

Influence of Spin-off and Private Companies in the process of Technology creation and Transfer at a University of Technology in South Africa

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Abstract: Going by the assumption that technology is not created for its own sake, this paper gauges the peculiar role that of spin-off, and private companies play in the process of technology creation and transfer at a University of Technology (UoT) in South Africa, using academic entrepreneurs as the lens. Structured questions were electronically administered to the 52 participants purposively drawn for the study. The sample was drawn from a database composed using UoT X's in-house research records. Included in the database, were active and non-active academics in terms of technology creation and transfer. It was noted that most active researchers and innovators were involved in one form of university–industry collaboration or another. Furthermore, it was observed that the private companies had a vital role to play as far as the process of technology transfer and commercialization is concerned. This is notably relevant given that the overwhelming majority of the participants (91.7%) reiterated the importance of university–industry partnerships in the transfer and commercialization of inventions. Moreover, highlighting the importance of private companies, a slight majority (52.8%) of the participants indicated that they were surely motivated to bring forth innovative products by private companies in the last five years.

Keywords: academic entrepreneurship; entrepreneurial university; technology commercialization; university of technology

JEL Classification: L26; M13; O31; O32; O33

1 Introduction and Background

Higher Education Institutions (HEIs) remain the main custodians of scientific breakthrough, the cradle of knowledge creation and technological innovation. To this end, the growing relationship between universities and industry has ensured that the commercialization of research output takes place, prompting the growing interest in the subject matter since the mid-1980s (Kutinlahti, 2005; Pattnaik &

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Pandey, 2014). Hence, university spinoffs and private companies are the hallmark of the dependable partnership between the industry and university.

University spinoffs and private companies contribute to economic development (Alessandrini, Klose & Pepper, 2013). On the one hand, University spinoffs contribute to economic development when they avail business opportunities by converting research output into usable technology that meet consumer needs in the market. On the other hand, spin-offs provide for third stream incomes besides employment opportunities (Pattnaik & Pandey, 2014).

The foregoing may account for the rekindled interest in the subject as well as provide justification for why some universities made rigorous efforts to gain third stream incomes from their research output by forging links with the industry. Joining the bandwagon after 1994, the South African HEIs embarked on this entrepreneurial transformation, and the University of Technology (UoT X) that is the focus of this paper being no exception (Nicolaidis, 2011).

The strong focus on commercializing university research output drives these institutions towards what is known as entrepreneurial universities. This comes against the backdrop of the growing number of studies that parade entrepreneurship as the “cornerstone” of economic growth (Smith, 2010; Pattnaik & Pandey, 2014; Yusuf & Albanawi, 2016). Particularly acclaimed is the unwavering role that entrepreneurship can play towards employment and poverty reduction. As such, public research organizations and notably universities have enhanced their entrepreneurial status, to cash-in on third stream research incomes (Rothaermel, Agung & Jian, 2007). To Alessandrini, Klose and Pepper (2013), the outright commitment shown by Institutions of Higher-learning towards entrepreneurial activities today, stems partly from the irresistible desire to grow the economy and the need to address social issues.

To foster knowledge creation, dissemination and development, the need for technology transfer has stimulated the establishment of Technology Transfer Offices (Alessandrini, Klose & Pepper, 2013). As a significant role player, the South African government directly or indirectly through research institutions promotes the commercialisation of research output, with the hope that this may foster the country’s wish of becoming a “knowledge-economy” and the associated economic growth (Department of Science and Technology, South Africa). This notwithstanding, the advancement towards becoming a knowledge economy has been thwarted by a barrage of challenges not limited to, the high costs of innovation; the slow pace of R&D and innovation; a relatively restricted number of scientists and engineers; and limited collaborative partnerships for innovation and technology commercialization (Schwab, 2011 cited in Alessandrini, Klose & Pepper, 2013). While the concept of partnership between universities and external organizations (such as private companies) is not new (Etzkowitz, 2003; Laredo,

2007), the extent to which these partnerships have been nurtured and formalized is limited.

