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Model Development through Reconfiguring Teaching, Research and Innovation Outputs for Commercialisation Success

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Abstract:
The effective and successful commercialization of research and innovation outputs, requires a careful appraisal of a university framework that can deliver a systematic model for research, development and commercialization of intellectual property.The model presented in this section was based on an overlapping Triple Helix Model. The testing and validation of the model was based on the developed instruments and Guidelines, Policies and Procedures to support the model and implemented at the Harare Institute of Technology. Collection of data using interviews and guided questions, stakeholder consultations, meetings held at several institutions were done and proved useful for deriving model specifications. Questions regarding intellectual property rights and sharing of profits dominated much of the discussions. The collected data and methods used for collection of data was sufficient to develop the model.The model developed brought about a systematic research and development framework which resulted in commercialisation of research and innovation output success.

Keywords: *Intellectual Property, Innovation, Systematic model, technology Incubation commercialisations.*

I. INTRODUCTION

The approach chosen was based on the literature survey which indicated conflicting paradigms [1] on how the development of systematic models should be carried out. A model can be looked at as an abstraction of reality, a simplified representation of the complex workings of a real-world system. The model should be simple but at the same time be adequate for the purposes of modelling. It is important to remember that a model no matter how good cannot capture all the factors of a system, as Dr George Box puts it "All models are wrong but some are useful" [2].Therefore, the development of the model was based on the generalized methodology for developing a systematic model which is constituted with seven critical steps as indicated in Figure 1.Furthermore, the "VDI 2221: Systematic Approach to the design of technical systems", was employed in an effort to develop a model with seamless integration, with technical task that maybe involved on technology and engineering designs' commercialization. This was a method developed by German Association of Engineers [4]. This method enabled the evaluation of results at each stage and presented the opportunity to work iteratively on all stages of the design process. The main reason for implementing VDI 2221 approach was to develop the technical architecture not as a theoretical framework but as a technical framework with industrial applicability.

The main thrust of the study was to initially qualitatively determine the actual challenges being experienced by the universities, government and industry with regards to research and commercialization of research outputs. Then a quantitative analysis was carried out on the impact of existing relationships on organizational performances. The results collected enabled the justification of the need for the model. An experimental analysis was then carried out on the feasibility of the model at Harare Institute of Technology in collaboration with TelonePvt Ltd, LexwareInc, ZimnatPvt Ltd, NetonePvt Ltd, ZUPCO Pvt Ltd and SecuricoPvtLtd.. The commonly used Helix Model was critically evaluated in Chapter 4 and its weaknesses and strength were presented.

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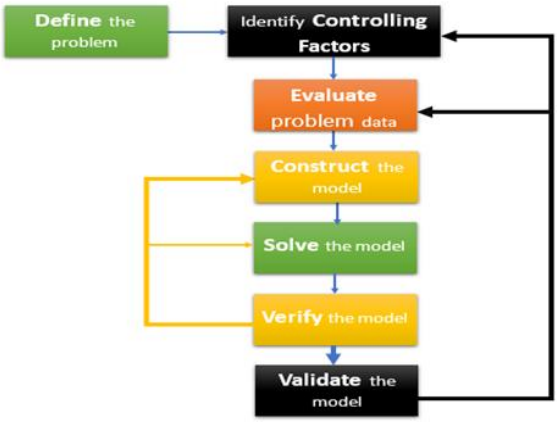

Figure 1: The seven steps for Systematic Model Building [3].

The results were then used as design specifications for the model architecture as they clearly highlighted the required areas of cooperation. A final model architecture was then developed along with the relevant departments and centers of excellence created at Harare Institute of Technology in order to realize the full potential of the system. The Parl and Beitz phase model for the design process [5].The experimental design approach embedded within the design enabled comparison of alternatives, identification of significant inputs that is separating the vital few from the trivial many, facilitated variability reduction, robustness design and also balancing tradeoffs. As a result, the methodology enabled collection of information effectively and in a reproducible manner.

