Technological Entrepreneurship Appraisal in Developing Countries: Challenges and Opportunities

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Abstract

This study aims to assess the challenges and opportunities in developing countries' technological entrepreneurship businesses in terms of competitive advantage and business performance, with a focus on SMEs. The study empirically examines the development of technology and entrepreneurship in developing countries. According to the findings, technology has been highly integrated into entrepreneurial activities (most especially in the aspect of the production process and innovation in marketing). In terms of the roles that technology has played in the development of entrepreneurship, it has primarily led to a shift from traditional modes of operation to a new frontier; it has also contributed to innovative improvements in the manufacturing process and enhanced marketing activities. Some challenges do exist with respect to integrating technology into entrepreneurship; the major challenge happens to be the complexity of integrating technology into an existing business; other challenges include the literacy level of the entrepreneurs and a lack of finance. Conclusively, the result of this study shows that the adoption of new technologies has a positive effect on competitive advantage. It also has a significant relationship with business performance. To ensure adequate company performance, all actors in government and entrepreneurship schemes must pay special attention to training workers on the effective use of technology in the management process of small enterprises. The government should make available a variety of financing options to entrepreneurs at reasonable rates. This will curtail the burden and challenges experienced in trying to integrate technology into entrepreneurship.

Keywords: *Technological Entrepreneurship; competitive advantage; SMEs; Business Performance*

Introduction

The conversion of discovery, development, and dissemination of technological innovations at the national level has become a part of the innovation and economic agenda for every developed economy (Mosey, Guerrero and Greenman, 2017). As Li *et al*. (2008) note, "technology entrepreneurship is an important way to commercialise technological innovation". Countries across the world, recognising this, now implement policies to support technology entrepreneurship. As a result, research has advanced, not just into exploiting technological innovation and capabilities, but also into translating this knowledge into commercially viable businesses. As Litan and Song (2008) point out, it is not enough to understand the development of new technologies, but entrepreneurs also need to exploit and commercialise them. The formation of small startup firms developing inventions and introducing technological discoveries with

significant potential and commercial application is crucial to the 'smart economy.' The process by which this is achieved is referred to as technology entrepreneurship (Evers, Cunningham and Hoholm, 2013).

One key to competitiveness and sustainability of regions and nations is to apply and interpret technological knowledge into practical businesses (Stokes, 1997). However, the domain of technology entrepreneurship is still very new, and the existing knowledge surrounding this phenomenon is still very limited (Beckman *et al*., 2012; Lindholm Dahlstrand, 2007). Moreover, while the terminology often floats around business, management, governmental, and academic circles, there is no common definition or understanding of the term (Spiegel and Marxt, 2011; Ratinho, Harms and Walsh, 2015).

Early academic research used the term 'technical entrepreneurship' and related it to the founding of new ventures, through 'spin-offs' either from university departments or industry research laboratories. For instance, Cooper (1971) uses the term 'technical entrepreneurship' to refer to "a company which emphasises research and development which is often founded by scientists or engineers, and usually includes a substantial percentage of professional technically trained personnel." Lamont (1972) describes 'technical entrepreneurship' as the desire of a university entrepreneur to commercialise new technology and start a new company.

The migration from 'technical' to 'technological' can be seen in recent studies, even though the terms are still interchangeably used. For instance, Jones-Evans (1995) defines a technical entrepreneur as the founding owner of a technology-based business with the responsibility of planning, launching, and managing the organisation. In the same vein, Nichols and Armstrong (2003) suggest that technology entrepreneurship has to do with organising, managing, and bearing the risk of technology-based businesses.

A rather complex definition is given by Jelinek (1996), who describes technology entrepreneurship as a "quintessentially social activity, requiring joint efforts to interpret ambiguous data, joint understanding to sustain technology efforts, and a persistent, coordinated endeavour to accomplish technological change." Based on the premise of 'opportunity discovery,' technology entrepreneurship can be defined as the use of technology to discover and exploit market opportunities and provide solutions. Indeed, Liu *et al*. (2004) define technology entrepreneurship as the way in which entrepreneurs draw on resources to exploit emerging technology opportunities. Technology entrepreneurship is of the 'character of opportunity', defined as the discovery and exploitation of market opportunity of technology (Li *et al*., 2008).