It has been suggested that the environment does not allow universities of technology in Africa to take the leading role in technology recreation nor align themselves towards a more entrepreneurial role (Derbew, Mungamuru & Asnake, 2015; Ssebuwufu, Ludwick & Beland; 2012). Contrary to the preceding authors, Derbew et al. (2015) hold a positive outlook towards the progress made and the current state of university-industry linkages in Africa. To support this view, Shore and Mclauchlan (2012) cite the rise in policies and practices focussed on enabling 'knowledge transfer', forging links with industry and commercializing university research output.

Along these lines, the movement for academic entrepreneurship at universities has benefited from external forces, including changes in the political economy of higher education and state disinvestment in tertiary education (Vernon, 2010). As a result, it has become mandatory for public universities to generate income streams to cover shortfalls, meet new 'key performance indicators' and, to prevent bankruptcy in some cases (Shore & Mclauchlan, 2012). Thus, universities are to form partnerships with external stakeholders as they strive to market their research outputs, though the details and consequences of commercializing are not well documented (Viale & Etkowitz, 2010). A previous study delved into the role of academics in the process of technology creation and transfer (Rorwana & Tengeh, 2015). The current paper strives to understand the role that spin-off and private companies play in the process of technology creation and transfer at UoT X.

2. Literature Review

2.1. Concept of Academic Entrepreneurship

The definition of the concept of academic entrepreneurship must be preceded by that of entrepreneurship. Entrepreneurship alludes to the potential and proclivity to develop, organize and manage a business in the effort to generate a profit. As such, the notion of entrepreneurship revolves around starting and growing businesses (Wood, 2011). Nicolaidis (2011) holds that entrepreneurship is a process that involves conceptualizing, launching, organizing, and through innovation- nurturing a business concept into a firm with the potential to grow. This definition suggests the entrepreneur is behind the birth and development of modern technologies, products and services.

Alluding to the concept of entrepreneurship, the academic entrepreneur would be anyone who uses the knowledge generated by an institution to create marketable products and services, to innovate, and establish new firms (Meyer, 2003). As an "umbrella name" academic entrepreneurship, includes the pull and push activities

that the university and industry initiate to market research output, and to generate third stream incomes for the university (Wood, 2011). Consequently, academic entrepreneurship epitomizes firms started by the employees of a university.

Wood (2011) argues that a process model for academic entrepreneurship is beneficial to both the university and industry as it clarifies all the activities, possible options, role players for each stage, and responsibilities of each stakeholder during the process.

According to Åstebro et al. (2013), for the past three decades universities have amended policies and changed the university culture to encourage university spin-offs. To this end, Lacetera (2009) argues that academic entrepreneurship does not mean only starting a new venture; it can take different forms, namely, industry–university collaborations, university-based incubator firms, start-ups by academics, etc.

2.2. Technology Creation and Transfer

2.2.1 Technology Transfer

Technology embraces the abstract and applied skills, knowledge, and objects that foster the creation of products and services (Lin, 2003). As such, technology is embodied in people, cognitive and physical processes, materials, facilities, machines and tools. It is important for universities to relate technology transfer to entrepreneurship to ascertain how income can be generated from the associated spin-off companies (Wright et al., 2004). To support this initiative, Wright et al. (2004) contend that the scientific disciplines at the university, resources, entrepreneurial culture, and processes should embolden the creation and development of spin-off firms.

Technology transfer entails that technology changes "hands." To complement the process of technology transfer and commercialization, academics are required to be proficient in recognizing opportunities and aligning research ideas to fill the needs of the market. Hence, the role played by the entrepreneur (academic) becomes central and strategic in development spin-off companies (Lockett et al., 2003). The scholar may prefer to manage the spin-off company alongside other academic duties to take advantage of the benefits associated with the direct involvement in the invention and knowledge of the technology.

