1975) within the social system (Rogers 1962). This study therefore posited that personal-level factors of adoption would lead to firm-level adoption, as well as firm-level factors of adoption. The study therefore proposed that: *Individual-level factors directly lead to firm-level adoption of digital innovation; individual-level factors of adoption directly influence firm-level factors of adoption.*

At the firm level, the literature inquiry found that the existence of technological readiness, managerial innovativeness, and organizational readiness (Boateng et al. 2011); strategic fit with operations (D'Ambra et al. 2013); and industry readiness (Molla and Licker 2005) will hasten or lead to the actual adoption of the innovation. The study therefore proposed that: *Firm-level factors lead to general adoption.*

Macro-environmental or societal-level factors that were discovered to enhance firm adoption of innovation include government championship (Caerteling et al. 2013); government policy (Boateng et al. 2011; Rogers 1962); trust; and risk culture (Boateng et al. 2011). These factors were expected to moderate the relationship between firm-level factors and adoption. Therefore, the study proposed that: *Firm-level adoption is moderated by societal-level factors.*

This interrelationship was proposed as a model, which is expected to work at the organizational level of adoption. The initial model of the F-TAM is shown in Fig. 1.1.

In this study, the factors that were reported in Doe et al. (2017) were tested for contextual validation in a developing country context through Delphi techniques of academics and industry experts. Specifically, the study examined to what degree the F-TAM reflects the adoption pattern among SMEs in Ghana; whether there were other factors that are not accounted for in this model; and whether changes in the model make the model more valid.

Using two rounds of Delphi interviews, the study sampled views of both academics and industry experts who had varying opinions on the adoption of mobile technology innovations in Ghana. Within two rounds of reducing the variety of responses, consensus of responses was achieved (Linstone and Turoff 1975). In the first round of interviews, the respondents were asked to comment on the original variables of the F-TAM (Doe et al. 2017), as well as the relationships that were posited to exist. Respondents were asked to suggest any variable that they believe should be added or deleted based on their experiences and knowledge of how SMEs adopt mobile digital innovation. Any new variable discovered was added as part of the second round of interviews. In the second round, respondents were asked to comment on the revised variables, restricting the comment to agreement, disagreement, and neutrality. Respondents were given an option to indicate any other comment they may have. The role of the researchers in that study was restricted to that of a

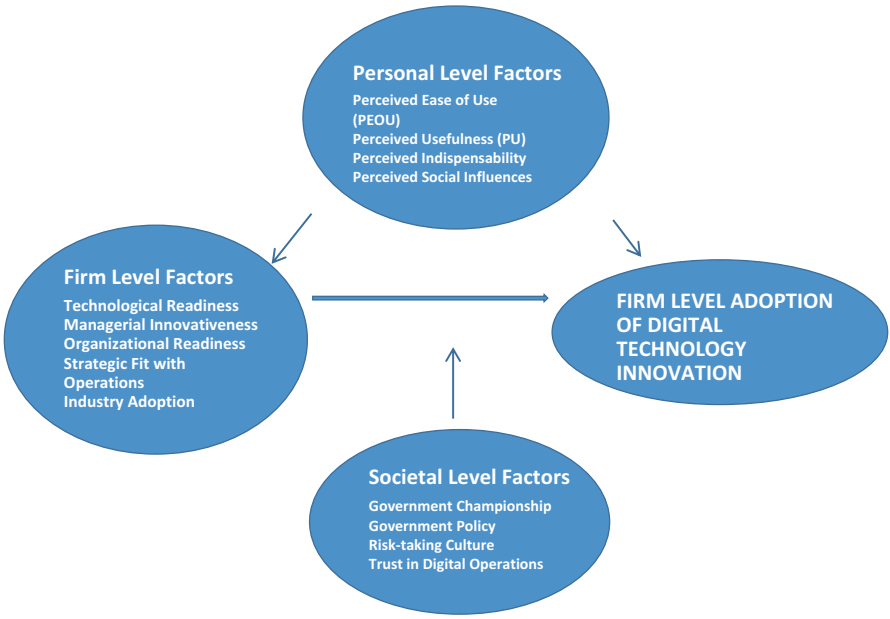

Fig. 1.1 Initial Firm Technology Adoption Model (F-TAM). (Source: Doe et al. 2017, 2018)

planner, facilitator, recorder, and reviewer or synthesizer of the data (Avella 2016). For each respondent, content analysis (Berelson 1952) became a useful mode of analysis to confirm or test a pre-existing theory (Ezzy 2002); in this case, the variables and relationships of the F-TAM model. For cross-case analysis, the concept-centric approach to qualitative data organization (Webster and Watson 2002) was used to arrange the contents of discussion into building blocks or themes. The model was then refined using pattern-matching techniques (Yin 2013).

