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Commercialisation of Research in Institutions of Higher Education: A Transformation Process

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Abstract: Higher Education Institutions need to address transformation, particularly looking at reducing graduate unemployment and improving their third-stream income. One of the strategies to achieve these transformational goals is to commercialise research produced by these institutions. Hence, this paper aims to explore ways in which institutions can incorporate the commercialisation of research concepts to have an impact on their output. The exploration process employs a qualitative thematic literature review methodology. The paper focuses on how to dissect the commercialisation and entrepreneurship concept, harness intellectual property, form partnerships and collaborations, address transformational change and structural reform, benefits and challenges of commercialisation, among the ways to deal with the commercialisation of research. This study revealed that the commercialisation of research requires active participation from leadership, an understanding of the roles of all stakeholders involved, creating an enabling environment and having incentive programs for motivation. Challenges highlighted include financial constraints, particularly in developing countries, lack of awareness, unclear policies, and tradeoff between publishing research papers and protecting intellectual property. It has been found that commercializing research can have meaningful outcomes in institutions and an enormous effect on the economy and society.

Keywords: Commercialisation of research, Economy, Entrepreneurship, Intellectual Property transformation

1. Introduction

Higher Education Institutions (HEI) need to address transformation, particularly looking at reducing graduate unemployment and improving their third-stream income. One of the strategies to achieve these transformational goals is to commercialise research produced by these institutions. Harman (2010) defined research commercialisation as the process of turning scientific discoveries and inventions into marketable products and services. The commercialisation process involves licensing patents to companies or by the creation of 'start-up' companies depending on the assignment to them of university intellectual property (IP) (Harman, 2010; Caulfield & Ogbogu, 2015). Added benefits of research commercialisation are to enable knowledge transfer between universities and research users, solve societal problems, strengthen university-industry-government partnerships, encourage ongoing public investment in university research and improve international economic competitiveness (Harman 2010; Arya, 2012; Caulfield & Ogbogu, 2015; Aubakirova, 2020). In essence, the commercialisation of research transforms HEI into entrepreneurial universities that are driving the knowledge economy phenomenon to diversify their sources of income and revenue.

The knowledge economy challenges the status quo of teaching and learning in traditional HEI as it requires fluid science and education engagements. The knowledge economy concept increases the requirements of education by incorporating essential skills such as entrepreneurship, understanding of patenting and licensing inventions, the value of customer services, and being innovative (Kichuk, Kunchenko-Kharchenko, Hrushchynska, Zhukova & Yarish, 2021; Farrell, Mapanga, Chitha, Ashton & Joffe, 2022). Consequently, HEI are actively establishing Technology Transfer Offices, science parks, entrepreneurship incubators, policies, and seed grants to create enabling environment for the commercialization of research (Kichuk *et al*., 2021; Diop & Asongu, 2022; Farrell *et al*., 2022). However, developing countries are still lagging in some of the above mentioned initiatives. For instance, African countries only allocate less than 1% of their Gross Domestic Product (GDP) to research and innovation with South Africa and Kenya leading at 0.8% according to the World Bank Statistics 2017 report (World Bank, 2021). The limited public investment in research and innovation makes it more competitive to acquire grants that provide a platform for scientists and innovators to bring their ideas to life. As a result, the few discoveries made in developing countries may end up in

theses and journal articles due to a lack of start-up capital among many reasons.

The transformation of HEI into entrepreneurial universities is at a transition stage whereby the concepts of invention licensing and entrepreneurship are neither well-known nor effectively implemented. There are offices and centers dedicated to such programs however, the reception is dependent on the research and innovation culture of the institution. For instance, an institution that purely focuses on teaching and learning is reluctant to learn as they do not understand the benefits of the new concepts (Harman, 2010; Farrell *et al*., 2021). Other contributing factors are that some of the institutions do not have enabling business-friendly policies in place and there is no flexibility to share teaching workload in order to provide sufficient time for entrepreneurship (Harman, 2010; Audretsch & Link, 2019; Ghio, Guerini & Rossi-Lamastra, 2019; Diop & Asongu, 2022). Furthermore, there is a challenge of risking IP protection at the expense of publishing to meet academic targets for promotion (Salter, Salandra & Walker, 2017; Kichuk *et al*., 2021). Academics are also required to commercial in a specific field to gain international recognition. The downfall of highly commercial research is that it limits the scope of academics and subsequently lacks the critical entrepreneurship skill necessary for commercialization.