What distinguishes technology entrepreneurs from other types of entrepreneurs is how they employ science and technology to approach and exploit market opportunities. In proposing a technology entrepreneurship policy framework for the US network economy, Hemphill (2005) refers to technology entrepreneurship as a business leadership style based on identifying potential high-technology-intensive opportunities, putting together resources such as human capital and cash, and using instantaneous decision-making skills to manage rapid growth. Similarly, Bailetti (2012) explains technology entrepreneurship as an investment in projects which engage special individuals and heterogeneous assets, committed to advances in scientific and technological

knowledge, for the purpose of creating and capturing value for the firm. Furthermore, Beckman *et al.* (2012) point out that technology entrepreneurship exists when "developments in science or engineering constitute a core element of the opportunity that enables the emergence of a venture, market, cluster, or industry."

Review of previous studies had demonstrated that there is a growing trend of technology entrepreneurship in Nigeria, with Nigeria leading Africa in the number of new technologies startups and startup investments. The government of Nigeria also recognises that technology entrepreneurship plays a key role in the development of the economy and has constructed policies and ideas to aid the establishment of technology ventures. However, in implementing these ideas, the government has failed woefully. A review of the literature of technology incubators in Nigeria reveals that there is little to no activity in the incubator scene, bearing in mind that all of the studies have narrowly focused only on government-sponsored and operated incubators. This is somewhat paradoxical, as the majority of the literature on entrepreneurship in Nigeria recognises that leaving the government to execute ideas always ends up having negative outcomes. This is why, in this study, more emphasis is given to privately operated technological ventures, which are completely neglected by previous researchers. Moreover, the research will bring the state of technology entrepreneurship in Nigeria up to date and investigate the challenges of technological ventures in Nigeria.

Literature review

Overview of Technology Entrepreneurship

More recently, a call for a review and consolidation of definitions of technology entrepreneurship has led to the appearance of new terms – digital entrepreneurship and digital technology entrepreneurship (Mosey, Guerrero and Greenman, 2017; Giones and Brem, 2017). Giones and Brem (2017) argue that definitions of technology entrepreneurship have evolved because of the conceptualisations of the term 'technology.' Although research in the field of technology entrepreneurship began as a result of the entrants' new ventures into high-tech industries (Gans and Stern, 2003), the focus of the majority of previous research has been on how technology is commercialised, such as academic spin-offs (Wright *et al*., 2007; Fryges and Wright, 2014; Mosey, Guerrero and Greenman, 2017). This has led researchers to focus on a 'technology-push' situation, in which the entrepreneur has a mission of creating a new technology, and finding a market and application for the new technology (Mojica *et al*., 2009; Giones *et al*., 2013). Digital entrepreneurship, however, is not concerned with the specifics of the technology behind a business idea, but rather on the service or digital platform that is based on it, while digital technology entrepreneurship is a hybrid of traditional, science-based technology entrepreneurship emanating from university intellectual property (Hartmann, 2014) with new and rapidly evolving internet-based digital startups or ventures (Giones and Brem, 2017).

Based on these definitions, the opportunities do not have to be revolutionary; they can be evolutionary advancements targeting an existing market or creating a new one. Together, these studies indicate that the definition of technology entrepreneurship will continue to evolve. However, they provide important insights into the field. While a variety of definitions of technology entrepreneurship have been suggested, in this thesis, the term technology entrepreneurship will be used in its broadest sense to refer to the discovery and exploitation of technological ideas and their use in creating new ventures by an individual or team of entrepreneurs.

Elements of Technology Entrepreneurship from Literature

Technology entrepreneurship is a field with some level of confusion and misunderstanding, either in the terminologies used, or of the criteria that constitute a 'technology venture.' Conversely, as with the general phenomenon of entrepreneurship, the approach to the study of technology entrepreneurship can broadly be divided into three levels (Phan and Foo, 2004):

The technology entrepreneur: Concerned with the individual, or team of individuals, responsible for founding and managing the technology venture.

The Venture: concerned with attributes and characteristics of the team, structure, process, and organisational linkages that mark a technology venture.

The Environment: Concerned with the role of technology and how the technology venture interacts with its environment, such as industry standards, government policies, geographical location, and markets.

The Technology Entrepreneur

In any entrepreneurial venture, the founder or owner-manager plays a crucial role and is central to the invention, survival, and success of the firm (Newton and Gary Shreeve, 2002). As Baron (2004) points out, the success of an entrepreneurial venture hinges on the actions of the entrepreneur, such as "the decisions they make, the strategies they develop, and the style of leadership they exercise." Likewise, in technology entrepreneurship, the founder or founding team plays a key role in the lifecycle of the entrepreneurial process. What is more, in technology entrepreneurship the firm is dependent on the technical knowledge of the founder or members of the founding team; in an earlier work, Cooper and Bruno (1977) note that the primary strength of a high-technology firm is in the knowledge and skills of its founders:

If the founder is strong in engineering, weak in marketing, and completely lacking in financial skills, then the new company must struggle with that combination of strengths and weaknesses. If a team of founders is carefully assembled, skills can be complementary, and the new firm is more likely to have the full range of capabilities needed to survive and prosper (Cooper and Bruno, 1977).