In summary, Doe et al. (2018) found that personal-level factors can better be described as *Employee Attitudes and Perceptions*. This clearly demarcates a particular firm's employee factors from the general public human factors captured in society-level factors. On the personal level, Perceived Usefulness, Perceived Ease of Use, Perceived Indispensability, and Perceived Social Influences were confirmed in the initial F-TAM to be contextually relevant at the personal level to stimulate firm adoption. Other variables added were Trial Feedback (Rogers 1962) and Employee Self Interest (Yun et al. 2007). These factors were discovered to be contextually relevant as personal-level factors that stimulate firm-level adoption.

Factors of adoption at the firm level were decomposed into two sub-groups of internal factors and industry factors. The internal factors confirmed from the initial F-TAM include Technology Readiness, Managerial Innovativeness, Organizational Readiness, and Strategic Fit with operations. Other variables

discovered were Ease of Support (Grandon and Pearson 2004) and Organizational Culture (Škerlavaj et al. 2010). Trust was discovered as a relevant variable at the firm level but was measured under Technology Readiness (Vize et al. 2013).

Industry adoption was confirmed from the initial F-TAM, but decomposed into Customer Needs (Hauser et al. 2006), Competitive Pressure (Rogers 1962; Soares-Aguiar and Palma-Dos-Reis 2008), and Partner Requirements (Iacovou et al. 1995). These factors together formed the industry factors at the firm level.

Societal-level factors confirmed from the initial F-TAM in Doe et al. (2018) include Government Championship and Government Policy. Government Policy was, however, decomposed into Government Policy Directions and Government Laws/Regulations. Both Government Policy and Government Laws (Tornatzky and Fleischer 1990) were confirmed. Other variables discovered from the Delphi interviews were Digital Media Infrastructure (Tornatzky and Fleischer 1990), Opinion Leadership (Rogers 1962), and Successive Government Commitment (Mathews 2012). Variables deleted from the initial F-TAM were Societal Risk Culture and Trust. Risk Culture and Trust were found to be more significant at the firm level than at the societal level.

The influence of Technology Characteristics on technology adoption had been posited by Rogers (1962). This effect was unanticipated in the initial F-TAM due to the orientation of examining the interaction effect at the different levels of adoption. Technology characteristics of Innovation Flexibility, Observability, and Relative Advantage of Innovation, Innovation Triability, and Innovation Complexity were realized to be significant if the study examined firm adoption as an eco-system. Triability was measured under Trial Feedback at the employee personal level and therefore deleted from Technology Characteristics.

The results of the Delphi interviews unearthed some new relationships not anticipated in the initial F-TAM (Doe et al. 2017). These include the following:

Societal-level factors were proposed to lead to personal-level factors. Personal-level factors were proposed to moderate the link between the firm factors and firm adoption. Societal-level factors were proposed to lead to firm adoption. Societal-level factors were proposed to lead to firm-level factors. Technology factors were proposed to influence personal-level factors, firm-level factors, and societal-level factors.

The study, at this stage, proposed a revised F-TAM that contained 62% of variables of the initial F-TAM (Doe et al. 2017). In the end, these changes or linkages between the constructs were proposed to make the model more representative.

The revised F-TAM is shown in Fig. 1.2.

In this study the authors sought to quantitatively test the suggested Firm Technology Adoption Model (F-TAM) using data from a developing country context. Firstly, Doe et al. (2019) developed and tested a reliable and valid instrument for measuring firm technology adoption using variables in the