The Universities South Africa established an Entrepreneurship Development in Higher Education (EDHE) program in 2016 that teaches HEI about entrepreneurship (EDHE, 2022). The EDHE program is training university students, academics and leaders on entrepreneurship with the objective of cultivating an entrepreneurship culture that will yield entrepreneurial universities, reduced graduates and youth unemployment, and innovative academics (EDHE, 2022). The EDHE program is one of few initiatives that are teaching entrepreneurship. However, their focus is more on students and there is minimal awareness conducted to recruit academics. Once again, the low participation of academics becomes an issue of interest and finding time from the tight teaching workload.

The aim of this study is to dissect the state of the transformative process for entrepreneurial universities and unpack challenges that cause the lack of participation so that solutions tailored to the African region that address such can be devised. The overarching objective of the study is to bring about awareness of entrepreneurship while creating a culture of commercializing research. In that way, academics and HEI will be able to form mutually beneficial partnerships with industries.

2. Theoretical Underpinnings

The commercialisation of research is key to the transformation of universities; hence, this study adopts the theory of change. The theory of change includes the process from inputs, activities, output and outcomes, and impacts. The theory of change can sharpen the planning and implementation of commercialisation since a person uses inputs to change and should be firm to choose roles one at a time (Coombs & Meijer, 2021). In commercialisation, the input phase involves the feasibility stage where the prototype or service is tested (Bhagavathy, Cardenes & McCulloch, 2021). It should be noted that this stage is necessary though its time consuming and expensive. However, there is seed funding provided by the universities and other private institutions that researchers can consider for a successful feasibility study.

After a successful feasibility study, the theory of change allows the commercialisation process to engage the researcher in several activities. These activities entail research and development of the prototype, transfer of knowledge, and collection of data for analysis (Bhagavathy *et al.*, 2021). The theory of change links to commercialization because the initiative can be evaluated in a systematic and cumulative way to put activities and outcomes together (Matschoss, Repo & Lukkarinen, 2020).

The theory of change entails that the researcher begins by stating the intended outcomes and putting them into context (Matschoss *et al.*, 2020; Coombs & Meijer, 2021). For instance, in this case, the intended outcome is for universities to produce impactful research that has economic value for communities through commercialization. An important economic factor may be the policy environment, where universities provide legislation on funding models of the research project at the stages of commercialisation. Moreover, another contextual fact may refer to social networks such as how communities can accept the project or how intergroup relations are addressed (Papadopoulou, Phillips, Salehi & Salder, 2021). The theory of change needs to be plausible in that implemented activities should lead to desired outcomes. There should be economic, institutional,

and human resources commitment for the change to be successful. The theory should have measurable records of accomplishment under conditions that enhance continuous improvement.

3. Methodology

The paper employed a qualitative thematic literature review methodology that builds from existing knowledge (Terry, Hayfield, Clarke & Braun, 2017). This methodology synthesizes knowledge in a manner that dissects the themes into details that bring out new knowledge on the subject matter (Snyder, 2019; Osorio, Centeno & Cambra-Fierro, 2020). Consequently, this paper explored the following themes: how to dissect the commercialization and entrepreneurship concept, harness intellectual property, form partnerships and collaborations, address transformational change and structural reform, benefits and challenges of commercialisation, among the ways to deal with commercialisation of research.

