Stimulating Academic Entrepreneurship through Technology Business Incubation: Lessons for the Incoming Sponsoring University

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Abstract

Universities facilitate academic entrepreneurship or their ‗third mission' by making available supporting mechanisms such as science and technology parks, incubators, and entrepreneurship programs. Botswana's STEM University seeks to develop a technology park in which it will commercialize the research and intellectual property developed by its faculty members, students, research centers and the country's private sector through incubation and other processes. As a business support process, technology business incubation nurtures start-up companies and mitigates the risk of their early failure. In this enabling environment, start-ups can concentrate on technology transfer and later ―graduate" or leave the incubator financially viable and self-sustaining. Pursuing academic entrepreneurship and the university-model of technology business incubation present benefits for the country, the local community and the university in terms of economic development, economic diversification, job creation, technology development, viable firms, successful products, and the enhancement of university income and prestige. However, university and faculty culture, and the extent of faculty members' knowledge and skills in entrepreneurship and social capital may temper this potential. Utilizing a narrative review of the literature, this paper sought to identify critical issues a newly-participating university should be aware of as it seeks to adopt the university-model of business incubation to facilitate its transformation from a primary focus on its traditional research and teaching missions to one also based on the formal commercialization activities characterizing academic entrepreneurship. The paper informs on approaches the university may adopt to encourage academic entrepreneurship among its faculty members.

Keywords: academic entrepreneurship, technology business incubator, technology transfer, technology park, STEM university, faculty reward systems, university culture

1. Introduction

1.1 Background

Entrepreneurship is considered ―a general proactive disposition, a trait syndrome of a person, or wealth-creating business activity, manifested in starting, owning and managing firms" (Laukkanen, 2003, p. 374). As an extension of this business activity, academic entrepreneurship occurs when members of the academic community, whether faculty members, researchers, students, or alumni, engage in the ―capitalization of knowledge" (Stal et al., 2016, p. 89) or research commercialization activities (Abreu & Grinevich, 2013; Louis et al., 1989). These commercialization activities tend to be innovative, comprise elements of risk, and may lead to financial rewards or prestige for the individual or the institution (Abreu & Grinevich, 2013). Academic entrepreneurship is considered the ―third mission" of a university, beyond the institution's first and second missions of teaching and research, respectively (Rasmussen et al., 2006). Universities pursue this ―third mission" to generate additional sources of revenue amid tightening institutional budgets, create new industries, and contribute to local and national socio-economic development and the development of knowledge-based societies.

Academic entrepreneurship is practiced through formal commercialization activities such as patenting, licensing of intellectual property and the creation of spin-off companies that transfer technology, and through informal commercialization activities that include contract research and consulting with industry and other external stakeholders (Abreu & Grinevich, 2013). Universities facilitate the development of formal commercialization

activities by availing an array of mechanisms such as science, technology or research parks, incubators and accelerators, entrepreneurship courses and programs, entrepreneurship centers, alumni commercialization funds and student business plan competitions (Siegel & Wright, 2015). Botswana's public research-intensive STEM university - the Botswana International University of Science and Technology (BIUST) - proposes to develop a technology park in which it will commercialize the research and intellectual property developed by its faculty members, students, research centers and the country's private sector, and facilitate the creation and growth of innovation-based start-up and spin-off companies through incubation and other processes. The technology park will incorporate an academic or university-model incubator.

BIUST's adoption of academic entrepreneurship as part of its strategic orientation is in response to Botswana's urgent need to diversify its natural resource-based economy. Revenues from its diamond mining industry enabled the country to move from being one of the twenty-five poorest countries of the world in 1966 to one with the world's fastest growing economy in the 1980s (Sarraf & Jiwanji, 2001). With increased demand for diamonds in recent years, the upper-middle income country was beginning to recover from the contraction of its economic growth experienced in the aftermath of the global recession of 2008–2009. However, the economic effects of the 2020 coronavirus disease pandemic (COVID-19) are projected to erode these gains with the economy expected to shrink by as much as 13.1% in 2020/2021 (Ramaphane, 2020).

Botswana's economic recovery will also likely be challenged by the country's track record in terms of entrepreneurship and innovation. Prior to the COVID-19 pandemic, Botswana's entrepreneurs, especially its small, medium and micro entrepreneurs (SMME's), faced challenges to keeping their businesses in operation. The Global Entrepreneurship Monitor (2015) reported that while 33.23% of Botswana's adults were involved in the early stages of business creation and ownership, only 4.6% of adults owned and managed an established business for more than three–and–a–half years. Botswana also has a poor track record for creating innovative products and services. The 2019 Global Innovation Index classifies Botswana as one of eleven underperforming upper middle-income countries, with a global ranking of 93 out of 129 countries (World Intellectual Property Organization, 2019). BIUST seeks, through its proposed investment in a technology park, to contribute to the diversification of the country's economy towards a knowledge-based one, exploit the possibilities of the Fourth Industrial Revolution and encourage entrepreneurship by converting its research findings into innovative technologies and products for the market.

1.2 Study Purpose and Research Questions

This study was exploratory in nature since its motivation was to inform BIUST's transition process towards research commercialization and incubation. The extant literature was reviewed in order to identify critical issues a newly-participating university should be aware of as it seeks to adopt the university-model of business incubation to facilitate its transformation from a primary focus on its traditional research and teaching missions to one also based on the formal commercialization activities characterizing academic entrepreneurship. It sought to investigate the link between academic entrepreneurship and technology business incubation and explore potential faculty-related and organizational barriers to incubation that the aspiring entrepreneurial STEM university might encounter and therefore prepare for. Accordingly, three research questions drove this study:

1. How does technology business incubation stimulate academic entrepreneurship?
2. What university and faculty factors can potentially hinder successful academic entrepreneurship and technology business incubation?
3. How can universities encourage academic entrepreneurship among its faculty members as a precursor to successful technology business incubation?