II. METHODOLOGY

This study analyses eight elements that influence research performance in Zimbabwean universities in order to develop a generic framework for research outputs commercialization. These elements are knowledge, skills and personality traits of researchers, creation of idea, paths of commercialization, product development and promotion, building competitive advantage in the market, finding a suitable business partner, nurturing healthy relationship with business partner and facilities and supports. Each of these elements are interrelated with each other

Step 1: Problem identification

At the beginning of the 21st Century the government embarked on a process to come up with aa sustainable solution for the resuscitation of the local industries as well as raising the local products and services standards toglobal standards. However, one of the major challenges was availability of technical human capital. In that regards, the researcher was mandated to transform one of the local polytechnics into a vibrant technology institution. Furthermore, the institution was to have a mandate whose thrust was technology, innovation and technopreneurship rather than entrepreneurship. Therefore, the mandate of the institute was to carry out development, incubation, technology transfer, and commercialization of research outputs. Several centers of excellence were established, and amongst them was the Technology Centre. A decade after the establishment all university strategic business units, research groups, training of researchers and additional centers of excellence, the results achieved with regards to commercialization of research outputs were negligible. Issues of concern included the manner in which the university engages with industry on issues of research and ultimately commercialisation.

Step 2: Determination of controlling factors of the model

The determination of the controlling factors of any model determines the success or failure of the model. The major contributing factors of this research are intellectual property rights, profit sharing, infrastructure availability, human capital, funding and operational agreements. Whenever research is to be carried out, issues of funding are of fundamental importance. For every model to be successful all these related factors were evaluated and relationships between factors were also evaluated.

Step 3: Data collection

The Oslo Manual was used as the main tool for designing the Questionnaires and Interviews. It is a statistical approach to support the measurement of innovation [7]. Oslo manual has been used in more than 80 different countries, with national statistical organisations and research institutes adapting the core set of guidelines to country-specific idiosyncrasies and user needs [8]. The framework has proved its value in the context of microeconomic analysis of business performance and plays an important role in the statistical programme of work of several countries [9]. By developing and implementing in-depth interviews with business, this report describes how business managers, the target of innovation surveys, perceive and report innovation [10]

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.Interviews and questionnaires were used for data collection. An online questionnaire was made using Survey Monkey, which is an online platform. Email addresses of participants were used to supply the link to the participants.

III. Population Size and Sampling

Approximately 250 participants were used in the study. These were from universities, industry and government. The data received was crosschecked for validity based on the email addresses used. The Zimbabwe Institute of Engineers' membership data base was used to collect data from industry experts. While the Confederation of Zimbabwean Industry's membership database was used to link up with industry captains. University staff data bases were used to send the links to university researchers. In this way all organs related to the research were consulted. Other areas where data was collected included Association of Small and Medium Enterprises, Ministry of Higher and Tertiary Education, Science and Technology Development and Ministry of Industry and Commerce.

Step 4: Construction of the model

Developing a systematic relationship model requires a clear understanding of the process and procedures needed to be used when utilizing the model and ultimately a clear set of goals to be achieved. The problem was defined, and a scope was developed indicating boundaries of influence, Data collection tools were developed and deployed using online platforms, Data was analyzed using Matlab, also a model was developed based on the qualitative and quantitative data collected.

IV. Analysis of the Helix Models

According to [11], the Triple Helix model is regarded as the most widely applied model as a framework of engagement between universities, industry and the government. Greater synergies are built based on mutual trust and understanding with the goal of improving products and services of each party [12]. The model is based on the "field and circulation "concept illustrated in Figure 2

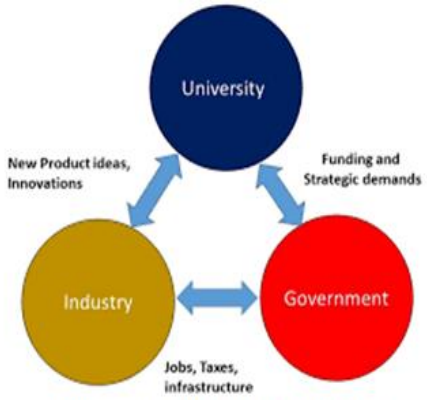

Figure 2: The Triple Helix Model [13].

The triple Helix model provides an overview on how the university, industry and government interact. The Triple Helix Model operates on a more interactive rather than linear model of innovation [14]. According to [15], the premise of a successful triple helix is that at least one helix can supply a driving force to initiate regional innovation. In Zimbabwe, entrepreneurial universities play diverse roles in university-pushed, government-pulled and corporate-led innovation, with different initiators in various triple helix models. Triple helixes emerge with rise of the university to equal status with the economy and polity; as knowledge-based societies embed academia, government and industry in lateral relationships.