4. Dissecting the Commercialisation Concept

The term commercialisation of research as defined above speaks about converting research and innovation discoveries into products and services that solve societal problems while creating revenue. Research starts with identifying a problem or gap that could potentially be addressed through dedicated exploration of relevant interventions (Gross *et al.,* 2018; Kishuk *et al*., 2021). Either the identified problem or gap is formulated into a testable hypothesis or question that will be answered based on the research finding. Similarly, entrepreneurship is identifying a problem or gap with the intention to provide a solution or service that creates revenue. Therefore, the commercialisation of research does require entrepreneurship skills. Table 1 shows the generic stages of commercialising research in HEI as basic research, commercialisation possibility including market research, technology feasibility and development, commercialisation, and business development (Hindle & Yencken, 2004; Bhagavathy *et al*., 2021). Each of the stages has sub-steps that are time-consuming, resource-extensive, and sometimes expensive. Furthermore, each step required a different form of funding instruments from either the institution, government, or private investors and specialized human capital, facilities, and infrastructure.

The commercialisation of research in HEI begins with the disclosure of research findings to university stakeholders such as the Technology Transfer Office (TTO) after completing market research (Hindle & Yencken, 2004; Bhagavathy *et al*., 2021;

Table 1: Stages of Commercialisation of Research in Higher Education Institutions

Stage	Activities	Funding Instrument	Housing/Responsible Stakeholder
Basic research	Test hypothesis Research market needs Commercialization possibility	Research grants	Laboratories
Disclosure of research and assessment	File for invention disclosure Evaluate whether it is a copyright, patent, know-how or trade secret	No cost	Technology Transfer Office
Prototype development and feasibility testing	Design, redesign and further testing Collect data for analysis	Seed grant	Research office or external funder
License assignment	File or sell the IP	Seed grant	Research office or external funder
Trials, market samples and demonstrations	Quality improvement User engagement	Investors, Government	Entrepreneurship Incubator Techno parks
Business development	New spin-off or existing business	Business angels	Inventor or the institution

Source: Author

Diop & Meijer, 2022). The market research stage is incorporated into the basic research step whereby the inventor discovers or improves a new product/service in the laboratory using a research funding grant and tests whether the product has a market and/or ability to generate revenue (Gross *et al*., 2018; Farrell *et al*., 2022). It is at this stage that the invention ought to solve local or international societal problems and must clearly state its contribution to the economy of the institution's community. The TTO decides if the disclosure is either published or protected as a copyright, patent, trade secret, or know-how given the outcome of its assessment (Hindle & Yencken, 2004; Ncube, 2013). This step is crucial for academics since publishing contributes to their productivity whereas filing for IP has financial gains. Only 15% out of 355 private funders showed interest in IP protection possibly due to the exorbitant fee required for this exercise (Chesbrough & Vanhaverbeke, 2018; Hart, An, Edwards, Mahadevan, Master & Edwards, 2021). This shows that most of the research funding does not cater for the IP protection cost.

The TTO further serves as an intermediary between the inventor and funders by assisting with seed grants for conducting technology feasibility studies in either a laboratory, technopark or science shop (Hindle & Yencken, 2004; Ncube, 2013; Kichuk *et al*., 2021). The invention is prototyped in the form of trials, market samples and demonstrators that form part of the output stage in the theory of change. This stage allows direct feedback from users with the aim of improving quality. This stage assists in establishing real-world clientele that will be retained by the quality of the product and customer service. The challenges faced include finding time to balance teaching and learning workload, and implications of private work policy shall the invention require resources that are outside the HEI, unclear roles of the involved stakeholder and undefined intergroup relations/benefits which could be outlined in outcomes as guided by the theory of change (Coombs & Meijer, 2021; Farrell *et al*., 2021). The invention is commercialised into a new spin-out start-up business mostly through the assistance of entrepreneurship incubators that are commonly found in HEI.