2.2.2. Participants in Technology Creation and Transfer

The exclusive knowledge associated with innovative business ideas is grounded in the research that individuals conduct (Hindle & Yencken, 2004). As such, university scholars are believed to excel in bringing forth ideas that can stimulate business startup (Gabrielsson et al., 2012). Given that the knowledge generated in a university setting does not naturally turn into a viable business, someone (for

instance faculty members) has to become the custodian of this knowhow in its early stage development by virtue of his or her direct involvement in its creation. Though university spinoffs are believed to have high-growth aspirations, like any other business they often fall short as a result of the risks associated with any startup.

2.2.2.1. Institutions of Higher-Learning

In modern times, universities are urged to make meaningful contributions to economic development and competitiveness. As such, universities become instrumental in generating knowledge, educating and informing the society (Perkmann et al., 2013). Thus, the implicit relationship between university and industry, as evident in the mission to commercialise academic research, dates back to the mid-1980s (Kutinlahti, 2005). Universities today are proactive in the attempt to commercialise research output and how they establish linkages with industry players. Through collaborations and support of new knowledge-intensive start-ups, universities have emerged as auspicious champions of innovation, business creation and technological change (Etzkowitz & Leyesdorff, 2000; Etzkowitz, 2003).

Given the need for the modern university to contribute to socioeconomic development, ensuring that the technology created by such institutions reached the final consumers (through commercialization), has become a paramount part of their mission. To support this, a variety of policy initiatives and programmes have been advanced to encourage university–industry collaboration and commercialization of research outputs (Kutinlahti, 2005; Mowery & Sampat, 2005). Conspicuously, policy-makers have enacted laws that grant intellectual property rights to universities for marketable research related outputs (D’Este & Perkmann, 2010). Other policies aim to bring universities and firms together for meaningful in partnerships and personnel exchanges-for instance, via university–industry centres and science parks. Beyond this, other initiatives seek to strengthen the university’s capacity to transfer knowledge through staff training (Woolgar, 2007). The current literature does not substantiate the volume of research on technology creation and commercialization of research by South African universities, though there is evidence to suggest progress in the past decade (Wilson, 2007).

2.2.2. University Academics

Through research, the academic entrepreneur develops ideas into goods and services that satisfy the needs of the customer (Wright, Birley & Mosey, 2004). In agreement, Wood (2011) notes that academic entrepreneurship is a multistage process that begins with the researcher or student. Given the inherent complexity of academic entrepreneurship, Barbaroux (2012) advances the need for collaboration in nurturing and commercialization new technology/product.

Most often, academics are among the many participants that facilitate the creation and transfer of research output from the university to the industry. Apart from having a professional knowledge in their specific scientific disciplines, they have an established network of contacts (Van Rijnsoever, Hessels, & Vandeberg (2008). Perhaps, this can be ascribed to the fact that their academic portfolio places them in a position to interact beyond the classic research and teaching arena (Baldwin & Blackburn, 1981).

2.2.3. The industry

The rapport between university and industry has customarily been about the patenting, licensing and commercialisation of research outputs. This suggests that the university proceeds to identify the most suitable industry partner to turn its innovation into a commercially viable product upon embarking on the intellectual property route. As such, the commercialization materializes when the university and its industry partner signs the deal that creates a spin-off or license agreement. At this stage, clearly the spinoffs would benefit all the stakeholders, and this provides the impetus for further collaboration (Wood, 2011).

2.2.3.1 Spin-off companies

According to Pirnay, Surlemont, and Nlemvo (2003), a spin-off is a generic name that encompasses many things and a university spin-off represents just one of them. To this end, Pattnaik and Pandey (2014) pinpointed the ensuing peculiarities of a university spin-off: a) the parent company that creates the innovation must be an academic institution; b) as the output, the university spin-off must be a legal entity that is not related to a university; c) the new entity must be in a position to benefit from knowledge generated by university and 4) the spin-off must intend to generate profit from the generation and commercialization of technology.