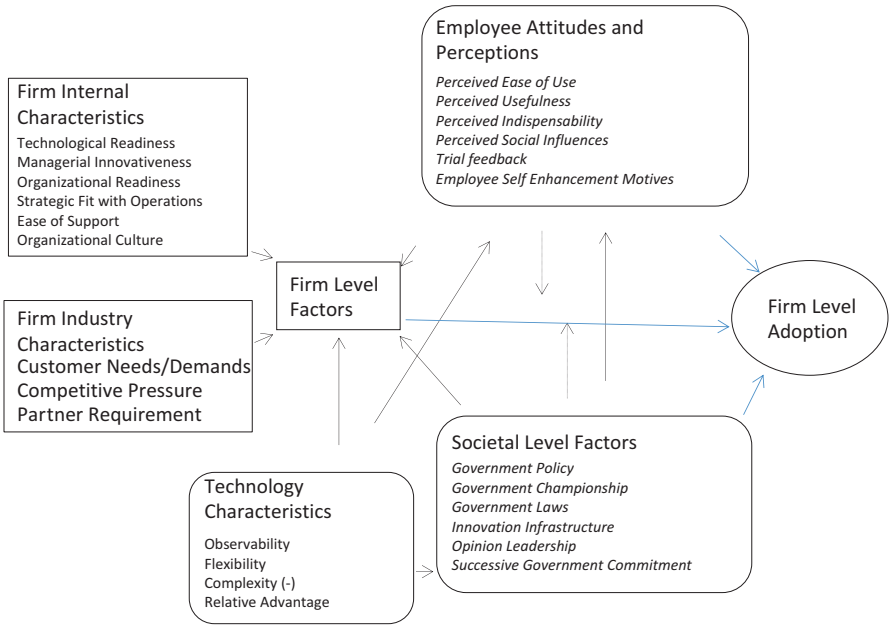

Fig. 1.2 Revised F-TAM model. (Source: Doe et al. 2018, 2019)

F-TAM. Using Churchill's (1979) process of questionnaire development, Doe et al. (2019) crafted or adapted question items from relevant previous studies, and went through an evaluation process of self-review, expert review, and focus group discussions to improve the face validity (De Leeuw et al. 2008). The questionnaire was field-tested using a sample of 25 respondents from the actual population, and was found to be valid and reliable for measuring firm technology adoption using the F-TAM. Secondly, Doe et al. (2019) collected 400 SMEs who were purposively sampled (Straits and Singleton 2017) due to the need to sample only SMEs that had, indeed, used mobile money financial technology innovation as part of their business process.

In that study, a series of hypotheses were made to test the propositions made in Doe et al. (2019). The summary of the proposed hypotheses and test results is shown in Table 1.1.

Surprisingly the data did not support the hypothesis that *Firm factors lead to firm adoption*. A significant implication from the findings in hypotheses H1, H2, and H3 is that they challenge earlier models, such as PERM, TOE, and TTF, which suggested that firm factors lead to firm adoption. Perhaps, if those studies had decoupled employee factors from other firm-level factors, the results would have been different. This finding underscored the essence of the F-TAM in examining the interrelationship between the three levels of adoption as an eco-system and decomposing employee factors from other firm-level factors.

Table 1.1 Firm technology adoption model

Hypothesis proposed	*Test results*
H1: Personal-level factors lead to firm adoption	Confirmed
H2: Personal-level factors lead to firm factors	Confirmed
H3: Firm factors lead to firm adoption	Not confirmed
H4: Societal-level factors influence personal-level factors	Confirmed
H5: Societal-level factors influence firm-level factors	Confirmed
H6: Societal-level factors lead to firm adoption	Not confirmed
H7: Technology factors influence employee factors	Not confirmed
H8: Technology factors influence firm-level factors	Not confirmed
H9: Technology factors influence societal factors	Not confirmed

Source: Authors' creation

Societal-level factors did not lead to firm adoption. This outcome similarly contradicts propositions in other models, such as the Culture, Policy and Technology framework (Bajaj and Leonard 2004), suggesting that policy issues constructed in F-TAM under societal factors will lead to firm adoption.

The results of Doe et al. (2019) triggered an inquiry into further relationships that were not anticipated and discovered that technology characteristics directly influence firm adoption. This study, furthermore, discovered that technological factors could moderate the relationship between firm-level factors and firm adoption. This particular proposition, if confirmed, would be another novel discovery in adoption studies. Earlier firm-level models such as PERM, TTF, and TOE, did not anticipate or conceive the idea of a possible strengthening of this relationship by technology characteristics.

Suspected mediating relationships were reported at this stage. Firstly, if personal-level factors lead to firm adoption and societal factors influence personal-level factors, then personal-level factors could actually mediate the relationship between societal-level factors and firm adoption. Secondly, if societal-level factors lead to firm-level factors and societal-level factors are influenced by technology characteristics, then societal-level factors could actually mediate the relationship between technological characteristics and firm-level factors. Finally, societal-level factors could mediate the relationship between technological factors and personal factors.