This study focused on the formal commercialization activities characterizing academic entrepreneurship for two reasons. First, these formal activities (i.e. patenting, licensing of intellectual property and the creation of spin-off companies) are those typically developed through technology business incubation. Second, encouraging faculty members to pursue formal commercialization activities will require concerted institutional actions if academic entrepreneurship is to form part of a university's strategic orientation. These actions will be particularly important as the literature indicates that science and engineering faculty members tend to engage more in informal, rather than formal, commercialization activities. For example, when Klofsten and Jones-Evans (2000) conducted a comparative study of science, engineering and medicine faculty in Sweden and Ireland, they found that 51–68% of respondents were involved in ―sdf‖ collaboration activities such as consulting, while 12–19% engaged in spin-off creation at least once during their academic career. Similarly, D'Este and Perkmann (2011) found that almost half of university researchers in ten physical and engineering science disciplines who had received research grants from the UK's

Engineering and Physical Sciences Research Council, engaged in collaborative research, contract research or consulting at least once over a two-year period while only 22% engaged in patenting.

University research commercialization activity is also limited within the Southern African Development Community (SADC) region where Botswana is located. Urban (2019) notes that despite the significance of commercialization of research for universities, universities in South Africa have been "slow to transform their traditional research and teaching activities to enable the commercialisation of research and technologies" (p. 193). Urban (2019) states that only a small percentage of research outputs are commercialised in South Africa despite the amount of research funding allocated to universities and science councils. This study is therefore significant because it informs on university practices and interventions that can encourage research commercialization.

Technology-based academic entrepreneurs are attracting increasing attention within the extant literature because of the non-commercial environment of the universities from which these entrepreneurs emanate (Siegel et al., 2003). This study is significant because there is a dearth of research knowledge on academic entrepreneurship or its link with technology business incubation within the Botswana context. This is despite the maturity of academic entrepreneurship and commercial technology transfer as areas of research study in the international peer-reviewed literature (Wright, 2014). This study therefore breaks new ground with regards to studies that specifically examine academic entrepreneurship, its predictors and moderators in Botswana. It contributes to the body of knowledge on the impact of faculty characteristics and the organizational culture of a university on academic entrepreneurship. According to Mosey and Wright (2007), the academic entrepreneurs' experience as an entrepreneur is heterogeneous. It is therefore important for an incoming sponsoring university to be aware of a wide range of issues occurring in other contexts that might potentially impact the successful execution of its "third mission".

2. Technology Business Incubators and Technology Parks

2.1 Technology Business Incubators

New and small businesses fail for several reasons such as due to the lack of managerial skills and access to high-risk capital (Allen & Rahman, 1985; Smilor & Gill, 1986). Business incubation overcomes these sources of business failure. According to the Hackett and Dilts (2004, p. 57), "A business incubator is a shared office-space facility that seeks to provide its incubatees (i.e. "portfolio-" or "client-" or "tenant-companies") with a strategic, value-adding intervention system (i.e. business incubation) of monitoring and business assistance." Its purpose is to provide necessary resources in order to nurture a new or growing business to some level of maturity (Sherman & Chappell, 1998). Lalkaka (2006) uses a biological analogy to best describe what occurs within an incubator. The researcher states that in an incubator, "a venture progresses from: a) an idea (conception), to b) early-stage (embryo), to c) a physical product (child), to d) the learning and testing (adolescent), to e) entry to market (adult)" (Lalkaka, p. 5).

Temali and Campbell (1984) classify incubators according to their primary financial sponsorship. This classification yields four types of incubators, each with specific objectives - nonprofit incubators that target economic development; university-related incubators that focus on the commercialization of science and technology produced by university research; privately sponsored incubators that seek to generate profits; and publicly sponsored incubators that focus on job creation (Temali & Campbell, 1984). A STEM university incubator can also be classified as a technology business incubator (TBI) whose core business is enterprise creation among technology-based ventures (Lalkaka, 2006). TBIs tend to be associated with STEM universities, research laboratories, and science or technology parks (Corsi & Di Berardino, 2014; Lalkaka, 2006; Phan et al., 2005).

Technology business incubators link technology, know-how, entrepreneurial talent, and capital (Smilor & Gill, 1986). They support their tenant companies by offering tangible resources and intangible opportunities in a shared physical environment (Bøllingtoft & Ulhøi, 2005). Tangible resources offered may include office, communication and administrative services (e.g. reception and printing services, and IT support); business services (e.g. strategic business planning, financial planning, finance clinics, entrepreneurship training, management counseling and training, mentoring by experts and business experts, human resource development, "hot desks", access to external networks of bankers, venture capitalists, technologists, and government officials, legal and intellectual property rights advisory services, advertising and marketing assistance, accounting services, access to trade shows, organization of open houses, public relations services, and import/export assistance); facilities and equipment (e.g. conference, meeting and training facilities, computers and internet services, shared laboratories and manufacturing space for developing and testing products); and financing (either by investing in the ventures themselves or by arranging contact to investors).

Start-up companies also receive intangible opportunities that include being placed in an environment of peers, important networks and psychological support across and between tenants, and the possibility to obtain legitimacy since the incubator may enhance both the tenant company's visibility and credibility (Bollinger et al., 1983; Lalkaka, 2002, 2006; Mian, 1996; Sherman & Chappell, 1998).

2.2 Technology Parks

The International Association of Scientific Parks (n.d.) defines a science park (also called technology park, technopole, research park or science and technology park) as "an organisation managed by specialised professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions." A science and technology park tend to have three characteristics:

1) A concentration of high-tech industries and specialized service centers;
2) The existence of at least one university/technology institute with which tenant companies may maintain some form of the formal link;
3) The promotion of knowledge transfer (tacit knowledge, and technology to tenant organizations) (Henriques, Sobreiro, & Kimura, 2018).