5. Harnessing IP

Harnessing the IP in universities involves a process where research output is recognized and rewarded by remunerating researchers during the commercialization process. This implies that harnessing the intellectual process includes some stages in the commercialization process ranging from IP audit, incubation of new ideas, reduction of ideas to the practical form, protection of the idea and exploiting the idea which are categorized as input and activities in the theory of change (Downie, 2005; Ncube, 2013; Kichuk *et al*., 2021; Kant & Shahid, 2022). The harnessing of IP activities is a disclosure of inventions, ownership of patents, licensing and registering companies (Delgado, Silva & de Rodriguez, 2019; Aziz & Nasir, 2021). There should be a pending patent application ready to be presented to investors and potential buyers or licensees for the commercialisation process to be smooth. Ensuring that there is a patent application keeps information confidential before it can be public.

The IP audit stage allows the researcher to keep records. These records will state the patent, trademark, copyright, trade secrets and confidential information (Ncube, 2013; Aziz & Nasir, 2021). Patent holders experience barriers when it comes to equity, commercialisation knowledge, and protecting their ideas from others who can steal the idea and run with it as their own. Universities need to up the game on implementing policies and overcoming strict regulatory processes of commercialisation. The commercialisation process needs awareness campaigns in universities to concertise researchers with privacy issues, ownership divisions and disclosure policies for researchers to engage in the process with confidence (Aziz & Nasir, 2021; Ravi & Janodia, 2022).

According to Aylen (2001), the harnessing of IP can generate third-stream income for universities. For instance, New Zealand reaped huge amounts of income from the seed fund, of which the seed fund involves the stage where the feasibility study is done for the prototype development (Aylen, 2001). Lack of knowledge about the commercialisation and IP process and information gaps leave research outputs in the cupboards being trophies. Others are exemplars for future researchers or kept in publication houses as other researchers are more comfortable with the publication process than the commercialisation process. Awareness and clarity on the process is a win-win strategy for both the researchers and the university as this process can generate social impactful research that is economical (Ncube, 2013; Delgado *et al.*, 2019).

6. Partnerships and Collaborations

The process of commercialisation needs researchers to collaborate with other parties to strengthen the process. For instance, commercialisation can have a significant impact on translating research and development (Downie, 2005; Hart *et al*., 2021). The partnerships integrate activities among businesses, universities, government and publicly funded research organizations. There can be a research consortium and research platforms that focus on the commercialisation of research. For example, in South Africa, the EDHE project hosted by Universities in South Africa (EDHE, 2022) to change the research landscape. In EDHE, among the platforms created to support entrepreneurship activities in universities, there is a community of practice that focuses on research. The project contributes to building strong collaborations among academics and linking universities to the private sector and potential investors. In 2022, there was a workshop that empowered academics on skills of commercialization (EDHE, 2022).

Partnerships and collaborations in the commercialisation process can have a sustainability impact on both the university and the communities that are served by them. For instance, companies attached to universities can invest huge amounts of money if the research output produced has a direct impact on industry production. Furthermore, the industry partners bring expertise on scale-up for mass production, technical barriers, and logistics for effective distribution of the new inventions to the market (Centobelli, Cerchione & Esposito, 2019; Ghio *et al*., 2019; Hart *et al*., 2021). This also creates new opportunities for graduates produced by universities and therefore can result in skilled graduate employment and job creation (Downie, 2005; Papadopoulou *et al*., 2021). Moreover, researchers remain relevant to address societal needs and make an impact with the investment they receive. Universities use innovation to sustain their research and continue to grow.

Several examples of activities on partnerships and collaborations range from including industry peers in review processes of universities and researchers being involved in industry space in activities such as board members, consultants, and speakers (Umoren, James & Litzelman, 2012; Centobelli *et al*., 2019). The partnerships can result in new degrees and short courses being born such as postgraduate diplomas, degrees in innovation and entrepreneurship, and IP protection or Finance Management course. Some companies or partnerships need to engage in formal agreements like the signing of memorandums of understanding or agreements to facilitate bilateral benefits (Skelcher, 2010; Ghio *et al*., 2019).

Cohen, Nelson and Walsh (2002) in their study in the United States of America found that partnerships and collaborations contributed to the efficient production of the manufacturing sector. Public research had a significant impact on both large firms and start-ups. It was suggested in their paper that partnerships were established through research publications, published reports, meetings, consultations, and the exchange of informal information (Cohen *et al.*, 2002). In addition, Hsu (2006) found that partnerships and collaborations can enhance growth and sustainability in start-ups.