In a follow-up study to understand other contextual factors that could explain how firm-level factors did not lead to firm adoption (Doe et al. 2019), Doe, Van De Wetering, Honyenuga, and Versandaal (nd) sought to find out whether firm size affects the relationships posited in F-TAM, whether personal

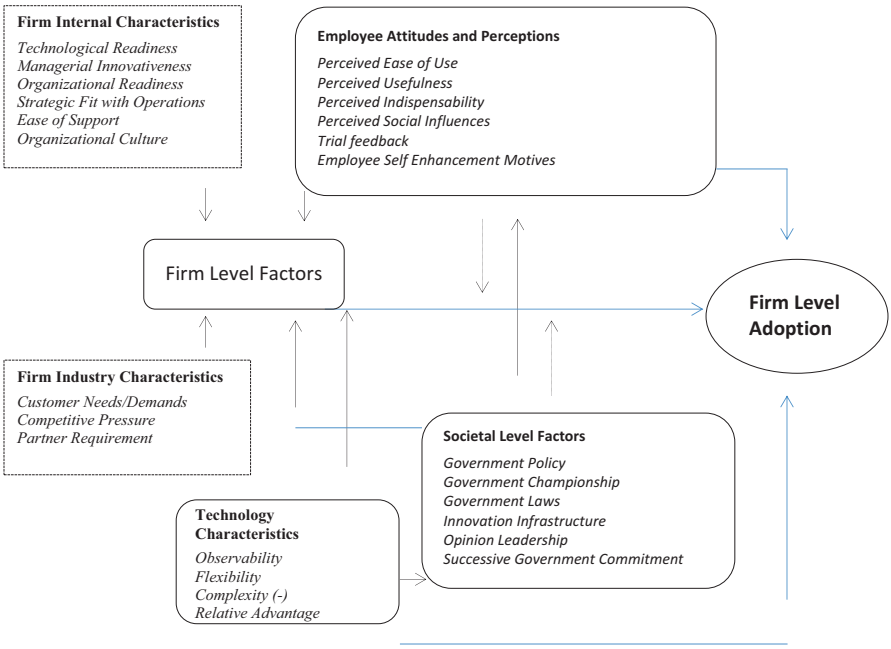

Fig. 1.3 Survey-tested technology adoption model (F-TAM). (Source: Doe et al. 2019)

factors and societal factors have any other effect on the proposed eco-system, and how technology characteristics influence the suggested eco-system of adoption. The study confirmed the relationships reported in Doe et al. (2019). Furthermore, apart from societal-level factors, personal factors and technological factors were discovered to moderate the relationship between firm-level factors and firm adoption. Without this moderating effect, firm-level factors would have been insignificant in the pool of factors that lead to firm-level adoption. The study also discovered a full mediating effect of personal-level factors on the relationship between societal-level factors and firm adoption. It was likewise confirmed that societal factors fully mediate the relationship between technology factors and firm-level factors, as well as fully mediate between technology factors and personal factors.

A pictorial view of the direct relationships supported by empirical data, in addition to the suspected moderating relationships, is shown in Fig. 1.3.

Reflection on F-TAM

The F-TAM is posited as an interaction of four groups of factors to influence adoption. The four groups of factors include personal-level factors, firm-level factors, societal-level factors, and technology-related factors. In the following sections, these relationships and factors are discussed.

Employees' Individual-Level Factors

These are individual perceptions or attitudes toward the technology. These factors can lead to technology adoption as a firm even when the firm has not officially prepared itself nor sanctioned the adoption of the technology. Employee adoption produces a subjective norm within the working environment, which leads to the emergence of other factors at the firm level. When the firm decides to organize itself to adopt (factors of adoption), adoption becomes easier because the actual users within the firm will indeed adopt. Their adoption will reinforce (moderation effect) the firm's effort to adopt. The only significant group of factors that precipitates these personal-level factors, according to the F-TAM, is the societal-level factors. Thus, employee personal factors serve as a mediator between societal-level factors and firm adoption, as well as between societal-level factors and firm-level factors. Specific factors at the employee personal level are:

Perceived Usefulness (PU) (Vankatesh et al. 2003). This is the degree to which a person believes that using a technology will increase his/her job performance or output: it is the performance outcome expectancy of the technology.

Perceived Ease of Use (PEOU) (Vankatesh et al. 2003). This is the degree to which a person believes that using a technology will be free of effort: the degree of ease associated with technology use.

Social influences (SI) (Shinh et al. 2013). This is the extent to which the adopter perceives that important others, such as family and friends, believe he/she should use a technology: the extent to which the use of a technology demonstrates class boundaries or social standing.