There are so many ways in which the triple Helix is applied [16], MIT and Stanford exemplify a U.S. "university-pushed" triple helix in contrast to a "government-pulled" triple helix in China and "industry-led" triple helix models in Zimbabwe. Regional triple helix innovation is also a function of academic goals and objectives, trust among university, industry and government and the strength of local organizing and initiating capabilities [17]. Nevertheless, knowledge spill-over increasingly occurs through commercialization of research results on campus, irrespective of societal or academic differences.

Harare Institute of Technology was established as a techno preneurial university. It is expected that a generative principle of university-industry- government interactions blossom and become a source of innovation. Ability to act as an independent entity is a necessary but not sufficient condition [18]. The key elements of the entrepreneurial university model are a research base with commercial potential, a tradition of generating start-ups,

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an entrepreneurial ethos on campus, Policies for defining ownership of intellectual property, Sharing profits and regulating conflicts of interest and Participation in regional innovation strategy.. According to [19], applied teaching/ learning is the new way of training students at universities. Furthermore, research-based assignments with a focus on targeted industries increase students' confidence in the learning process.

Development of a systematic research, development and commercialisation of intellectual property framework

This chapter focuses on the development of a model that details the interconnectedness of components within a university. The ultimate goal of the model is to improve the influence and roles of the university within the broader well-known Triple Helix model framework of engagement between university, industry and government. As a result, the model presented in this research was developed through the improvement of the existing triple helix model for university-industry-government engagement. It is more focused on creation of a holistic platform that can foster the engagement in order to industrialize a country through research outputs and innovation. The key principles of the academic model are illustrated in Figure 3

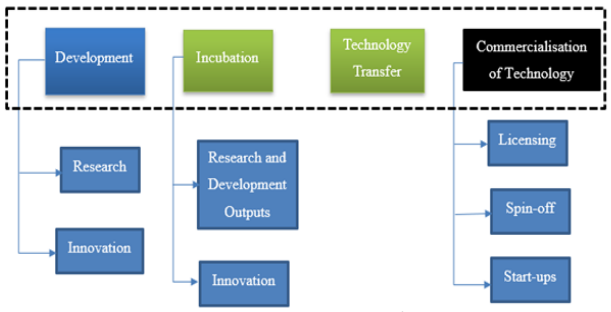

Figure 3: The HIT Principles

The figure 18 shows the relationship between these principles and how they are utilized for systematic research, development and commercialization of intellectual property. In this case, the Harare Institute of Technology was used as a development, testing and validation environment.

The Kanhukam we-Sharma Model for IP commercialization and engagement framework.

This section describes the design and evolution of the proposed Kanhukamwe-Sharma (K-S) Model of engagement since the transformation of the institution from a Polytechnic College to a university. Since its establishment a decade ago, Harare Institute of Technology has been mandated to develop, incubate, transferandcommercialise technology. However, the attainment of the mandate had been an uphill task to achieve commercialisation aspects as the university needed clear frameworks on how to motivate the students and staff to develop innovative solutions. The proposed model evolved through the following stages:

- T_α – Transformation phase also referred as the alpha stage of the model.
- G_β – Growth phase also referred as the beta stage of the model.
- O_γ – Optimisation phase referred as the gamma stage of the model.

The following sections detail the stages that the model went through in order to achieve a reliable model for unlocking value from the research outputs. The model was based on two trajectories namely the academic and the commercialization trajectory.

The (K-S) T_α transformation stage

The Kanhukamwe-Sharma ((K-S) T_α) stage is regarded as the transformation stage of the K-S model as the university was being established. The university was transformed from a technical college which had limited infrastructure and model of engagement that was different from those of other universities. Different Schools were formed and within them several departments were established which represent the number of degree programmers' being offered by the institution. In order to attain its mandate, the university introduced modular based programmers' where a module or in some cases modules accompanied were supported by a practical. Furthermore, student research projects were encouraged from the 2nd year through to the final 4th year. The 2nd year project is a group project, comprising a maximum of four students. It encourages teamwork and sharing of expertise and skill. During this stage the students are taught problem identification, data collection tools and general problem-solving techniques. The 3rd year project is a purely research and design project carried out within a semester.