7. Transformational Changes and Structure Reform

Transformational change should be based on the growth of the competitiveness of the economy and the accelerated development of the entrepreneurship ecosystem (Arya, 2012; Aubakirova, 2020). Universities should provide skills that can be used for building economies and should be able to instil an entrepreneurial mindset in the transformation process. It has been suggested by Simsek (2013) that leadership is key to the transformational process and should open doors for organizations.

Transformation in higher education in the commercialisation of the research process proposes that leadership bring a new strategic vision. For instance, chapter 9 of the National Development Plans (NDP) vision 2030 in South Africa quotes as:

> *"Universities educate and train people with high-level skills for employment… South Africa needs knowledge that equips people for society in constant social change… In today's knowledge society, higher education underpinned by strong science and technology innovation system is increasingly important in opening up people's opportunities…"*

This implies leaders in management should have the technical expertise to lead the process and be flexible to adjust where necessary. In the implementation phase, leaders need to recognize that there will be a cultural change in the university (Gamze,

2014; Aubakirova, 2020). This affects structures and leadership needs to find ways to report changes to university formal reporting structures and concertise the entire university community that there will be changes in processes, systems, roles, and relationships. Transformational changes should improve the quality of offerings in the university (Arya, 2012; Simsek, 2013; Caulfield & Ogbogu, 2015).

There should be new structures formed for the commercialisation process to succeed (Downie, 2005; Gamze, 2014). Commercialisation needs structures such as centers of entrepreneurship and innovation, TTO, institutes of entrepreneurship, and incubators among others. These structures should promote the participation of entrepreneurship activities and have platforms to link universities with the private sector to increase partnership agreements (Audretsch & Link, 2019; Centrobelli *et al*., 2019). In addition to TTO, there should be commercialization managers or officers and lawyers specializing in contracts. In top management, there should be a Deputy Vice-chancellor or Senior director responsible for innovation and entrepreneurship (Simsek, 2013; Ghio *et al*., 2019). There could be new companies within the universities that are entities assigned to generate revenues for universities. For instance, Auckland University's Uniservice Ltd in New Zealand deals with commercialisation aspects and generates huge revenues for the university (Downie, 2005). Also, other universities in South Africa own hospitals used to train students, conduct research, and generate revenues for the university. Universities can also offer new degrees and diplomas in programmes such as entrepreneurship, innovation management and others as they see fit in their surrounding environments. The programs in commercialization need to be provided in proper infrastructure and be offered by qualified human resources (Aubakirova, 2020).

8. Benefits of Commercialisation

Commercialisation of research in HEI command changes in the organogram, curriculum programs and policies. The transformation itself to the knowledge economy creates more job opportunities within the HEI that will require a variety of skills and competencies (Kichuk *et al*., 2021; Farrell *et al*., 2022). Interested university staff will have to embark on lifelong learning to acquire new skills necessary to successfully breed the research commercialisation culture. For instance, academics will be trained on entrepreneurship and IP protection so that they can better understand the process of research commercialisation and expectations based on their roles. The proposed new programs will have a clientele of the HEI community including top management, the partners from the government and the industries as the collaboration engagements will also be a great platform to market the new programs (Centobelli *et al*., 2019; Ghio *et al*., 2019; Hart *et al*., 2021). Community members can be trained on the new concepts as part of the HEI community engagement so that they become employable should an opportunity arise or be equipped with skills to run sustainable businesses. Consequently, the third-stream income of the HEI from the short courses and economic development in communities will be boosted. The revenue generated by the start-ups from the commercialized research or sales of IP contributes to the third-stream income (Aylen, 2001; Delgado *et al.*, 2019).