Nonetheless, the success of a 'technology firm' is not restricted to entrepreneurs who are deemed to be 'technical.' There are instances where a non-technical entrepreneur has successfully founded and managed a 'technology company.' An entrepreneur who is bold, imaginative, and constantly seeking opportunities to commercialise new products and technologies also has equal chances of founding and managing a successful technology firm (Baumol, 2002). Recognising

their technical weakness, the entrepreneur has the option of combining with a technical co-founder or assembling a technical team who concentrate on producing the technology product or service to be exploited (Oakey, 2012). Some such examples include the Steve Jobs and Steve Wozniak partnership in creating Apple, Inc., Jack Ma of Alibaba, Tim Westergren of Pandora, Jeff Bezos of Amazon, Andrew Mason of Groupon, and Michael Bloomberg of Bloomberg (Dorf, 2008; Oakey, 2012).

Nevertheless, where complex technological advancements are central to the venture, the talent, experience and actions of the entrepreneur are overwhelmingly significant (Beckman *et al*., 2012b). Technology entrepreneurs have been recognised to display characteristics that are quite different from other types of entrepreneurs. In addition to their technical knowledge and industry experience in a particular technology or research lab (Cooper and Bruno, 1977; Colombo and Grilli, 2005), they are known to have some level of advanced degree, mostly in engineering and/or science, with an impressive social network of colleagues to aid in building the venture (Barringer, Jones and Neubaum, 2005). Cooper and Bruno (2000) recognise that technical entrepreneurs are moderately motivated by high financial rewards and highly motivated to apply their creative and technical skills to solving real issues.

One often-pursued avenue has been an attempt to relate the experience and talent of the technology entrepreneur to their venture performance. Roure and Keeley (1990) propose that, in measuring the success of a technology-based venture, while individual traits and skills are important to the founders or founding team, relevant experience is just as (if not more) valuable. Jones-Evans (1995) argues that technical entrepreneurs can be differentiated based on their occupational and organisational background into researcher, producer, user, and opportunist. This classification is useful and will be discussed further below: it provides a basis for differentiating the performance of 'technology-based' ventures, as well as providing cues to how policymakers can support technology entrepreneurs.

The State of Technology Entrepreneurship in Nigeria

This study is focused on Nigeria because of its vibrant technology entrepreneurship activities. Nigeria is sometimes considered the 'silicon valley' of Africa because of the existence of multitude of growing successful technology ventures (Obasemo, 2015). Some examples of these are: Iroko TV, Jobberman, Andela and Hotels.ng. IrokoTV, dubbed the 'Netflix of Africa' whom closed several funding rounds of investment in excess of US$30m (Fick, 2016); Jobberman which has grown into one of Sub-Saharan Africa's most popular job search engines with more than 1.5million visitors monthly and one of the companies in Nigeria's technology space enjoying venture capital backing. It was 100% acquired last month by the $167million-valued One Africa Media (Asegbeloyin and Ndiomewese, 2015). Andela, another Nigerian technology venture has raised $40 million so far in seed funding (Shieber, 2017). It is backed by investors including DBL Partners, Chan Zuckerberg Initiative, GV, Spark Capital Amplo, Salesforce Ventures, and Africa-focused TLcom Capital. Hotels.ng which started in 2012 has now grown into the biggest online hotel booking agency in Nigeria, using seed investment of $225,000 from SPARK in 2013. It became another beacon of success in Lagos technology space when it announced its first funding

round of $1.2million from EchoVC Pan-Africa Fund, a seed-stage technology fund, and Omidyar Network (Ibukun and Ackerman, 2019).

In addition to growing technology ecosystem, Nigeria is one of Africa's leading destination for venture capital investment. In 2017, $560m was invested into African new technology ventures by VCs focused on African markets. South Africa, Kenya and Nigeria continue to dominate as investment destinations accounting for 76% of total (Kazeem, 2018). In 2018, a report by Disrupt Africa reported that Nigeria has emerged as the premier investment destination for venture capital in 2018; with 58 new technology ventures raising a total of US$94,912,000. South Africa fell behind with 40 businesses raising US$59,971,000; while Kenya ranked third in terms of the number of technology venture that attracted new venture capital funds (Disrupt Africa, 2018).