The businesses in a technology park may range from start-up companies established by researchers and spin-off companies established by academics wishing to commercialize their research, to larger industrial companies (United Nations Industrial Development Organization [UNIDO], 1999). The technology park may focus on one or more technologies and house an incubator, accelerator, companies at different stages of maturity, dry and wet labs, research institutes, hotel accommodation, conference/exhibition venues, onsite childcare facilities, health and wellness centers, and retail centers (Lalkaka, 2006; O'Neal, 2005).

Placing a technology business incubator within a technology park may enable tenant companies to gain from synergies with other park members and the credibility of the park, space within the park after "graduation" from the incubator, and the seamless integration of university learning and venture creation (Lalkaka, 2006, p. 10). Locating near to a university may provide park tenants with paid access to university communications, IT, and network support services, library services, laboratory equipment and services, graduates as potential employees, and qualified university personnel and therefore accumulated knowledge, possibility of consultations and intellectual exchange of ideas (Lalkaka, 2006; UNIDO, 1999). Besides innovation and technological development, technology parks contribute to local, regional and national economic growth and development through diversification of the industrial base of the local economy, job creation, general and academic entrepreneurship development, skills development, income for the sponsoring university, business and personal incomes and taxes, and social development (European Commission, 2014; Lofsten & Lindelof, 2003; Phan et al., 2005).

3. Method

We conducted a semi-systematic or narrative review of the extant literature to find out what is known about academic entrepreneurship and technology business incubation. While with narrative reviews, unintentional bias may be introduced through extra weight being placed on one research article over another, this method was selected because of its ability to collate findings from studies in diverse disciplines, namely science, engineering, business and higher education, that characterize the body of knowledge for our study (Ferrari, 2015; Snyder, 2019).

Two databases - ProQuest and ScienceDirect - and Google were searched for relevant peer-reviewed journal articles, reports and peer-reviewed conference papers. Reports prepared under the auspices of the United Nations and European Commission were considered for this study. Searches were made using the terms: "academic entrepreneurship", "technology entrepreneurship", "university entrepreneurship", "technology business incubator", "university business incubator", "business incubation", "research commercialization", "university technology transfer", "science park", and "technology park". These terms were searched for in titles, abstracts and keywords for each peer-reviewed journal articles found in the databases and online generally.

The inclusion criteria were (i) peer-reviewed journals published in English between the years 1980 and 2020; (ii) research that focused on academic entrepreneurship, incubation, technology transfer within the university, and science and technology parks; (iii) articles with accessible abstracts and full text; (iv) peer-reviewed conference papers; and (v) United Nations and European Union reports on technology business incubation. Exclusion criteria were (i) editorials, commentaries, conference abstracts, reviews, and duplicates; (ii) journals/studies focusing on

incubation/incubators with no mention of the university-model; and (iii) studies on technology transfer outside the university context.

This search process yielded 139 journal articles and 4 reports for review. The identified peer-reviewed journal articles and reports were then assessed for evidence in relation to the study's three research questions that seek to identify the relationship between academic entrepreneurship and technology business incubation, and faculty and university factors that affect their implementation.

4. Findings

Findings are organized according to the three research questions that guided this study.

Research Question One: How does technology business incubation stimulate academic entrepreneurship?

Technology business incubation stimulates academic entrepreneurship (i.e. faculty members' engagement in research commercialization activities) by developing faculty members' entrepreneurial skills, capacities and mindsets, and facilitating the commercialization process.

Faculty Members' Entrepreneurial Skills, Capacities and Mindsets

While prospective academic entrepreneurs may be at the forefront of their scientific field of expertise and may even be entrepreneurial in terms of identifying new research areas and sources of research funds (Lockett et al., 2003), they are often nascent entrepreneurs (i.e. those considering starting their own businesses) without the knowledge and skills to identify research opportunities with commercial market applications (Venkataraman, 1997; Vohora et al., 2004). They may lack the entrepreneurial competencies to develop a viable business opportunity (i.e. opportunity development competencies) and to access the resources necessary to develop the new venture (i.e. resource acquisition competencies) (Franklin et al., 2001; Rasmussen & Wright, 2015).

Faculty members may also have little or no experience working in businesses in the private sector, experience useful for running their businesses, acquiring vital resources, and navigating the environment external to the university. Commercialization may be difficult for these aspiring academic entrepreneurs whose lack of marketing knowledge and skills may lead them to focus more on their product and its underlying technology, rather than on market opportunities and the final customer's product needs and benefits (Otto, 1999). According to Bower (2003):

> It is a difficult challenge for academic founders with little prior market knowledge and linkages, and no previous experience of professional investors and their requirements, to select the applications and business models which will support successful venture creation. (p. 97)

While technology business incubators may differ by the type, duration, comprehensiveness and quality of business assistance services offered, incubation typically provides opportunities for faculty members to develop their entrepreneurial skills and management capacities through in-house entrepreneurship education and training programs, and counselling and mentoring services (Bøllingtoft & Ulhøi, 2005; Hackett & Dilts, 2004; Lalkaka, 2006). These entrepreneurial education and training programs develop faculty members' abilities to create, launch and run their companied by imparting skills in business planning, product development, supply chain and quality management, marketing techniques, business management, financial planning and budgeting, and accounting practices (Bøllingtoft & Ulhøi, 2005; Buckley & Davis, 2016; Chan & Lau, 2005; Kirby, 2004; Lalkaka, 2006; Lyons, Li, & Zhao, 2003; Mian, 1996; Sherman & Chappell, 1998; Smilor & Gill, 1986; Smilor, 1987; UNIDO, 1999).

This education and training component may be delivered through formal/structured training programs, training workshops aimed at specific business skills, seminars, market research and marketing clinics, finance clinics aimed at raising investment finance, one-on-one mentoring sessions with experienced businessmen, and technical consultancies organized to educate tenants on issues related to intellectual property, patenting, and licensing. Training may be tailored to the specific needs of individual company owners with some incubators utilising pre-incubation questionnaires to prepare targeted entrepreneurial development assistance. A university incubator may utilise a questionnaire that enables new entrepreneurs to identify the specific skills they need assistance to develop - whether business management skills or soft skills such as their creative thinking skills, problem-solving skills, decision-making skills, time and project management skills, communication and presentation skills, negotiation and persuasion skills, selling skills, leadership skills, team-working skills, or social networking skills (Kirby, 2004).