Additionally, the acquired skills affirm that the commercialisation of research is a multidisciplinary exercise. Therefore, it will ignite collaboration across disciplines within the HEI and yield multi-skilled staff and students. This will further improve knowledge transfer as people from different backgrounds will be working together by sharing their expertise which then creates learning opportunities for the partners and collaborators (Downie, 2005; Kichuk *et al*., 2021; Papadopoulou *et al*., 2021). The quality of produced graduates will improve and subsequently increase the chances of employability or starting sustainable businesses. The entrepreneurship training will instill traits such as creativity, innovative, strategic thinker and problem-solving while enhancing self-esteem as alluded to by Ncanywa (2019) and Farrell *et al*. (2021) in their definition of an entrepreneur. The commercialisation of research will contribute to curbing the high unemployment rate due to reliance on formal employment, particularly from the government.

The entrepreneurial academics partaking in the commercialisation of research will have the ability to devise customised solutions for immediate societal problems. For instance, HEI in rural Eastern Cape and Limpopo serve low-skilled unemployed community members who have access to agricultural land whereas Western Cape and Gauteng are dealing with increased demand for basic services like water, electricity, and reticulation system caused by urbanisation (Rogan, 2018; Bischoff-Mattson, Maree, Vogel, Lynch, Olivier & Terblanche, 2020). The inventions from the research will allow community access to improved services. In so doing, the

communities will be part of the solution making process. The partnerships will also increase economic activities between local government, institutions, local businesses and community members with the ultimate goal of creating circular economy culture.

9. Challenges of Commercialisation

The commercialisation of research concept is not necessarily new, however, its implementation varies due to ineffective articulation, unclear roles of stakeholders, lack of commitment and economic inequality. The commercialisation of research concept is understood at face value as converting research findings or inventions into services and products (Harman, 2010; Caulfield & Ogbogu, 2015). However, the translation of the conversion process with the necessary steps can lose its meaning based on the knowledge of the translator. For example, the concern about suppressing academic exchanges and research publications due to the non-disclosure requirement when filing for IP protection discourages participation (Aylen, 2001; Ncube, 2013). Research publications are one of the performance indicators for scholars that qualify them for promotion. Opting for commercialisation may delay one's promotion and participation in the commercialisation of research becomes a tradeoff between the two (Salter *et al*., 2017; Chesbrough & Vanhaverbeke, 2018). Hence, this paper seeks to highlight the need for clear policies that are accommodative of this concept. The policy must create room for consideration of the commercialisation of research as a component of scholars' performance indicators.

HEI policymakers have a key role in the rollout of the concept. The process of revising policies for inclusion of the commercialisation of research concept must involve all stakeholders such as students, staff and community members (Gamze, 2014; Farrell *et al*., 2021). This will allow all stakeholders to better understand their roles and benefits. It is upon knowing what is expected of you that you will commit, especially when the benefits are clearly spelled out. The policies must state principles of including community members as stakeholders of the institution, establish efficient funding models that benefit the investor, government and the inventor, and how the teaching workload will be allocated without threatening the scholars' income (Harman, 2010; Farrell *et al*., 2021; Diop & Asongu, 2022). The policy must have frameworks that explain terms of the interrelations. The funding frameworks must be formulated with the aim of creating enabling ecosystem for resource-poor HEI to minimize the economic inequality (Farrell *et al*., 2021).

10. Conclusion and Recommendations

The aim of this study was to explore the commercialisation of research in HEI by focusing on articulating the concept, its benefits and challenges faced. The commercialisation of research is dissected into stages with steps, funding instruments available and offices/structures that can be consulted for each stage. For example, the disclosure of the invention is done at the TTO at no cost while scaling-up and prototype development can be done at techno parks with financial assistance from investors or the government. Benefits of research commercialisation include income generation, job creation, skills transfer and customised solutions to societal problems. This conceptual study revealed that there is a differing understanding of the concept, hence, the unclear roles of stakeholders, who are the stakeholder and consequently the low commitment. It was further discovered that most of the challenges stem from unclear policies and frameworks to guide the process. Therefore, this study recommends that HEI must undergo structural reform and formulate/revise policies to explain the interrelations from partnerships, funding models accommodative of poor-resourced HEI and stakeholders' roles.