The ventures mentioned above are just a few examples of successful technology ventures in Lagos, Nigeria. Although it may be challenging to reflect Nigeria's development of technology entrepreneurship with other sub-saharan countries as cultures and political climate differs. However, in many ways, Nigeria can be used as a representative symbol of technology entrepreneurship development in the region of sub-saharan Africa, as it is the country with the largest economy and population in Africa.

Nonetheless, In Nigeria, the field of technology entrepreneurship is still very much in its early stages. A research study carried out by VC4Africa (2015), the biggest online community of African entrepreneurs and investors, revealed Nigeria to be one of several countries acting as technology venture hotspots of Africa. The research, which tracked 104 investments in start-ups across Africa, named Nigeria as the top destination for investment, spotting an upward trend in technology entrepreneurship in the country in coming years.

In spite of this, there are very few academic studies on technology entrepreneurship in Nigeria. The first serious discussion and analysis of the state of technology entrepreneurship emerged in the 1990s, when Adjebeng-Asem (1990) examined some factors that had led to the state of technical entrepreneurship in the country. The study highlighted negligence by bureaucrats and ruling class Nigerians of the part played by technological innovations within small-scale informal enterprises in establishing technology-based industries in more developed countries, such as Britain and the United States. At the time, there was a clear divide between the 'formal' and 'informal' sector, particularly in employment, with the former consisting of medium to large-scale enterprises that employed not less than ten people, made up of private and public business establishments, Federal and state government companies, departments, ministries, and agencies. The informal sector, on the other hand, comprised small-scale organisations involved in the production of goods and services, employing less than ten people (Adjebeng-Asem, 1990). The study used empirical data from a previous study that examined blacksmiths of Ife (Western part of Nigeria) and other parts of Nigeria and found that, fundamentally, the efforts of these small-scale blacksmiths had been ignored and considered inconsequential. Furthermore, the paper highlighted some critical factors in the social structure of the economy that undermined the potential of technical entrepreneurship, such as drive, tenacity, dynamism, natural aptitude, and sheer will to survive, in the socio-economic development of the country. Adjebeng-Asem (1990) suggested that

the Nigerian government should address these shortcomings and organise a systematic evaluation of the potential and capability of the sector, particularly the assembly plants in the eastern part of Nigeria, and investigate ways of helping improve their skills and the quality of their products and services.

It seems possible that these results were due to the state of Nigeria at the time, considering the country was just thirty years into independence and in full control of its booming oil industry. Additionally, the sample selection of blacksmiths in rural Nigeria raises questions of the author's understanding of technical or technology entrepreneurship, as the study fails to define the boundaries of technical entrepreneurship. Nonetheless, the study happens to be the only one to provide an overview of the state of technology entrepreneurship in the country at the time. However, the political turmoil that engulfed the country in the 1990s left Nigeria in a deplorable state, with little to nothing done to improve the standard of living of its population, help small and medium businesses, or invest in infrastructure.

Over the past decade, much more information has become available on the state of technology-based entrepreneurship in Nigeria. A prominent study by Aderemi *et al*. (2008) examines the mechanisms used in learning, as well as the factors that influence the choice and performance of women in technological and non-technological, small-scale enterprises and identifies self-conceptualization, friends, business contacts, internet, and radio as some of the learning mechanisms. On the other hand, relevant programmes on television, attendance at trade fairs, government-organised programs, seminars, and workshops had a substantial impact on the choice of technological ventures by women. The study, which was conducted on 210 technological and non-technological women's businesses in south-western Nigeria, found that while unemployment was a major motivation factor for women to start non-technological businesses, the case was different for technological businesses. According to the studies, women are more inspired to start a technology-based business based on personal interest rather than unemployment (Aderemi *et al*., 2008). Additionally, it was revealed that age, role model/mentor, educational background, previous experience, and socio-cultural factor are significantly responsible for the choice of ventures, either technological or non-technological, although the learning mechanisms of television, trade fairs, and seminars were more relevant to technological ventures.

While this prominent study is useful in understanding some of the motivations and learning mechanisms for both technological and non-technological ventures, it has some limitations. Once again, the study fails to define what it refers to as technological and non-technological ventures, raising questions about the author's understanding of technology entrepreneurship. It also fails to consider how any of the motivation factors or learning mechanisms influence the entrepreneurship process (idea generation, raising capital, product launch, marketing, and building an organisation). Another weakness is its limited scope of focus on just women in entrepreneurship.