During incubation, entrepreneurial education is also achieved through peer interaction, that is, through informal processes involving interaction, discussion, and exchange between faculty members as tenants, and incubator management and other tenants (Buckley & Davis, 2016; Kirby, 2004; Smilor, 1987). Incubation provides a social

environment where faculty members can share experiences —and not feel that their difficulties are unique or a result of misfortune or incompetence" (Lalkaka, 2006, p. 46). According to Smilor (1987), incubation provides a valuable learning experience and allows for quicker solutions to problems because tenants have the opportunity to meet and talk with other entrepreneurs who have experienced and solved similar problems or faced similar business situations. Cooper, Hamel and Connaughton (2012) found that university incubator tenants interacted in order to have more access to the knowledge and problem-solving skills of others. The researchers found that tenants considered sharing informing as beneficial to reducing uncertainty for start-up organizations in high-tech environments. The layout of the incubator and open doors encourage and facilitate this peer interaction process (Lalkaka, 2006).

Academic entrepreneurship within the university is also encouraged by changed mindsets. From their case studies of Italian university business incubators, Grimaldi and Grandi (2005, p. 116) found that incubation contributed to the diffusion of an entrepreneurial culture within the university and encourages academics to accept the ‗commercialization of research results through new ventures' as part of the university's institutional mission.

Facilitating the Commercialization Process

The commercialization process requires technological know-how skills that university inventors rarely possess – skills related to developing product concepts, designing products and processes, and production or manufacturing (Amboala & Richardson, 2016; Scillitoe & Chakrabarti, 2005). Technology business incubation facilitates the commercialization process by shortening the commercialization learning curve for faculty members. It links them to critical internal and external networks that develop their technological know-how skills and provide access to important resources and services (Bøllingtoft & Ulhøi, 2005; Smilor & Gill, 1986). Incubation also reduces the cost, time and other delays typically encountered in bringing products to the market (Lalkaka, 2006). According to Shaw (1993), collaboration with other key players in a network leads to a more effective prototype development, testing, evaluation and marketing process, and creates differential advantages for the entrepreneurs. The researcher considered these networks to facilitate the processes of learning by doing, learning by using and learning by interaction.

With regards to internal networks, faculty members may access a variety of sources of learning that create synergy among tenant companies (Bøllingtoft & Ulhøi, 2005). Tenant companies obtain valuable information about potential markets, business locations, innovations, and sources of capital (Aldrich, 1999) and information that would not be available to them otherwise (Adler & Kwon, 2002). Internal networks may enable collaborative relationships that result in formal or informal partnerships and joint ventures (Bøllingtoft & Ulhøi, 2005; Campbell & Allen, 1987). Companies use incubators as internal marketplaces where trading relationships such as subcontracting and joint purchasing can develop between incubator tenants (Bøllingtoft & Ulhøi, 2005; Campbell, 1989; Markley & McNamara, 1995; Sherman & Chappell, 1998). Campbell (1989) found that two fifths of companies that had graduated from an incubator had purchased goods or services at least once from other companies in the incubator, and about a quarter had sold to other incubator companies. Furthermore, half of those that sold to other companies continued to trade with these companies after they moved out of the incubator.

During incubation, faculty members are also brought into contact with the services of the university technology transfer office (UTTO) which functions as a technology intermediary in the incubation process (Markman et al., 2005) by facilitating —commercial knowledge transfers through the licensing to industry of inventions or other forms of intellectual property resulting from university research" (Siegel et al., 2004, p.116). The technical assistance received supports commercialization by providing guidance on the technology transfer processes, research and technology supply pipelines, and intellectual property protection (Hannon, 2005).

Access to external networks during incubation are equally important to tenant companies because they —link tenants with potential partners, customers, local business, etc." (Bøllingtoft & Ulhøi, 2005; p. 274). The careful pre-incubation selection criteria applied for tenant entry into the university incubator may eliminate the lack of credibility that a new start-up company would otherwise experience when dealing with investors, suppliers, customers and employees (Smilor, 1987). By raising the credibility of faculty members' companies, incubation facilitates their later access to additional technology, funding and seed capital from private financial institutions (e.g. investors and banks), governmental programmes and foreign investment (Lalkaka, 2006).

Incubation also provides access to companies located in the local area and other potential buyers/customers in the supply-chain, business contacts in academia, industry and government who may serve as mentors and sources of information, advanced research institutes or academic staff at other universities, other entrepreneurial support organizations, and community and local government economic development agencies (Buckley & Davis, 2016; Lalkaka, 2006; O'Neal, 2005). Export sales may result when academic spin-off companies have advanced

technologies that are attractive in international niche markets. Civera, Meoli, and Vismara (2019) found that these companies have a greater propensity to internationalize than their non-academic counterparts, and particularly when the parent university is more internationalized.

When incubation stimulates academic entrepreneurship by providing faculty members with access to these important internal and external networks, it simultaneously develops their individual social capital. Some researchers suggest that faculty members may lack the social capital needed to move from scientific networks to commercial social networks (Rasmussen & Wright, 2015). They may have close or strong ties with team members in their department and with fellow researchers outside their universities but have loose or weak ties with industry (Granovetter, 1973). Interaction with industry is important for faculty members to be able to identify and modify a viable business concept, obtain valuable information and resources especially financial resources, and build a positive reputation and credibility. Faculty members should have the social skills to engage with investors who provide funding and seed capital and with potential customers. While industry requires articulate and credible partners, some faculty members may encounter difficulties communicating with actors from outside their scientific research network due to differences in knowledge, interests, goals, and assumptions (Davidsson, 2002). Van Weele, van Rijnsoever, Eveleens, Steinz, van Stijn., and Groen (2018) conducted 90 semi-structured interviews with entrepreneurs, incubator managers, investors, university technology transfer officers, mentors and policy makers in four Western European countries to explore the challenges of Western European start-ups. The researchers found that the university entrepreneurs lacked an entrepreneurial culture and market orientation and were unfamiliar with activities related to managing and growing their business such as presenting to investors, reaching out to customers or managing employees. The researchers attributed the lack of market orientation in part to education systems in Europe that have not developed entrepreneurial skills and commercial mindsets.