References

Arya, D.K. 2012. So, you want to lead a transformational change! *Asia Pacific Journal of Health Management*, *7*(2):8-14.

Aubakirova, G.M. 2020. Transformational Change in the Economy of Kazakhstan. *Studies on Russian Economic Development*, 31(1):113-119.

Audretsch, D.B. & Link, A.N. 2019. Embracing an entrepreneurial ecosystem: An analysis of the governance of research joint ventures. *Small Business Economics*, 52(2):429-436.

Aylen, D. 2001. Knowledge management: Harnessing the power of intellectual property. *Ivey Business Journal*, 65(4):58-58.

Aziz, S. & Nasir, S.N.C.M. 2021. Internet of things (IoT) and smart home technology in Malaysia: Issues and challenges for research in adoption IoT and latest technology for home building. In *AIP Conference Proceedings* (Vol. 2347, No. 1, p. 020094). AIP Publishing LLC.

Bhagavathy, S.M., Cardenes, I. & McCulloch, M. 2021. Have the cats been herded? An evaluation framework for simultaneous public interventions. *Energy Research & Social Science*, (81):102278.

Bischoff-Mattson, Z., Maree, G., Vogel, C., Lynch, A., Olivier, D. & Terblanche, D. 2020. Shape of a water crisis: Practitioner perspectives on urban water scarcity and 'Day Zero' in South Africa. *Water Policy*, 22(2):193-210.

Caulfield, T. & Ogbogu, U. 2015. The commercialization of university-based research: Balancing risks and benefits. *BMC Medical Ethics*, 16(1):1-7.

Centobelli, P., Cerchione, R. & Esposito, E. 2019. Exploration and exploitation in the development of more entrepreneurial universities: A twisting learning path model of ambidexterity. *Technological Forecasting and Social Change*, (141):172-194.

Chesbrough, H.W. & Vanhaverbeke, W. 2018. Open innovation and Public Policy in the EU with Implications for SMEs. In Researching open innovation in SMEs (pp. 455-492).

Cohen, W.M., Nelson, R.R. & Walsh, J.P. 2002. Links and impacts: The influence of public research on industrial R&D. *Management Science*, 48(1):1-23.

Coombs, S.K. & Meijer, I. 2021. Towards Evaluating the Research Impact made by Universities of Applied Sciences. *Science and Public Policy*, 48(2):226-234.

Delgado, B.M.G., Silva, A.P. & de Rodriguez, J.M. 2019. Concept Map on Health and Intellectual Property in Central America and the Dominican Republic. *Revista Panamericana de Salud Publica*, 43, pp.NA-NA.

Diop, S. & Asongu, S.A. 2022. Research productivity: Trend and comparative analyses by regions and continents. *Journal of the Knowledge Economy, pp.1-19*.

Downie, J. 2005. The power of money: Commercialisation of research conducted in public institutions. *Otago L. Rev.*, (*11*):305.

EDHE. 2022. Background on EDHE Programme. Available at: https://edhe.co.za/about/. Accessed 24 March 2022.

Farrell, A., Mapanga, W., Chitha, N., Ashton, J. & Joffe, M. 2022. Characteristics, enablers and barriers affecting entrepreneurial behaviour for academics in low-and middle-income countries: A scoping review. *Development Southern Africa*, pp.1-15.

Gamze, S.A.R.T. 2014. The new leadership model of university management for innovation and entrepreneurship. *Eurasian Journal of Educational Research*, (57):73-90.

Ghio, N., Guerini, M. & Rossi-Lamastra, C. 2019. The creation of high-tech ventures in entrepreneurial ecosystems: Exploring the interactions among university knowledge, cooperative banks, and individual attitudes. *Small Business Economics*, 52(2):523-543.

Gross, R., Hanna, R., Gambhir, A., Heptonstall, P. & Speirs, J. 2018. How long does innovation and commercialisation in the energy sectors take? Historical case studies of the timescale from invention to widespread commercialisation in energy supply and end use technology. *Energy Policy*, (123):682-699.