The students are encouraged to improve their skills on

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research methodologies, synthesis and majority of the prototyping is carried out through simulation application packages. The final 4th year Capstone Projects have more emphasis on all stages of research and design. Prototyping and validation are the critical elements of the final year capstone design project. During the alpha-model, there was high dependency on HIT200, HIT300 and HIT400 research outputs which are carried out as from 2nd, 3rd and 4th year of study respectively. The desired framework for the systematic unlocking of value from university research included the involvement of industry and the government at large. The alpha-framework which existed from the inception of the university prior to the new framework by the researcher is illustrated in Figure 4below. During the initial establishment of the university, the Library and the Research Board played major roles on showcasing the university research outputs. However, there was no clear path within the model on how student and staff research outputs could be commercialised. The research index of the university was very high, journal publications and conferences were also highly sponsored.

The (K-S) T_β growth stage of the model exhibited weaknesses regards the available staff to achieve significant growth of the university through the transformation agenda. In order to improve the quality and quantity of the research outputs the university managed to embark on an aggressive capacity building programme of staff through MTech and DTech/PhD programmes. This was necessitated by strategic partnerships between the university and Amity University, IIT Madras, SRM, DTU, VIT and Stellenbosch University in South Africa as well as some Chinese, Indonesian and South Korean universities.

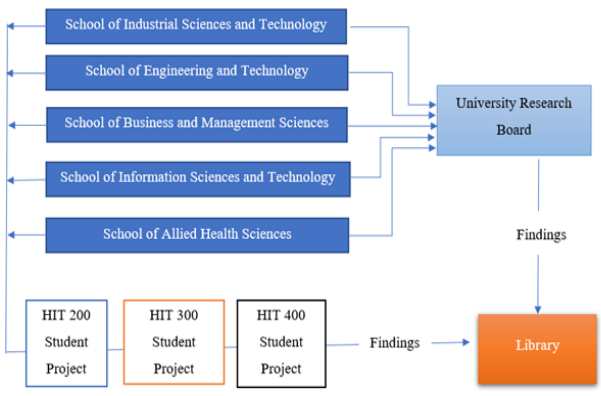

Figure 4: The *(K-S) To Transformation* stage for research management

This exercise empowered the university staff and as reported on results and discussions, there was a significant change in research outputs. The K-S model for the beta growth stage is illustrated in Figure 5 below.

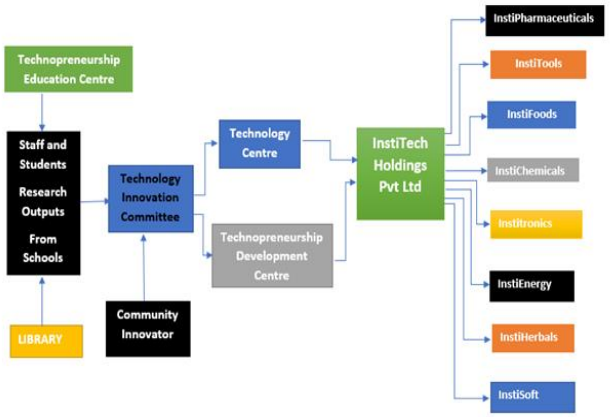

Figure 5: The (K-S)Gβ Growth stage for research management

However, the shortcomings of the model were that it defeats the purpose of rapid industrialisation. If an investor would like to invest in a student idea, they were restricted to use on the SBUs. The SBUs were beneficial to the university but had detrimental effects on the staff and students. This framework excluded those businesses that could emerge without the need for HIT to own shares within them, as well as assist the staff and the students with knowledge and mentorship. As the university grew, this framework approach became unsustainable. This gave rise to the problem that the researcher embarked on, that is to develop as systematic model to commercialise university research.

Innovation development process

The challenges on differentiating between innovation management and research management created hurdles for the university. In order to achieve the desired objective of seamless engagement between the industry, government and university, the researchers developed an innovation management framework which is part of the broader model. The framework is indicated in Figure 6

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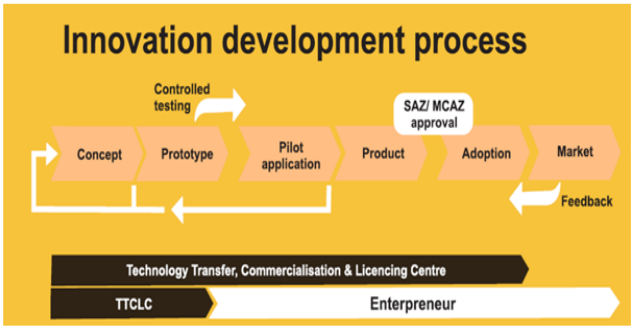

Figure 6: The HIT Innovation Development Process

The university has the capacity to develop any prototype due to the availability of both academic and research laboratories. The researchers have developed and tested a framework that is illustrated in Figure 24. Consequently, innovation outputs have increased marginally and the time from product conceptualisation to market has also decreased.