Research Question Two: What university and faculty factors can potentially hinder successful academic entrepreneurship and technology business incubation?

Technology-based academic entrepreneurship attracts research attention due to the non-commercial nature of universities, and the fact that the key stakeholders in this process - university scientists and engineers, university administrators, and firms/entrepreneurs - have different motives and behaviours and themselves operate in different cultural environments (Siegel et al., 2003). The literature indicates that university culture and faculty culture may challenge successful academic entrepreneurship and technology business incubation.

University Culture

The variant cultures of the university and the technology business incubator may present a source of tension to successful academic entrepreneurship and technology business incubation. Every organization (e.g. the university) has its own culture, that is, the set of shared values and norms that controls organizational members‘ (e.g. university administrators, faculty members, support staff, students, council/board members) interactions with each other and with people (e.g. government, accrediting agencies, grant agencies, unions, suppliers) outside the organization (Bartell, 2003; Deal & Kennedy, 1982; Jones, 2013). An organization‘s culture shapes the way organizational members set personal and professional objectives, perform tasks and administer resources to achieve them (Huyghe & Knockaert, 2015).

Table 1 extends findings of Lalkaka (2002; 2006) and summarises potentially conflicting values and norms that faculty members must internalise in order to simultaneously function successfully within a technology business incubator and university setting. University and enterprise activity may conflict given their respective missions, time cycles and terminal values.

Challenges to successful academic entrepreneurship and technology business incubation may develop from universities being forced to behave like firms by accommodating downstream commercial activities involving the development of products alongside its upstream development of basic research projects (Sideri & Panagopoulos, 2018), and when the non-commercial environment of universities must create a supportive environment ~~–~~which can potentially reduce the conflict of interest between traditional and entrepreneurship efforts” (Urbano & Guerrero, 2013, p. 227). The tension a university experiences when seeking to pursue technology commercialization activities is best summed up by Ambos, Mäkelä, Birkinshaw, and D'Este (2008):

> At its heart, the challenge essentially involves taking an organization that is equipped for and accustomed to doing one thing (academic research) and at the same time asking it to build a capacity for doing something entirely different (commercialization of technologies and ideas). The extraordinary challenge here is that universities and their faculty are not simply required to switch from one (single-handed) activity to another, but to develop the

simultaneous capacity for two activities (academic rigor and commercialization). Thus, tensions arise at the level of the organization as a whole as it strives to manage these two sets of activities at the same time, and also at the level of the individual who has to work out how to balance his or her time between competing demands. (p. 1425)

Table 1. University Culture versus Enterprise Culture

Sources of Differentiation	University Culture	Incubator-Enterprise Culture
Mission/Focus	Student Learning Faculty Research	Enterprise Creation Commercialization
Time Cycles (time use revolves around:)	Academic Calendar -Teaching, Assessment of Learning (e.g. Assignments, Tests and Exams, Grading, Student Evaluations), Graduation Faculty Scholarship (e.g. Publications, Conference Presentations, Applications for Grant Funding) Faculty Rewards (e.g. Tenure, Promotion, Sabbatical) Productivity Management (Evaluation of Teaching, Research, and Service)	Acquisition of Seed Funding Resource Procurement Concept and Prototype Development and Testing Production Timelines Product Marketing Managing Staff and Finances Internal Networking External Networking
Terminal Values	Teaching and Research Quality University Reputation University Ranking	Profitability Risk-taking Technology Transfer and Innovation

Faculty Culture

According to Merton (1957), ―ike other social institutions, the institution of science has its characteristic values, norms, and organization…. the pursuit of science is culturally defined as being primarily a disinterested search for truth and only secondarily, a means of earning a livelihood" (p. 659). The primary motivation of university scientists is therefore recognition within their scientific community of the knowledge generated from funded research and disseminated through publications in peer-reviewed journals and conference presentations (Siegel et al., 2003). While a body of empirical research indicates that entrepreneurial activities in universities and spin-off activity are associated with higher research productivity and quality (e.g. Colombo et al., 2010; Di Gregorio & Shane, 2003; van Looy et al., 2011), there are also studies that find that the pursuit of academic entrepreneurship may create a cultural tension between values and interest such that faculty members must decide whether to engage in commercial activities in addition to, or instead of, traditional research and journal publication activities. Blumenthal, Campbell, Causino, and Louis (1996) suggest that university technology transfer activities risk corrupting the research and pedagogical missions of the university by mixing commercial and scholarly interests. Lalkaka (2006) notes ―he reluctance to sully one's academic reputation by engaging in commercial activity, rather than getting recognition for publishing learned papers" (p. 18). Some academics view the adoption of the culture of entrepreneurship as posing a threat to the integrity of the university and its role as an independent critic of society and producer of knowledge, with the capitalization of knowledge appearing to be taking precedence over disinterestedness as the norm of science (Etzkowitz, 1998; Krimsky, 1991; Pelikan, 1992; Rasmussen & Wright, 2015).