A significant analysis and discussion of the subject of technology entrepreneurship is given by Siyanbola *et al*. (2011) who present a framework for developing technology entrepreneurship in developing countries. The study, which asserts that "technology entrepreneurship is the creation of new ventures to exploit technological innovation and discoveries", highlights the roles of

technological entrepreneurship in socio-economic development. Siyanbola *et al*. (2011) list the main principles as follows;

- Technology entrepreneurship is an instrument used to introduce technological innovations into the marketplace. Where there are breakthroughs in research and development laboratories, it is the place of a technology entrepreneur to commercialise the product or service.
- Technology entrepreneurship possesses the capability of improving a country's technological know-how. As technology entrepreneurs make efforts to start ventures, commercialise products, and introduce innovative services, learning takes place either by direct involvement or simply through observation, thus improving the region's knowledge of technological activities.
- Through the efforts of commercialising new technologies from research laboratories, patents are generated, which is one way to measure a country's technology capabilities and development.
- Technology entrepreneurship serves as a platform to bring about the successful diffusion of technological innovation in an economy.
- For technology entrepreneurs to be successful in their ventures, they thrive to meet the necessity of market needs which brings about socio-economic development.

Siyanbola *et al*. (2011), from their study, present a framework for technology entrepreneurship development. The framework suggests that technology entrepreneurship facilitates the innovation process by creating the impetus that drives each step in the process (idea generation and screening, discovery, feasibility study, development of prototype, patenting and approval, production, marketing, and adoption), and dictating the mode and quality of value creation from those steps. Additionally, the framework suggests that technology entrepreneurship is enabled by favourable policies, institutions, financial and institutional support. The main weakness of this study, however, is that it is conceptual, rather than based on empirical data, which creates a gap for future studies to expand on the subject and contribute to the literature.

Challenges and opportunities in technological entrepreneurship

Disruption is a term used in technology and entrepreneurship to refer to a form of innovation that creates new market and value networks at the cost of displacing existing and established market-leading firms, products and alliances (Venkataraman, 2004). In a study which compared the importance of talent and experience in venture performance, Eesley and Roberts (2012) discovered that highly talented founders have a greater incentive to generate entrepreneurial experience by learning from each experience. Once an industry has been disrupted, the impact of prior funding experience becomes negative. Similarly, Furr, Cavarretta and Garg (2012) argue that, in an unfamiliar and dynamic environment, management with more flexible reasoning talent are more likely to influence major changes than teams with experience in a focal industry. As

Eesley and Roberts (2012) state, "After an industry technological disruption, talented but inexperienced entrepreneurs have a better chance of seizing the opportunity."

Furthermore, researchers have shown that a founder's human capital affects the performance of a 'technology-based' venture. Formal education level, sound prior experience, a profound level of existing technological knowledge, and good knowledge of the market of operation all have a positive influence on technology companies (Marvel and Lumpkin, 2007). Similarly, Gimmon and Levie (2010) suggest that relevant human capital - such as having previous business experience and technological background - influences the survival of a technology venture. Pickernell *et al*. (2011) assert that graduate entrepreneurs have a greater propensity to be able to gain access to knowledge and a range of resources, including government resources, university advice, informal networks/trade associations, and direct industry resources.

Conversely, after a study of 506 high-tech industries in the manufacturing and services industry in Italy, Colombo and Grilli (2005) found that, in new technology-based firms, the founder's educational background and previous work experience affect the performance of the venture differently. While the years spent in education had no relation to the growth of the firms, specific education in graduate and undergraduate levels of economics and managerial fields had a more positive effect on the firm's growth. Furthermore, in professional experience, founders with previous technical experience in the field of the new venture had superior results to founders with experience in a different industry or in the same industry but in commercial functions. Studies which use econometrics as a method of analysis fail to acknowledge how their findings might differ in a different geographical setting. Ganotakis (2012) highlights the need for technical entrepreneurs to complement their technical skills and knowledge with managerial capabilities gained from either education or experience.

All the studies reviewed so far, however, suffer from a selection bias, either by selected companies or in specific regions and industries. One question that needs to be asked is: in developing regions, where there is limited technology knowledge and poor education infrastructure, what human capital, skills, and characteristics would be necessary for technology entrepreneurs to launch a successful venture? Moreover, are technology knowledge and managerial experience enough to launch a technology company? As pointed out, much research on technology entrepreneurship uses the biotechnology and semiconductor industries as its setting. As a result, we know little about entrepreneurial activity in novel areas, such as ventures that rely on user-driven technical innovations, pursue technical innovations for education, and target technologies for developing economies. (Hitt *et al*., 2010). "Is technology entrepreneurship different in these settings Hitt *et al*. (2010)?" asked. Having discussed the characteristics and experiences that influence the founders or founding team, it is important to ask how they come up with new ideas and discover opportunities. The next section discusses how the individuals or founding team of a technology firm explore opportunities and ideas and how they exploit them to form new ventures.