Perceived Indispensability (PI) (Shinh et al. 2013). This is the extent to which livelihood, work, or an activity is dependent on the use of a technology.

Trial Feedbacks (Rogers 1962). This is the post-trial perception of the technology an individual holds.

Perceived Employee Self-Enhancement Motives (Yun et al. 2007). This is the extent to which an employee believes the adoption of a technology will yield a personal tangible or performance benefit.

Firm-Level Factors

Firm-level factors: These are all preparations in the form of technical, infrastructural, and financial preparations that the organization must have to be able to adopt a technology. In many earlier models, this factor had been proposed to include human resources (Employees). In the F-TAM, however, decomposing employee factors out of organizational factors shows a divergent result worth mentioning. Apart from the employee factors, the rest of the factors at the organization level were not significant in precipitating firm-level adoption. If employee-level factors were part of organizational factors, the result would have shown a significant effect on firm adoption just as earlier models have

reported. Indeed, this result highlights the essence of examining the phenomenon of adoption from an eco-system perspective. These organizational-level factors are precipitated by internal factors, industry factors, societal-level factors, and employee factors. Among SMEs in general, these organizational-level factors would be irrelevant without the moderating influence of personal, societal, and technological factors.

Among large firms, however, these organizational factors are likely to lead directly to firm adoption. In this regard, one issue worth investigating in further studies is whether industry factors alone would precipitate firm adoption if it is decoupled from the internal organizational factors, just as employee factors were decoupled from firm-level factors. Specific factors at the organization level are:

Technology Readiness/Innovative Readiness (Boateng et al. 2011). These are the availability of internal technologies relevant to the firm, the current technology, and the knowledge required. This variable also measures Trust (Vize et al. 2013).

Managerial Readiness (Lumpkin and Dess 2001). This is the management's attitude toward change, future orientation, proactivity, support, and risk behavior.

Strategic Fit with Operations (Goodhue and Thompson 1995). This is the extent to which a technology fits business operations or tasks to be performed.

Organizational Readiness (Boateng et al. 2011). This is the scope, size, managerial structure, organizational slack resources, business process, creativity, and openness of the firm, that is, the preparedness of the organization toward future environmental changes.

Ease of Support (Grandon and Pearson 2004). This is the ready availability of a technical hand to assist the firm in resolving initial and further problems that may arise from the use of a technology.

Organizational Culture (Škerlavaj et al. 2010). It is the predisposition to try new technologies and to absorb possible gains or losses resulting from an adoption attempt.

Customer Readiness/Market Demand (Hauser et al. 2006). The extent to which serving a particular customer group requires the use of a technology.

Competitor Pressure/Actions (Rogers 1962). This is the extent to which industry competition is dependent on the adoption of a technology, that is, the extent to which a competitor's action produces pressure, as well as the mimetic response by rivals in the industry.

Partner Requirements (Dimaggio and Powell 1983). This is the extent to which firm partners require the firm to use a technology in its transactions with them.

Societal-Level Factors

For firm-level adoption of a technology innovation, societal-level factors are macro-environmental readiness and changes that must happen to lend support to adoption. These are mainly governmental actions and support for adopting, societal active promotion in the form of a recommendation, and infrastructure. Since organizations exist in a society, these societal-level factors lead to the availability of factors at the firm level through a diffusion process. They, however, do not lead directly to firm adoption. At any time an organization decides to adopt a technology, these societal factors reinforce the organizational effort (a moderation effect) to adopt. The only significant group of factors that precipitate societal-level factors are technology characteristics. Therefore, societal-level factors mediate between technology characteristics and employee-level factors, as well as between technology characteristics and firm-level factors. The specific factors at the societal level are:

Government Championship (Howell et al. 2005). This is the extent of active promotion made by influencing top-level government officials, their views of the technology, support, and active removal of obstacles.

Government Policy (Bajaj and Leonard 2004). These are deliberate policies aimed at promoting a technology in a country or social system.

Government Laws (Tornatzky and Fleischer 1990). These are a society's set of laws and legal instruments that regulate the purchase, use, and disposal of a technology/innovation.

Opinion Leadership (Rogers 1962). This is a *word of mouth communication* in which one person (opinion leader) informally influences the actions and attitudes of others who may be opinion seekers or opinion recipients.

Technology Infrastructure (Tornatzky and Fleischer 1990). This is the supporting infrastructure, such as telecommunications networks, upon which a technology or an innovation can thrive within the society.