Patenting strategy

The new technologies resulting from the interventions carried out by the researchers at the university have resulted in three major categories of IP. These are the utility patents, design patents and plant patents. Figure 7 illustrates the organs associated with patenting in Zimbabwe and the associated timelines.

Commercialisation strategies and schemes.

Once a patent has been filed in Zimbabwe, a provisional patent is issued. Issues of commercialisation can break or make an institution especially when it comes to shareholding and revenue sharing. The model proposed and validated by the researchers identified the university as a system that should empower the inventors, staff and students at large. The main thrust was to improve the synergies between industry and academia through proffering solutions for the industry by offering licences for production of new goods. Conventional commercialisation schemes are Patent licensing, Research grants and contracts, R&D joint ventures, Technical services for a fee. Some of the above-mentioned schemes such as research grants and contracts are usually associated with the incubation period of the business idea.

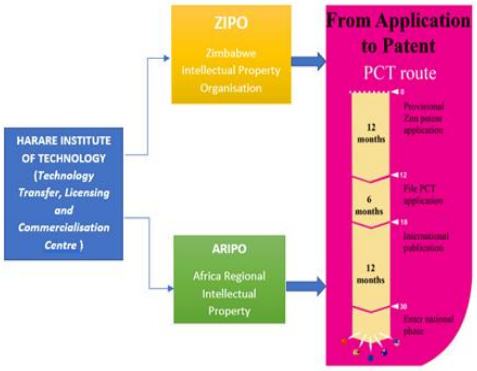

Figure 7: The HIT patenting process timelines

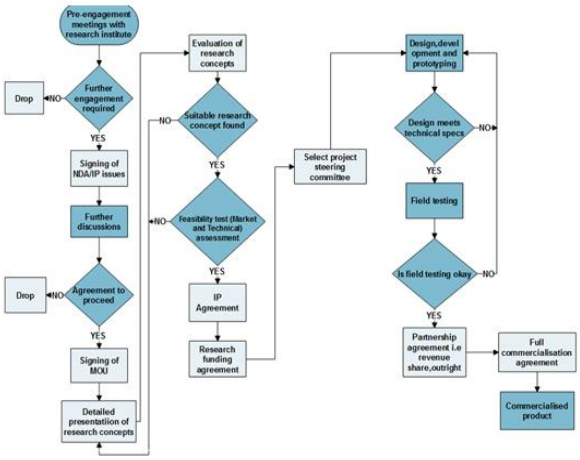

Figure 8: The HIT commercialization process and activities

At times a technology may not result in the formulation of a patent but is commercial sable. That has been the common trend with technologies from developing nations such as Zimbabwe where societal needs supersede technological advancement. As a result, spin-out companies are registered by students and staff in an effort to address societal needs as compared to the issuing of licenses.

The commercialisation of an idea, service or product involves some of these processes and activities as illustrated in Figure 8.The potential market for the technology can be an important factor in the choice of the commercialisation path. Not every invention warrants the creation of a new company. Some markets, quite simply, will be too small to warrant company creation. In other cases, markets may be controlled by large and mature companies that would make it difficult to compete. There is need to be realistic about the value of the technology and to carefully weigh the size and structure of the market as part of choosing the right path to commercialisation.

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Incubation process

Having a product and a registration of a company are not the only activities being offered by the Technology Transfer, Licensing and Commercialisation centre to university start-ups. The major mandate of the TTLCC, involves the incubation of the start-ups through the innovation management process. The researchers developed an Incubation Policy which explains the obligations of the university and those of the start-up company as illustrated in Figure 9

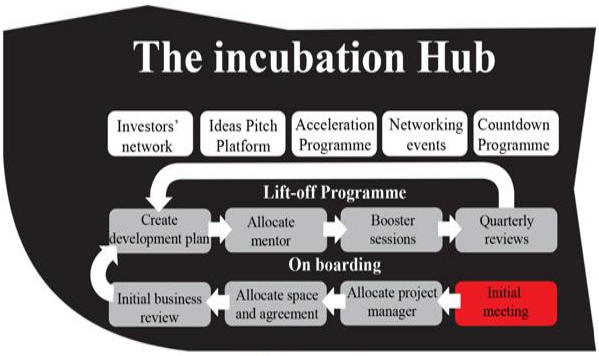

Figure 9: The HIT incubation process

The goal of the incubation hub is to address the challenges that are faced by the youths when they need to start or scale up their businesses. In this case it will be student, staff and the community at large.