According to Steffensen et al. (1999) a spin-off company is a new venture that is established from a parent organization. If academic employees leave the university (parent organization), they take along technology that serves as the ticket for the spin-off in a high-technology industry. Similarly, Smilor et al. (1990) look at university spin-off companies from two angles: (a) one of the founding members is active or retired academic (b) the spin-off firm is the result of a or technology-based idea originating from a university.

The relationship between a university-based parent organization and its spin-off can be beneficial to both parties. This is realised when a spin-off can provide financial or non financial assistance to the parent organization towards the creation and transfer of technology. Such transfer via spin-offs enforces the university's role in its region's development (Pattnaik & Pandey, 2014).

Most often, the formation of a university spin-off is championed by entrepreneurs with no links with academic institutions and their primary focus is to take

advantage of technology generated by the university. Hoping to reap financial benefits, investors establish the platform that ensures that universities collaborate with external entrepreneurs to establish spin-offs (Shane, 2004). Britain is an example of a country that continuously promotes and encourages the formation of university spin-off firms (Clarysse & Moray, 2004; Wright et al., 2004).

Shane (2004) is of the view that university spin-offs benefit a nation in at least five ways: they facilitate the commercialisation of university technology; they promote local economic development; they support the university's mission of research and teaching; they are a source of third income stream for universities besides licensing to established companies and they are comparatively high performing companies.

3. Research Methodology

3.1. Research Technique

The quantitative research approach was enlisted to investigate the role that spin-off and private companies played in the process of technology creation and commercialization at UoT X. This approach is premised on the popularity of the quantitative method within the managerial and behavioural sciences field (Baruch & Holtom, 2008). As such, questionnaires become relevant where perceptions and attitudes are investigated.

Structured questionnaires were designed and electronically administered to the participants to collect data related to technology creation and commercialization with special emphasis on the influencers. The survey questionnaire approach was preferred because it provides an accurate and quicker means of evaluating information about the population. Beyond this, surveys are perceived to be more appropriate in cases where there is the apparent lack of secondary data. The validity and reliability the survey instrument was assured by utilising mostly questions that have been tested in similar studies.

3.2. Sample Population

In-house research reports from 2008 to 2013 were utilized to create a databank for the study that comprised of academics that conducted university-industry research projects during the period. Hence, the database held records of both active and non-active academics in terms of research as per their research outputs, technology creation and transfer activities. Fifty-two (52) respondents were drawn from this database for the study.

The electronic survey questionnaires were administered to all 52 academics after guidance on how to complete the questionnaire. A total of 36 fully completed questionnaires were returned after two reminders. Twenty (20) of the 36 academics that responded to the survey, had been less active academics while 16 had been

active. Realizing a response rate of 70% was considered fair enough for this type of survey and in line with Baruch and Holtom (2009).

The Statistical Package for Social Sciences (SPSS) version 22 program was used to capture and to analyze the data. As a vital component of any good research in social sciences that involves human beings, ethical concerns were addressed. To Welman and Kruger (2001), ethics denote rules and regulations set by the authorities to safeguard the subjects under study from harm. In this case, the researcher assured the confidentiality of respondent's information. Furthermore, the respondents were given the opportunity to opt out should they felt uncomfortable participating in the study. Beyond these, the objectives and the benefits of the study were clearly explained to the respondents prior to their participation, and finally the researcher solicited approval to conduct the research from the appropriate authority at UoT X. Consequently, the research instrument was submitted to the ethics committee for endorsement. Additionally, an understanding was reached between the researcher, technology transfer office and the director of research with regards to the protection of the research archives given to the investigator and confidentiality of the information therein.

4. Results and Discussions

The results are presented and discussed under three headings: background information, self-Efficacy, beliefs and opinions and information on past and current research engagements and behaviour.

4.1 Background information of respondents

4.1.1 Faculty of employment, professional rank, employment status and work responsibilities

The most represented faculties were Applied Sciences (25%); Engineering (25%); Business (16, 7%) and the non-faculty group (13.9%). At first glance, this may be an indication of the research activity levels of these faculties.