The Idea/Opportunity

It is generally agreed that the entrepreneur is utterly crucial in technology entrepreneurship; in most cases, it is the job of the individual founder or founding team to identify and evaluate opportunities and to come up with the ideas and strategies to explore them. Duening, Hisrich and Lechter (2009) maintain that all technology ventures are based on the vision of a new product or service tapped by the founder or founding team. Moreover, the major difference between technology entrepreneurs and conventional entrepreneurs is the involvement of technological/technical systems in the ad hoc nature of their venture. Aside from that, idea-generation and opportunity recognition are among the general characteristics shared with other categories of entrepreneurs (Dorf, 2008; Evers, Cunningham and Hoholm, 2013).

In describing the formation phase of a new technology venture, Spiegel and Marxt (2011) note that both new and existing technology ventures constantly find new ways of introducing new products and services, and building improved ventures. The question often asked by every technology entrepreneur is: "What problem can I solve using technology that can create a successful business?" Thus, "How can technology-based companies uncover, generate and select new business opportunities?" (Duening, Hisrich and Lechter, 2009). Entrepreneurship begins with an idea which, when evaluated, becomes a valuable opportunity.

However, the factor distinguishing technology entrepreneurship from other entrepreneurship domains is the high rate of innovation. Innovation is defined as something new, either a new way of developing a product or an improved process (Van de Ven *et al*., 1999). Schumpeter (1950) originally introduced the concept of innovation as the use of new technologies and new ideas to produce the effect of 'creative destruction.' According to Schumpeter (1950), while established companies were concerned with improving their normal ways of carrying out activities, new entrants (innovators) used the concept of creative destruction to introduce new products and services. That said, innovation is beyond just invention or introducing new products and services. It spans the entire entrepreneurial process and can sometimes be found in reinventing products (Evers, Cunningham and Hoholm, 2013). In addition, it is important to ask what factors influence technology entrepreneurs to generate and explore technological ideas and opportunities and how these factors influence them.

Generally, in entrepreneurship, there are two broad motivations of ideas which lead to the creation of new firms: entrepreneurship out of *necessity* and entrepreneurship out of *opportunity* (Broughton and Ussher, 2014). While opportunity entrepreneurs participate in entrepreneurship activities in order to exploit perceived business opportunities, necessity entrepreneurs get involved in entrepreneurship as a requirement, usually as a result of having no other employment option. (Block and Wagner, 2010). That said, job satisfaction could be another motivating factor for necessity entrepreneurs (Acs *et al*., 2004), while Hechavarria and Reynolds (2009) found that opportunity entrepreneurship has a strong correlation with high-technology, high-growth firms.

While it may be true that technology entrepreneurship is mostly explored by opportunity entrepreneurs who choose to start a business opportunity by taking advantage of a perceived opportunity (e.g., Bill Gates, Steve Jobs), this fails to consider regional factors, such as emerging economies where there is a population of necessity entrepreneurs. Is it possible that opportunity

entrepreneurship is enhanced by the regional environment in which the entrepreneur is situated? Or would perceived opportunity entrepreneurs thrive in building successful technology ventures in a region where the practice of entrepreneurship is predominantly out of necessity?

The background of a technology entrepreneur can also be a motivating factor to the type of ideas and opportunities found. In a study of the typology of technology entrepreneurs, Jones-Evans (1995) identifies four distinct types of entrepreneurs, based on their organisational background: the research technical entrepreneur, the producer technical entrepreneur, the user technical entrepreneur, and the opportunist technical entrepreneur.

The technical entrepreneur who has a foundation in scientific or technical development at a university or other academic higher institution is termed a research technical entrepreneur (Jones-Evans, 1997). The research technical entrepreneur is often linked to the academic entrepreneur since they originate typically from university settings, research labs or spin-offs (Wright, 2007). The producer technical entrepreneur has previous experience in a larger organisation, with first-hand commercial and developmental knowledge of products and services. Evers, Cunningham and Hoholm (2013) note that the role of a 'producer' on a team is essential because they are the 'doers' who think practically of what should be done.

The third classification is the 'user' technical entrepreneur who has a background in a supporting role or as an end user, not particularly involved in the development of the technology. Conversely, Shah and Tripsas (2007) argue that the user entrepreneur is an 'accidental' entrepreneur who happens upon an idea while using an already commercialised product, develops a solution and shares it with others for feedback. This type of entrepreneur relies on the collective feedback of other users and usually develops an idea to commercial value after experimentation, adaptation, and preliminary adoption (Shah and Tripsas, 2007). This class of entrepreneur is less studied in the dominant literature in entrepreneurship, which emphasises the discovery of entrepreneurial opportunities by individuals with relevant knowledge and experiences (Venkataraman, 1997).