The initial phase is termed the on-boarding stage and it involves allocation of a project manager, allocation of working space, signing of relevant agreements and the initial business review. The second stage is termed the lift-off programme stage, creation of the development plan, mentorship, booster sessions and quarterly reviews. This stage is highly dominated by the Techno preneurship Development Centre. This is the crucial stage that can make or break a start-up. Business skills are imparted on the staff and students or the incubated personnel in order to efficiently operate their start-up companies. The programme takes two years to complete..

The model presented in this section was based on an overlapping Triple Helix Model. The optimisation of the existing model was in line with the Institute's mandate and the National Vision 2030. The testing and validation of the model was based on the developed instruments and Guidelines, Policies and Procedures to support the model. Some of the guidelines and committees are yet to be established.

V. Results and Discussion

The chapter mainly focus on the determination of model inputs and outputs, causes of lack of commercialisation of research outputs, evaluation of existing commercialisation strategies, challenges associated with commercialisation and the impact of IP registration.

Commercialisation challenges

Most universities as well as R&D institutions do not have in place clear and comprehensive operating guidelines to govern day to day management of consultancy, technology transfer and commercialization of IPRs. Several other bottlenecks inhibit the smooth commercialization of IPRs and these include bureaucracy, lack of entrepreneurial, management and legal skills, lack of awareness of IPRs, lack of an intellectual property policy, lack of data bank on specialists and research findings from R&D institutions, insufficient marketing strategies for products and services, weak university - industry linkages. Although there are nighteen (19) universities in Zimbabwe only two universities (HIT and National University of Science and Technology (NUST)) have IP policies in place. As a result, majority of the staff and students in Zimbabwe have no knowledge of Intellectual Property Rights (IPR)

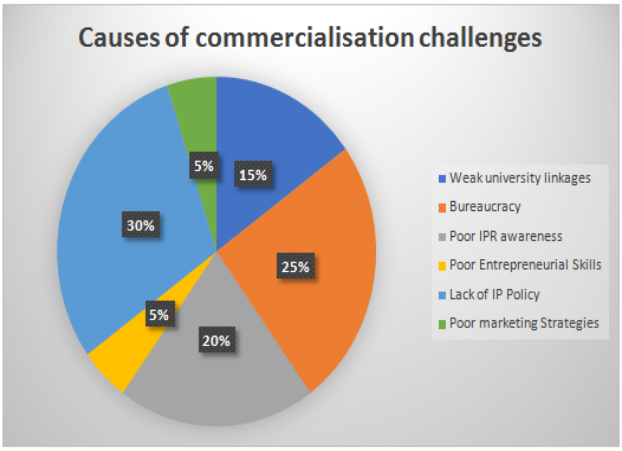

Figure 10: Causes of poor commercialization strategies

Benefits of Intellectual Policy Rights

Our study also seeks to determine the benefits of operational zing the IP policy at a university and the nation at large. A sample of ten universities was used to acquire data regarding the use of the IP Policy. The results of the findings are illustrated in Figure 30 below.

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An intellectual property policy should aim at achieving the following creating an environment that encourages and expedites the dissemination of inventions and new knowledge generated by researchers for the greatest possible public benefit, protecting the traditional rights of scholars to control the products of their scholarly endeavors, ensuring that the commercial results, financial or otherwise, are distributed in a fair and equitable manner that recognizes the contributions of all stakeholders, ensuring that both intellectual property and other research products are made available to the public through an efficient and timely technology transfer process; promoting, preserving, encouraging and aiding scientific investigations and research, establishing standards for determining the rights and obligations of a university as well as inventors and their sponsors with respect to inventions, also encouraging, assisting and providing mutually beneficial rewards to a university or R&D institution and its members who transfer intellectual property to the public, ensuring compliance with applicable laws and regulations and enabling a university or R&D institution to secure sponsored funding at all levels of research.