In terms of professional rank, the results indicate that a considerable proportion of the sample comprised of associate professors (25%), followed by senior lecturers (19.4%), lecturers (19.4%), full professors (13.9%), and junior lecturers (2.8%).

With the understanding that the employment status of an academic may impact on his or her research and entrepreneurial activities, the results indicate that the majority (80.6%) of the staff members were full-time employees, while 19.4% were on contract.

In terms of the work responsibilities of the respondents, 77.8% of respondents have both research and teaching responsibilities at UoT X.

In summary, Associate professors constitute the largest group (25%), while the majority of respondents were from the faculties of Engineering (25%) and Applied Sciences (25%). The number of respondents from units not affiliated to the faculties are higher than for faculties, and 81% of the respondents are full-time employees of UoT X. Units independent of faculties have more active researchers than faculties. In respect of work responsibilities, 77.8% of respondents have both research and teaching responsibilities at UoT X.

4.2 Self-Efficacy, Beliefs and Opinions

In this section, the researcher attempted to elicit information on how the respondents see themselves and how they perceive research activity. This information is very important, as insight is gained from the individual instructional staff responses.

4.2.1 Passion for entrepreneurship

Academics were implored to relate their interest in entrepreneurship. It was noted that while the overwhelming majority (91%) indicated a remarkable interest, the remainder (9%) noted otherwise.

4.2.2 University–industry linkages

In response to a question formulated to gauge involvement in university–industry linkages, it was apparent that 78% of the respondents were involved in university–industry linkages and only 22% of the respondents had never been involved in any university–industry linkages. These results tend to align with the literature that suggests that academics become involved in technology transfer to further their research, rather than for commercialisation (D’Este & Perkmann, 2010). In the context of UoT X this is particularly relevant, given that research happens to be one of the three highly promoted core mandates of the university (that is, research, teaching and learning, and community engagement).

4.2.3 University–industry partnerships

On a scale of 1 to 5, where 1 denotes low importance and 5 high importance, the participants were asked to rate the importance of university–industry partnerships. The results (Table 1) indicate that 91.7% of the respondents see industry–university partnerships to be highly important. Approximately 3% of the respondents did not see the importance of university–industry partnerships, while 5.6% of the respondents rated industry–university partnerships as moderately important. These results concur with the findings of Bammer (2008) that support the need for collaboration between relevant stakeholders.

Table 1. Frequency distribution of respondent on importance of university-industry partnerships

	Frequency	Percent	Valid Percent	Cumulative Percent
2	1	2.8	2.8	2.8
3	2	5.6	5.6	8.3
High importance	33	91.7	91.7	100.0
Total	36	100.0	100.0	

4.2.4 Ability to transfer technology

In response to a question that sought to ascertain the technology transfer skills of the participants, the results (Table 2) note a significant proportion (80.6%) of academics consider themselves skilled enough to excel in technology transfer. 16.6% of the respondents did not have confidence in skills as far as technology transfer was concerned, while 2.8% did not respond to the question. A scale of 1 to 5 was utilised for this question, where 1 represented not skilled enough and 5 skilled enough.

Table 2. Frequency distribution of respondents' technology transfer skills

	Frequency	Percent	Valid Percent	Cumulative Percent
Not skilled enough	3	8.3	8.3	8.3
2	3	8.3	8.3	16.7
3	10	27.8	27.8	44.4
Skilled enough	19	52.8	52.8	97.2
Missing	1	2.8	2.8	100.0
Total	36	100.0	100.0	

4.2.5 Innovative products produced

In this section the respondents were asked to disclose if they had produced any innovative products. As noted in Table 3, approximately 47% of respondents indicated that they had produced innovative products, while 53% indicated that they had never produced any innovative products.