Sideri and Panagopoulos (2018) summarize studies in which faculty scientists question the role of markets in influencing academic freedom (Baldini, 2008; Davis et al., 2011), reducing faculty members' autonomy to self-select their research agendas and methods of dissemination (Davis et al., 2011; Jacobsen et al., 2001), and forcing them to think like entrepreneurs (Lockett & Wright, 2005). Investigating the experience of a non-entrepreneurial university that shifted to an entrepreneurial one, Sideri and Panagopoulos (2018) found that scientists, who were just beginning to entertain the idea of commercialization, questioned whether commercialization activity violated their integrity as scientists, considered it as taking their time away from their research, and had a poor understanding of the dividing line between basic research and what can be commercialized. Resistance may be obtained from faculty members who need to learn how to start and run their businesses. A question may also arise as to whether academic entrepreneurship will lead to a brain drain from the university when scientists must choose between pursuing research interests within the traditional university setting or commercialization interests within an incubator (Rasmussen &

Wright, 2015). The potential for a brain drain among faculty members may be supported in findings that commercialization success often requires the continued involvement of the faculty-inventor (Agrawal, 2006; Jenson & Thursby, 2001; Lowe, 2001; Shane, 2004) and that it is —star" scientists who tend to transfer new and valuable academic knowledge (Zucker & Darby, 1996).

Research Question Three: How can universities encourage academic entrepreneurship among its faculty members as a precursor to successful technology business incubation?

Perkmann et al. (2013) states that —universities are ‗professional bureaucracies' (Mintzberg, 1979) that rely on the independent initiative of autonomous, highly skilled professionals to reach their organisational goals" (p. 424). This reliance therefore requires due consideration be given to factors that influence these professionals to contribute to the attainment of university goals. The extant literature suggests that universities may encourage academic entrepreneurship by harnessing university culture, improving university climate, and facilitating effective partnerships between potential and practicing academic entrepreneurs and the university technology transfer office.

Harnessing University Culture

University culture includes standards or guiding principles that staff members use to determine which types of behaviors, events, situations, and outcomes are desirable or acceptable (Jones, 2013). University culture is as a key driver for academic entrepreneurship (Clark, 1998; Jacob et al., 2003, Martinelli et al., 2008; Siegel et al., 2004). A university may signal the importance and its endorsement of academic entrepreneurship through its *mission*, one of the key institutional instruments through which faculty members internalize the university's culture. An organizational mission states the organization's unique purpose, provides the context for its strategy, and motivates the behavior of organizational members towards common organizational goals (Bart et al., 2011). Huyghe and Knockaert (2015) suggest that a university may influence research scientists' intentions to engage in entrepreneurial activities through the incorporation of academic entrepreneurship into the university's mission and the subsequent dissemination of this information to research scientists through various forms of communication (e.g. newsletters, speeches by university management, etc.). In their study of how organizational characteristics affect research scientists' entrepreneurial intentions, these researchers found that the more universities emphasize academic entrepreneurship in their mission as compared to research and teaching, the greater were research scientists' intentions to engage in spin-off creation and commercialization activities involving intellectual property (i.e. patenting and licensing).

A university's espoused values and norms expressed in clear *policies and procedures* that clarify issues related to their participation in both academic entrepreneurship and incubation, may also positively shape faculty members' perceptions towards academic entrepreneurship. Owen-Smith and Powell (2001) found that faculty members based their decisions to disclose new technologies to the university on the university's policies guiding technology commercialization. University policy should elucidate the institution's commercialization strategy, and its position on the distribution of commercialization-related revenues (e.g. net royalties, equity and equity proceeds, and licensing fees), the relative obligations of the university and faculty members, and the use of university resources (e.g. facilities, equipment, personnel, etc.) for commercialization purposes.

Faculty members considering academic entrepreneurship should be able to clearly interpret from university policy how the institution defines and will resolve conflicts of interest, commitment and internal equity. *Conflicts of interest* arise over financial issues (Campbell & Slaughter, 1999). More specifically, conflicts of interest may arise when faculty members use university resources for commercialization activities, manipulate research design or fail to present accurate research results if the findings do not yield a profit or desired result for the sponsoring entity, delay the dissemination of research findings on the grounds that proprietary information has to be protected in order to secure the competitive edge of the client, or delay student publications because of proprietary interests (Matveev, 2002).

Faculty members will require to know how the university defines *conflicts of commitment* or conflict over competing faculty responsibilities (Campbell & Slaughter, 1999). Conflicts of commitment may occur between the role of the faculty as an academic entrepreneur and his/her role as lecturer, researcher, or public servant (Matveev, 2002). Enacted policy should clarify how the university will assess the impact of engaging in commercialization activities on faculty teaching, research productivity, service, and time. The pursuit of academic entrepreneurship raises the question as to whether faculty members will be required to resign to enter incubation on a full-time basis; operate their incubated business part-time while undertaking regular, though reduced-load, university teaching and research work; take off for a semester/year as sabbatical, unpaid leave, casual leave, earned leave to undergo incubation; or some other arrangement. The related policy should address whether the university will preserve the position,

seniority and other academic benefits accruing to the faculty member who pursues academic entrepreneurship and participates in technology business incubation (Government of India, 2019).

The policy should also address the situation of expatriate faculty members whose work permits are tied to their employment as university teaching staff. For example, the non-transferable Botswana Non-Citizens' Work Permit lists the name of the employer (the university) and the type of employment (lecturer/professor and specific field/university department). The implications for expatriate faculty members of resignation from the university in order to commercialize their research in an incubator or concurrent business ownership while maintaining contractual university teaching should be clarified. The requirement for faculty members to resign in order to pursue academic entrepreneurial activities requires special policy attention, as the act of resignation negates Blair and Shaver's (2020, p. 3) definition of an academic entrepreneur. According to these researchers, an academic scientist is an "entrepreneur" if four conditions hold:

1) The person must – alone or with others – have created a new business.
2) The academic scientist must expect to own equity in the business.
3) The academic scientist must have undertaken some business-related activities within the past 12 months.
4) The academic needs to remain in the employ of his/her university.