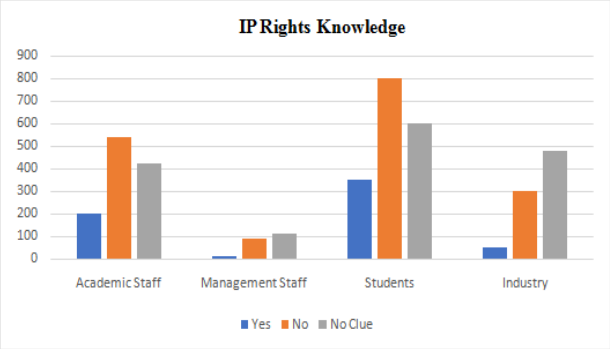

Figure 11: IP rights knowledge

Effects of human capital on commercialisation

The number of experts a university or company has in its pool, has a bearing on the success of its research outputs. Figure 31 illustrates human capital distribution in Zimbabwean Universities.

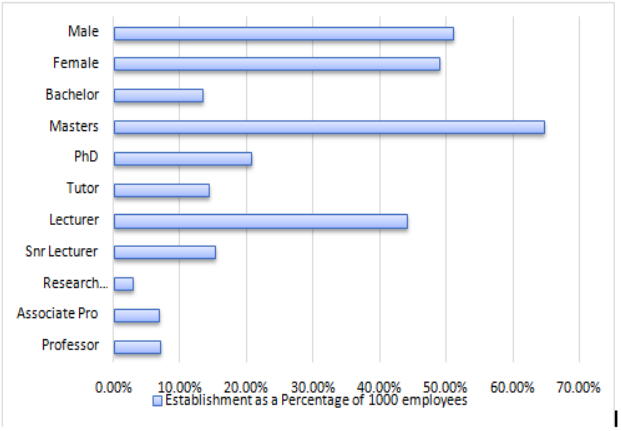

Figure 22: Skills mixture per 1000 university employees

A sample of two hundred lecturers was used to conduct a study to determine how many of them are actively involved in research and also how many of their research outputs has resulted in commercialised products or license from 2013 to 2018. The results of the survey are.

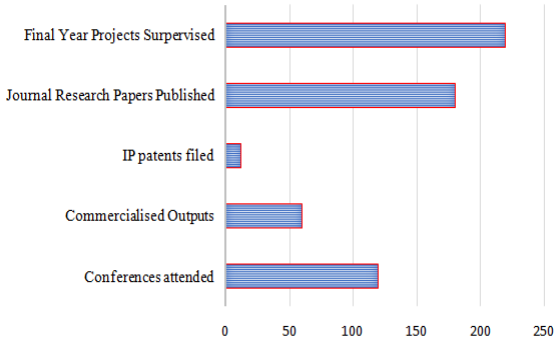

Figure 33: Research trends for university lecturers at HIT

At the beginning of the 21st century, emphasis has been on publishing of research output, “Publish or Perish”. The idea was to motivate the academia to publish in order to gain recognition and improve university rankings. However, the tide has changed, countries now want to establish knowledge-based economies hence the need for commercialisation of research outputs.

Research Funding

The operationalisation of the IP policy requires huge funding. However, research funding in developing nations in Africa has always been a challenge. Majority of state-owned universities depend largely on government funding for their operations. The university-industry linkages in Zimbabwe are very weak. As a result, industries shun funding university researches. In an effort to sustain the research ecosystem, the universities have

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embarked on fundraising activities to raise research funds. Most universities in Zimbabwe depend highly on their internal funding system as indicated in Figure 14.

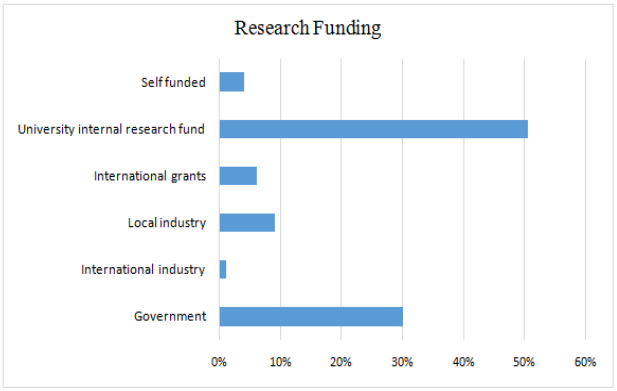

Figure 44: Research funding

The local industry usually assists with other research resources such as access to laboratories and technical expertise when available. However, such assistance affects the research ecosystem since it is not contractual even where industry is expected to capacitate the universities to buy state of the art equipment.