Harman, G. 2010. Australian university research commercialisation: Perceptions of technology transfer specialists and science and technology academics. *Journal of Higher Education Policy and Management,* (32):69-83.

Hart, K., An, S., Edwards, A.M., Mahadevan, R., Master, E.R. & Edwards, E.A. 2021. Could open science stimulate industry partnerships in chemical engineering university research? *The Canadian Journal of Chemical Engineering*, 99(10):2186-2194.

Hsu, D.H. 2006. Venture capitalists and cooperative start-up commercialization strategy. *Management Science*, 52(2): 204-219.

Kant, L. & Shahid, F. 2022. Managing intellectual property and technology commercialization: Experiences, success stories and lessons learnt - A case study from Vivekananda Institute of Hill Agriculture, India. *The Journal of World Intellectual Property*, 25(1):143-156.

Kichuk, Y., Kunchenko-Kharchenko, V., Hrushchynska, N., Zhukova, Y. & Yarishe, O. 2021. Intellectual Capital of Institutions of Higher Education in the Knowledge Economy. *Journal of Optimization in Industrial Engineering,* Special issue*,* pp.159-166.

Matschoss, K., Repo, P. & Lukkarinen, J. 2020. Network analysis of energy transition arena experiments. *Environmental Innovation and Societal Transitions*, (35):103-115.

National Development Plan (NDP): Vision for 2030 – Chapter 9. Available at: www.nationalplanningcommission.org.za. Accessed 4 February 2022.

Ncanywa, T. 2019. Entrepreneurship and development agenda: A case of higher education in South Africa. *Journal of Entrepreneurship Education*, 22(1):1-11.

Ncube, C.B. 2013. Harnessing intellectual property for development: Some thoughts on an appropriate theoretical framework. *Potchefstroom Electronic Law Journal/Potchefstroomse Elektroniese Regsblad*, 16(4):368-395.

Osorio, M.L., Centeno, E. & Cambra-Fierro, J. 2020. A thematic exploration of human brands: Literature review and agenda for future research. *Journal of Product & Brand Management*, 26(6):695-714.

Papadopoulou, K., Phillips, R., Salehi, F. & Salder, J. 2021. Entrepreneurship Education and Career Paths: Evidence from an Entrepreneurship Centre. Institute for Small Business and Entrepreneurship.

Ravi, R. & Janodia, M.D. 2022. Factors affecting technology transfer and commercialization of university research in India: A cross-sectional study. *Journal of the Knowledge Economy*, 13(1): 787-803.

Rogan, M. 2018. Food poverty, hunger and household production in rural Eastern Cape households. *Development Southern Africa*, 35(1):90-104.

Salter, A., Salandra, R. & Walker, J. 2017. Exploring preferences for impact versus publications among UK business and management academics. *Research Policy*, 46(10):1769-1782.

Simsek, H. 2013. Transformational Leadership in Educational Context: A Fantasy of Education Scholars. Editor's Choice: Selected Keynote Speech. *Eurasian Journal of Educational Research*, (51):1-6.

Skelcher, C. 2010. Governing partnerships. In *International handbook on public–private partnerships*. Edward Elgar Publishing.

Snyder, H. 2019. Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, (104):333-339.

Terry, G., Hayfield, N., Clarke, V. & Braun, V. 2017. Thematic analysis. *The SAGE Handbook of Qualitative Research in Psychology*, (2):17-37.

Umoren, R.A., James, J.E. & Litzelman, D.K. 2012. Evidence of reciprocity in reports on international partnerships. *Education Research International*, *2012*.

USAf. 2022. Available at: www.usaf.ac.za. Accessed 3 March 2022.

World Bank. 2021. Research and development expenditure (% of GDP) – South Africa. Available at: https://data.worldbank.org/indicator/GB.XPD.RSDV.D.ZS?locations=ZA&name_desc=true. Accessed 24 March 2022.