Jones-Evans' last type of technical entrepreneur is referred to as the 'opportunist' technical entrepreneur, because this type of entrepreneur has no previous experience in a technical organisation and has no technical skills relevant to developing the technology. Preliminary work on 'opportunistic' entrepreneurs was undertaken by Smith and Miner (1983), who differentiated 'opportunistic' entrepreneurs as hailing from a middle-class background, with a broad education and some management experience, seeking to capitalise on new and innovative opportunities. However, this type of entrepreneur is known to exhibit a high level of success and growth because of their opportunistic adaptation (Bhide, 2000). This prompted Pendergast (2003) to ask whether "opportunistic" entrepreneurs manifest different traits from "visionary" entrepreneurs. In most cases, 'opportunist' and 'user' entrepreneurs combine with the 'researcher' or 'technical' entrepreneur to form a successful technology firm (Oakey, 2012). Interestingly, the 'user' and 'opportunist' types of technical entrepreneur can be linked to the theory of entrepreneurship based on opportunity, in which the entrepreneur creates and exploits opportunities, and generates change (Simpeh, 2011).

In an attempt to understand how new technology ventures are formed, Jones-Evans follows the individual-level analysis to determine how the previous occupation of the entrepreneur affects the formation process. While Jones-Evans' study is useful in categorizing technical entrepreneurs, it fails to explain further how their previous occupational experience influences the role they play in the founding process or in opportunity discovery and then development of the technology firm. Moreover, its method of analysis has a number of limitations. The study selected participants from a government scheme, SMART, which did not function as an exclusive hub to technology firms. Instead, it merely highlighted technological innovation as one of its criteria.

However, although limited to one region, this study was useful in categorising technical entrepreneurs based on their previous occupational experience. It also highlights some elements which motivate technology entrepreneurs when thinking of a new venture to found. As Dorf (2008) points out: "Good opportunities also emerge from circumstances of employment or experience." An opportunist technical entrepreneur may be motivated to exploit ideas and opportunities while working for a technology-based venture, despite lacking technical experience or technical skills. Likewise, a user technical entrepreneur might be motivated by their experience in using or testing a product. In this respect, Weiss (2012) suggests the following questions as a pointer to discovering new business opportunities, seen from the user's point of view:

- What problems are being solved?
- What frustration is currently experienced with the present solution?
- How are users presently solving their problems?
- What better ways can be used to solve the problem? What skills are available?
- How is the solution different from what is on offer?

Taken together, these studies highlight the importance of the individual involved in founding a new technology venture, focusing on the mechanism and influences by which technology founders generate ideas and explore opportunities. However, these studies do not acknowledge other players, such as the management team and strategic investors, who influence the initial startup phase, growth, and success of most technology ventures. Hayton and Zahra's (2005) study of the human capital characteristics of the top management of 340 high-technology ventures found that the top management team is an important source of knowledge for the ventures; thus affecting their capacity to thrive, through venturing activities, innovation, and financial performance.

Furthermore, little is known about technology entrepreneurs in emerging and developing countries, either due to the difficulty of gathering information from the field or a lack of focus on the region, since the field of technology entrepreneurship is still relatively in its early stages and is still evolving. Nonetheless, it is equally important to understand the context in which technology entrepreneurs operate, as well as their unique traits and characteristics. This will provide an improved understanding of technology entrepreneurship and entrepreneurs and how they come upon ideas and exploit opportunities (Shane and Venkataraman, 2003).

The Venture

Another important aspect of technology entrepreneurship is the venture itself. As such, emphasis has been placed on what constitutes technology firms in terms of industries, venture formation, growth, and survival (Beckman *et al*., 2012). Furthermore, Bailetti (2012) outlines that the theory of the firm in technology entrepreneurship has to do with "why firms exist, what determines their boundaries, what determines their structure, and what drives their different actions and performances." But before understanding these integral aspects of the firm, it is important to understand how technology firms are defined and categorised. While there is general acceptance of the importance of 'technology firms' in the marketplace, there is a lack of agreement in the literature of how to classify technology firms and their activities (Grinstein and Goldman, 2006).

Technology firms are different from traditional firms because of their level of engagement with technology, research and development, and a concentrated workforce of science and engineering employees (Oakey, 2012). Also, they are mostly nascent firms, which are new and innovative in nature (Newbert, 2005). Some research suggests technology companies can be 'high growth' firms due to their fast growth rate (Colombo and Grilli, 2005).