University policy should also clarify how the institution will resolve existing or perceived *conflicts of internal equity* or conflicts over the university's internal distribution of rewards and workload (Campbell & Slaughter, 1999). Particularly in entrepreneurial universities, internal university practices may favour faculty members who engage in entrepreneurial activities to the extent that these individuals receive higher salaries and benefits and lower workloads than their non-entrepreneurial peers, and their disciplines or departments are accorded relatively higher priority or recognition in university life (Matveev, 2002). Clear policies and procedures are also imperative to assist academic entrepreneurs to acquire the legitimacy that must simultaneously be acquired from multiple internal university stakeholders who may have different expectations of these faculty members (Francois & Philippart, 2019).

A university may use exemplar transmitters of its culture - *role models* - to encourage academic entrepreneurship. Role modeling refers to a cognitive process in which individuals observe attributes of people in social roles similar to themselves and increase this perceived similarity by imitating these attributes (Gibson, 2004). According to Huyghe and Knockaert (2015), "peer examples signify that academic entrepreneurship is accepted as a legitimate activity within the university" (p. 143). The researchers conceptualized "role model" as someone in the university, who you know personally, and who created a company based on university research, applied for a patent and/or licensed technology, and engaged in consulting and/or contract research with industry. Huyghe and Knockaert (2015) found that the presence of role models involved in the different types of academic entrepreneurship (i.e. spin-off creation, intellectual property rights and consulting and/or contract research with industry), led to stronger intentions among research scientists to imitate the same type of commercialization mechanism. Furthermore, they found that research scientists who detected entrepreneurial role models in their university were more confident that they could successfully engage in entrepreneurial activities themselves.

Enterprising peers or role models can play a key role in encouraging both academic entrepreneurship and incubation activity within the university. Hoye and Pries (2009) and Rasmussen and Wright (2015) found that key to overcoming faculty members' resistance to pursuing academic entrepreneurship were the stance of the lead professor in a research group or lab, the faculty inventor's enthusiasm, and his/her involvement in a wide range of technology transfer activities such as licensing. Similarly, Urban (2019) found that members of a department were likely to be participate in technology transfer when the chair of the department and peers at the same academic rank in their department participated in that activity. These role models are likely to be tenured faculty members. When Haeussler and Colyvas (2011) examined engagement in commercialization activities among over 2200 life scientists in Germany and the United Kingdom, they found that scientists more likely to engage in commercialization activities were professors or post-tenure scientists, and senior scientists with established reputations and greater experience.

Adjusting the University Climate

Schneider, Ehrhart, and Macey (2013) define organizational climate as "the shared perceptions of and the meaning attached to the policies, practices, and procedures employees experience and the behaviors they observe getting rewarded and that are supported and expected" (p. 362). The literature suggests that a university can encourage academic entrepreneurship by addressing an important aspect of its organizational climate - the rewarded behaviors of faculty members. Academic entrepreneurship may be encouraged when a university's *promotion and tenure system* explicitly rewards faculty members for engaging in formal and informal commercialization activities. A

higher reward may accrue to the faculty member who creates a spin-off company or holds a company directorship, and with the higher number of patents received, licenses, and research and consultancy projects. Huyghe and Knockaert (2015) found that research scientists, working at six Swedish and German universities which explicitly allocated rewards for entrepreneurial endeavors, had higher levels of spin-off and patenting or licensing intentions. While also investigating organizational factors and academic entrepreneurship, Urban and Gamata (2020) found that university reward systems focused on academic entrepreneurial activity had positive influences on academic entrepreneurship outputs of academics and scientists working at South African universities. Modifying the reward system to reflect commercialization activities may incentivize faculty members to consider technology transfer. When Siegel, Waldman, Atwater and Link (2004) investigated key organizational issues that promote successful knowledge transfers, the researchers found that insufficient rewards for university researchers were a barrier to effective university technology transfer, and universities almost exclusively used publications and research grants rather than involvement in university technology transfer in promotion and tenure decisions.

Strengthening the Support offered by the University Technology Transfer Office

As a university office, the university technology transfer office (UTTO) administers the commercialization process of the institution‘s intellectual property (IP). It functions as an intermediary between the university and industry in the commercialization process. Several studies recognize the complementary role of a UTTO along with an incubator and science park (Holgersson & Aaboen, 2019). For instance, Caldera and Debande (2010) find that universities that have both a UTTO and a science park tend to perform better because the two organizations complement each other, while Siegel and Phan (2005) report that the role of the incubator is to support the research of university scientists while the patenting takes place in the UTTO.

According to Markman, Phan, Balkin, and Gianiodis (2005):

> The success of business incubators and technology parks in university settings is often determined by how well technology is transferred from the labs to their startup firms. University technology transfer offices (UTTOs) function as ‗technology intermediaries‘‘ in fulfilling this role. (p. 241)

The UTTO can play an important role in preparing faculty members for entrepreneurship and incubation by providing them with information, guidelines and resources on the IP protection-commercialization process and introducing them to the notion of academic entrepreneurship. Sideri and Panagopoulos (2018) found that the UTTO was able overcome faculty members‘ reluctance to engage in academic entrepreneurship by educating faculty scientists on the basics of commercialization and addressing key troubling moral and cultural aspects of technology transfer. The researchers state that this process was able to address ―frictions deriving from the uneasy relationship between commerce and science, gain faculty‘s trust, and allow for a meeting of minds‖ (p. 962) between faculty members and the technology transfer office.

Faculty members can be inducted on the disclosure process and why and how the UTTO carries out its remit in terms of evaluating and valuating disclosures of new discoveries, seeking legal protection for the technology, selling licensing agreements to industry, collecting royalty, and enforcing contractual agreements with licensees. They are able to appreciate that, once a technology is patent protected, the UTTO‘s determination of whether to commercialize the discovery through licensing in exchange for sponsored research, equity, or cash depends on the technology itself, that is, whether the stage of the technology can be described as an early-stage invention (i.e. a discovery based on basic research with a highly uncertain market potential), proof of concept (i.e. a technology developed to the point that it shows signs of having the proposed effect), reduction to practice (i.e. a technology whose intended results have been reliably and repeatedly reproduced), or prototyping, formulation or compound (i.e. the new technology can be constructed as a reliable method of producing a given or desired result) (Markman et al., p. 250).