Table 3. Production of innovative products

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	17	47.2	47.2	47.2
No	19	52.8	52.8	100.0
Total	36	100.0	100.0	

4.2.6 Influences on producing an innovative product

The participants were implored to relay the factors that had impelled them to create innovative products. As noted in Table 4, the greater part of the respondents (47.2%) indicated the limited influenced of the availability of funding on their ability to realise innovative products, while 27.8% of respondents suggested that they had been positively motivated by the availability of financial support in the last five years, and approximately 16.7% of respondents indicated that availability of funding had very little influence.

Table 4. Availability of funding support

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low influence	4	11.1	12.1	12.1
	2	2	5.6	6.1	18.2
	3	17	47.2	51.5	69.7
	High influence	10	27.8	30.3	100.0
	Total	33	91.7	100.0	
Missing	System	3	8.3		
Total		36	100.0		

4.2.7 Influence of private companies

The respondents were asked to indicate how private companies had influenced them to produce innovative products. According to the results displayed in Table 5, the highest number of respondents (52.8%) indicated that they had been highly influenced by private companies during the past five years to produce an innovative product, while 38.9% of respondents indicated that private companies had had a low influence on them in the past five years.

Table 5. Private company

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low influence	11	30.6	33.3	33.3
	2	3	8.3	9.1	42.4
	3	15	41.7	45.5	87.9
	High influence	4	11.1	12.1	100.0
	Total	33	91.7	100.0	
Missing	System	3	8.3		
Total		36	100.0		

4.2.8 Financial support to participate in commercialisation.

In this section the respondents were asked to state if they are aware of UoTx's financial support for commercialisation. According to Table 5, 47.2% of respondents acknowledged that UoT X provided financial support to participate in commercialisation, while 50% did not know if UoT X provided financial support to participate in commercialisation.

Table 5. Financial support to participate in commercialisation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	17	47.2	48.6	48.6
	No	3	8.3	8.6	57.1
	Don't know	15	41.7	42.9	100.0
	Total	35	97.2	100.0	
Missing	System	1	2.8		
Total		36	100.0		

4.2.9 Funding opportunities for university-industry research projects

The respondents were asked to state whether UoTx offered funding support for university–industry research projects. Results as reflected in Table 6, indicate that 66.7% of respondents confirmed that UoT X did provide opportunities for UoT X staff to participate in university–industry linkages, while approximately 22.2% did not know, 8.3% disagreed and 2.8% did not answer the question.

Table 6. University–industry funding opportunities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	66.7	68.6	68.6
	No	3	8.3	8.6	77.1
	Don't know	8	22.2	22.9	100.0
	Total	35	97.2	100.0	
Missing	System	1	2.8		
Total		36	100.0		

5. Conclusions, Limitation and Scope for Future Studies

Universities have progressively honoured their position as the forbearers of knowledge, innovation and technology advancements. It is no doubt that interest in academic entrepreneurship and creation of university spin-off companies has gained momentum in South Africa in the recent decades. Though not very common, university spinoffs and private companies are perceived to make vital contributions to economic development, towards the commercializing of university technologies; towards generating third stream incomes and fostering the university's mandate of research and teaching. Thus, the aim of this study was to establish the role that private and spin-off companies play in the process of technology creation and transfer at a selected University of Technology in South Africa. It was noted that most active researchers and innovators were involved in one form of university–industry collaboration or the other. Furthermore, it was observed that the private companies had a vital role to play as far as the process of technology and commercialization is concerned. This is particularly relevant given that the overwhelming majority of the participants (91.7%) reiterated the importance of university–industry partnerships in the transfer and commercialization of inventions. Further, highlighting the importance of private companies, a slight majority (52.8%) of the respondents noted the significant

influence of spin-offs and private companies in the creation of innovative products during the past five years.

The low entrepreneurship culture at UoT X, was evident in the attainable participants' reluctance to take part in the study as they did not perceive the immediate benefits of academic entrepreneurship. Furthermore, the results are based upon the perceptions of academic entrepreneurs alone. Hence, there is the need for a broader study that complements the views of academic entrepreneurs by capturing those of the private companies involved.

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