It has become commonplace to distinguish firms in technology entrepreneurship as either high-technology or low-technology. However, a bias exists more towards high-technology industries, such as bio-technology, manufacturing, and semiconductors (Smith, Collins and Clark, 2005; Oakey, 2012). Other researchers classify technology entrepreneurship firms into 'New-technology-based Firms' and 'Incumbent-technology-based Firms'; in which the NTBFs are responsible for 'radical innovations' and ITBFs are already existing firms who possess the resources and capabilities to reinvent already existing technologies (Spiegel and Marxt, 2011). That said, much preference is ascribed to 'New-technology-based Firms,' which are still analysed as, or linked to, 'High-Technology Companies' (Roure and Keeley, 1990).

Additionally, some researchers have taken cues from industry classifications to aid the categorisation of technology firms (Kile and Phillips, 2009). Grinstein and Goldman (2006) argue that, for lack of guidance on how to classify technology firms, some researchers simply sought to use industry membership as the criterion for classification. As a result, it has placed more focus on manufacturing, electronics, and pharmaceutical industries, all of which are predominantly high-technology industries. Grinstein and Goldman (2006) identified these discrepancies in the field and proposed characteristics for classifying technology firms under 3 dimensions: the nature of R&D activity and organisational market condition, the nature of the product strategy, and the corporate culture. Outlining 21 characteristics associated with technology firms, the study concluded that R&D simply does not stop at being the core of a technology firm, as noted by Smith, Collins and Clark (2005); R&D activities are also embedded within the organisational characteristics of the firm.

Furthermore, a link is made between R&D activities and market conditions, because consumer demand, as well as marketing, influences R&D activities. A technology firm that has a product strategy of introducing new products into the marketplace has a good chance of growth and prosperity (Grinstein and Goldman, 2006). This view is complemented by Tanev (2012), who

argues that one of the conditions for a technology company to have a global competitive advantage is to have technically advanced product offerings with significant first-mover advantage. However, Grinstein states that inputs such as R&D and corporate culture are more important than outputs (i.e., products and processes).

One prominent criterion in all of the characterisations is that the firm must be innovative, and technology driven. In other words, it should have in-depth roots and interaction with science, engineering or technology. Consequently, ventures in technology entrepreneurship may be broadly divided into two categories: technology-venture and technology-based venture. Fundamentally, technology companies are mostly responsible for creating, developing, and selling the core technologies (Cooper and Bruno, 1977). Some examples include Google in creating search technology, Medtronic in medical technologies, and Intel in creating semiconductors and chip devices. By contrast, technology-based companies rely on core technologies already built (Lamont, 1972). Examples include Amazon Inc., relying on internet technology to sell other products, and Beats Electronics, relying on audio technology to sell headphones. Accordingly, technology ventures are able to create and develop novel technologies in-house, whereas in technology-based ventures, that function can be outsourced. Technology firms, such as Apple Computers, possess the capability of creating new markets and changing the direction of existing industries, while most technology-based firms tap into already existing markets, even though they use technology to extend their market reach (Grinstein and Goldman, 2006).

A widely held consensus is that research and development form a significant part of technology entrepreneurship (Beckman *et al*., 2012). While this is true for most firms whose primary purpose is developing new technologies from scratch (that is, technology firms), the technology-based firms can afford not to be heavily invested in R&D. However, some technology-based firms are also known to innovate increasingly on existing technologies to produce better efficiency. An example would be Facebook, which, while not inventing social networking or the internet, improved upon these technologies to deliver a better social web connectivity service.

It is important in technology firms that the founders are equipped with technical experience or have technical backgrounds (Cooper and Bruno, 1977). But in technology-based firms, founders may have other backgrounds in business, marketing or economics (Ganotakis, 2012). In technology firms, as argued above, the solution or value offered is mainly the technology, while in technology-based firms, the technology drives the solution or value offer (Grinstein and Goldman, 2006). In effect, most technology firms are listed under the technology sector in industry classifications. However, technology-based firms may be listed in other sectors, such as finance, transport, retail, media, and education.

Conclusion and Recommendations

From the findings of the review, the adoption of new technologies has positive effect toward competitive advantage. It also has significant relationship toward business performance. In light of this conclusion, it is recommended that;

- There is need for all actors in government and entrepreneurship scheme to pay special attention to train workers on the effective use of technology in the management process of small enterprises to ensure adequate performance of the company.
- The government should provide abundant means of finance to the entrepreneurs at an affordable rate in order to mitigate the numerous challenges experienced.

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