The UTTO may seek to demystify the process of starting a business by organizing seminars that introduce faculty members to entrepreneurship prior to incubation. Prior to incubation, faculty members with spin-off companies may have to satisfy an incubator‘s general selection criteria that assess their business‘ potential for growth and diversification of the economy, ability to create jobs, generate net profit, pay incubator rentals; technical criteria that assess their technology‘s value-addition, time to market, patent situation, uniqueness of concept; and business criteria that assess their own market knowledge, management and marketing skills, ability to develop a network of cooperative relationships, capacity for hard work and ability to handle crisis and risk (Lalkaka, 2006). It may be worthwhile for faculty members to gain an early understanding of the details behind these criteria. UTTOs can bridge their knowledge gap by exposing them to a range of introductory entrepreneurship principles including how markets work (Hoye & Pries, 2009; Marvel, 2013; Sideri & Panagopoulos, 2018). UTTOs may explore

collaborations with institutional business schools to develop or integrate entrepreneurship curriculum for this purpose (Siegel & Wright, 2015). Urban (2019) notes that the general low rate of academic start-ups in South Africa has been attributed to a preference for licensing to established companies and a general lack of entrepreneurial intentions. The researcher states that the support provided by technology transfer offices to academics in South Africa, tends to focus on the "identification and protection of new intellectual property, with much less focus on start-up formation" (p. 194).

5. Conclusion

This study sought to identify critical implementation issues a newly sponsoring university could learn from as it initiates actions geared towards developing a "third mission" based on technology transfer and research commercialization activities. These activities that constitute academic entrepreneurship have the capacity to enable the university to realize the direct and indirect impacts of its research outputs and intellectual expertise on different facets of the local and national economy while also contributing to the diversification of the country's economy towards a knowledge-based one.

Consistent themes emerging from the narrative review of the literature provide several "lessons" or recommendations for universities who identify academic entrepreneurship as their strategic orientation and target the development of incubators and technology parks in their strategic plans. Universities should develop clear policies and procedures that clarify revenue distribution, relative faculty/university obligations and other key issues in order to obtain early "buy-in" from faculty members. Faculty members are core to TBIs and hence their entrepreneurial skills and management capabilities must be enhanced to improve their desire and passion to be enterprising. Universities should utilize entrepreneurial role models to overcome the fears of the "entrepreneurially skeptical" concerned with the mixing of academic and commercial roles (Laukkanen, 2003). Business schools should be engaged to assist the university technology transfer office in faculty socialization towards an understanding of their potential entrepreneurial role and the requirements for incubation selection.

Universities must recognize and communicate the value afforded by the commercialization of research. Academic entrepreneurship should be institutionalized within the context of the institution's mission. Universities should modify their reward structures. The traditional triad reward system of teaching, research, and service should be reviewed to include commercialization by academics in promotion and tenure guidelines. These guidelines must be explicit on how academic entrepreneurial activities will be assessed and documented. Universities must also recognize the collaborative nature of commercialization activity and facilitate the additional support required by its faculty members from the university technology transfer office, other relevant institutional administrative and research offices, and external agencies.

Theoretically, our findings suggest that the impact of technology business incubation on academic entrepreneurship is mediated by two factors: 1) The development of faculty members' entrepreneurial knowledge and skills and management capacities; and 2) Internal and external networking during the commercialization process. The relationship is moderated by university culture and faculty culture. These latter factors influence the direction or strength of the relationship between technology business incubation and academic entrepreneurship. The practical contribution of this study can be seen as providing information for any university seeking to develop its "third mission" through investment in an incubator on a stand-alone basis or within a technology park. The findings from this narrative literature review are significant for such an institution because it directs attention to areas where concerted institutional actions must be taken if academic entrepreneurship is to form part of the university's strategic orientation. It provides the basis for better management of the transition to academic entrepreneurship and incubation by bringing to the fore a range of issues occurring in other contexts that might potentially impact the successful execution of the institution's "third mission".

One limitation of this study which potentially tempers the study's recommendations and impacts the generalizability of its findings to the Botswana International University of Science and Technology (BIUST) relates to the fact that some of the studies used in this review might have been based on universities and faculty members with relatively more world-class innovative research than may be obtained in the local context (Wright, 2014). However, this limitation is muted by BIUST's selective faculty hiring strategy and the presence of local and expatriate faculty members who trained in commercialization-oriented departments at international universities and have commercialization experience and intentions. Furthermore, while this review may not have included all the relevant published literature due to the limited databases examined and the language criterion, this narrative review meets the specific aim of identifying a wide range of issues occurring in other contexts that might potentially impact the successful execution of the "third mission". It is envisaged that future research will seek to unpack the effects of this

organizational change, and both the supply-side (i.e. characteristics and attitudes of individuals) and demand-side (i.e. contextual conditions, e.g. the culture of the society where the university is located) factors that influence engagement in academic entrepreneurship and technology business incubation, at the local university (Jain et al., 2009). The link between teaching, the university's first mission and academic entrepreneurship, and the role of other players such as graduate students, alumni, and external researchers in the private sector will be explored (Marzocchi, Kitagawa, & Sanchez-Barrioluengo, 2019).

Academic entrepreneurship and technology business incubation are potential catalysts for Botswana's adoption of the Fourth Industrial Revolution to ease its reliance on mineral resources for earnings. However, the achievement of this potential will require organizational change and particularly change targeting the human resources and technological and organizational capabilities of the university. The newly sponsoring university will have a myriad of decisions to make as it embarks on developing academic entrepreneurship through a technology business incubator and technology park. For example, decisions will have to be made on whether its technology business incubator and technology park will specialize on one or more science and technology field and on all forms of formal commercialization activity. Learning from others should assist initial decision-making, policy and procedure development, as well as the subsequent implementation of these strategic initiatives while also ensuring that the pursuit of the university's 'third mission' achieves institutional and national objectives.

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