Successive Government Commitment to Promoting Innovation (Mathews 2012). This is the extent to which previous government innovation-related projects, policy, and actions are continued by successive governments.

Technology Characteristics

Technology factors are the characteristics of a technology itself, as proposed by Rogers (1962). True to this proposition, when a technology (innovation) is observable, offers a relative advantage, is not complex, is flexible, and can be tried before full adoption, it can be adopted directly without the influence of other factors. Technology characteristics, however, strengthen (moderates) the firm's effort to adopt a technology. Technology characteristics do not directly influence personal factors nor organizational factors, but indirectly do. Specific technology-related factors examined in the F-TAM are:

Flexibility: This is the relative ease with which a technology can be applied to do different things apart from what it was initially defined to do.

Observability: The relative ease with which the technology can be seen by others who use it early.

Relative advantage: These are the benefits that the usage of the technology provides over other competing technologies.

Complexity: This is the relative difficulty associated with the use of a technology, and is expected to have a negative relationship with adoption of the technology.

Reflection of Relevance and Further Studies

Scientific Relevance

This study makes some critical contribution to the field of innovation studies in business research. This central idea of the F-TAM is a significant departure from earlier models. While it challenges propositions in earlier models, it proposes new concepts and variables for further studies. The study has significant implications for scholarly debate and further studies. Among the technology adoption and innovation studies, the study proposes a new model called the Firm Technology Adoption Model (F-TAM). This model is an interactive ecosystem model that examines the effect of both personal-level and societal-level of adoption on firm factors of adoption as well as on firm adoption. The study challenges the dominant idea in earlier studies that factors of adoption at any particular level of adoption alone will generally lead to adoption. This idea is prevalent in models such as TAM, TRA, ITMA, UTAUT, and DOI at the personal level; TOE, PERM, and TTF at the firm level; and CPT and PERM model at the societal level.

This study challenges the idea of positing intention to adopt as a sole antecedent of adoption, with all other factors leading to intention to adopt. This is because the gaps between intention to adopt and actual adoption are the contextual gaps of socio-economic development, infrastructure, and cultural norms, which can often hinder actual adoption in some contexts.

This study is the first to propose an interactive eco-system of measuring adoption of a technology and, by extension, any innovation; and prompts a re-examination of earlier models at personal, firm, and societal levels with regard to other influences.

Industrial Significance

For industry practitioners, the findings of this study provide a framework with which organizations can easily promote adoption of any innovation in the organization context. The interactive effect highlights where emphasis needs to be laid in order to ignite adoption and the sustainability of the digitized technology. For instance, at the firm level, employee factors and the nature of

the technology itself are more important than other internal organizational factors. This idea is obviously missed by earlier models that classify all firm-level factors as one. 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 firm technology adoption.

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. This is more so for technological strategies if they are to be sustainable. 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 factors shown in the F-TAM model. Firms that understand the interaction effect of adoption factors are more likely to deploy more sustainable strategies that lead to sustainable corporate performance in the competitive digitized era than those that do not.

Limitations and Future Research

This study has limitations that future research should seek to address.

Firstly, the proposed model has only been tested using data from one developing country context. Further studies would need to sample data from multiple developing country contexts. This may be done with larger samples of over 2000 SMEs randomly sampled across regions.

Secondly, the discipline of marketing posits with the marketing orientation (Kotler and Levy 1969) that customer needs are placed at the heart of the 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 factors are decoupled from internal organizational factors at the firm level, industry factors could lead to adoption. This needs to be explored in further studies.

The proposed new model has just begun its journey of acceptance and validation. Apart from an extended study in other developing country contexts, the model needs to be go through a comparative test, *vis-a-vis* other models that have been proposed to explain technology adoption or any other innovation at the firm level. Further studies can focus on this area.

In the course of developing this model (more precisely at the second stage), some relationships were deleted due to their ability to cause a feedback effect in the model. For instance, whether personal-level factors will influence societal-level factors; whether firm-level factors will influence societal-level factors and personal-level factors; and what effect firm adoption will have on personal-level factors, firm-level factors, and societal-level factors. These are all worth exploring in further studies.

The F-TAM was tested among SMEs under voluntary adoption conditions. There are circumstances under which governments impose some mandatory conditions for firms to adopt, or firm managers impose mandatory conditions

for adoption. Further studies of SME adoption under mandatory conditions is recommended to explain what variations can occur in this model.

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