VI. Conclusion

Universities are increasingly being regarded as industries that trade in particular goods and have to make profit in order to survive. While this rationalist policy may be abhorred by many, the public funders of education in many countries have drastically reduced funding to universities so that they have to adopt this attitude in order to continue their existence. Collection of data using interviews and guided questions, stakeholder consultations meetings held with several institutions were useful for driving model specifications. The Kanhukam we-Sharma ((K-S)T_{α}) stage is regarded as the transformation stage of the K-S model as the university was being established. The university was transformed from a technical college which had limited infrastructure and model of engagement that was different from those of other universities. The (K-S)T_{β} growth stage of the model exhibited more requirements regards the available staff to achieve significant growth of the university through the transformation agenda. The third (K-S)Oγ phase brought about some relief and had the effect of motivating staff and students to generate more research outputs. Lack of license sales or new business start-ups had nothing to do with the quality of the patents generated but was hugely influenced by lack of a systematic approach to commercialisation of the university intellectual property rights. As a result, the reconfiguration of the (K-S)Tα and (K-S)G$_{\beta}$ frameworks together with the new thrust of the TTLCC through the (K-S)Oγ phase, resulted in the development of the K-S model by the researchers. The model has demonstrated the need to have a mutually beneficial interactive interface between government, university and industry. This allows for an engagement framework that is productive and responsive to the needs of all the stakeholders. By optimising the Triple Helix model, the researchers have proceeded to advance the K_S model which has brought about a systematic framework for research, development and commercialisation of Intellectual Property at the university

VII. Acknowledgment

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VIII. References

1. Maresova, P., Stemberkova, R. and Fadeyi, O., 2019. Models, Processes, and Roles of Universities in Technology Transfer Management: A Systematic Review. Administrative Sciences, 9(3), p.67.
2. Stouffer, D.B., 2019. All ecological models are wrong, but some are useful. Journal of Animal Ecology, 88(2), pp.192-195.
3. Jenner C., 2012. Process Principles. http://processprinciples.com/2012/05/a-systematic-modelling-approach/https://lynnmunoz.wordpress.com/2013/10/13/systematic-model-of-processing/
4. Rivera, C.A., Poza, J., Ugalde, G. and Almandoz, G., 2017, May. A Knowledge Based System architecture to manage and automate the electrical machine design process. In 2017 IEEE International Workshop of Electronics, Control, Measurement, Signals and their Application to Mechatronics (ECMSM) (pp. 1-6). IEEE.
5. Martins, M.B. and Kaminski, P.C., 2019. Differences in Open Innovation practices between headquarters and subsidiaries in the automotive industry: the French case. Cogent Engineering, (just-accepted), p.1684806.

March - April 2020
ISSN: 0193-4120 Page No. 10152 - 10162

6. Kannengiesser, U. and Gero, J.S., 2017. Can Pahl and Beitz'systematic approach be a predictive model of designing?.Design Science, 3.
7. Audretsch, D.B., Lehmann, E.E. and Warning, S., 2017. University spillovers and new firm location. In Universities and the Entrepreneurial Ecosystem. Edward Elgar Publishing.
8. Organisation for Economic Co-operation and Development and Statistical Office of the European Communities, 2018. Oslo Manual 2018: Guidelines for collecting, reporting and using data on innovation. OECD publishing.
9. Manual, O., 2018. Guidelines for collecting, reporting and using data on innovation, The measurement of scientific, technological and innovation activities. October, 22, p.255p.
10. Gault, F., 2018. Defining and measuring innovation in all sectors of the economy. Research policy, 47(3), pp.617-622.
11. Frederiksen, M.H. and Knudsen, M.P., 2017. From creative ideas to innovation performance: The role of assessment criteria. Creativity and Innovation Management, 26(1), pp.60-74.
12. Yoda, N. and Kuwashima, K., 2019. Triple helix of university–industry–government relations in Japan: Transitions of collaborations and interactions. Journal of the Knowledge Economy, pp.1-25.
13. Rexhepi, G., Abazi, H., Rahdari, A. and Angelova, B., 2019. Open Innovation Models for Increased Innovation Activities and Enterprise Growth. In Open Innovation and Entrepreneurship (pp. 37-49). Springer, Cham.
14. Ismail, N., Nor, M.J.M. and Sidek, S., 2015. A framework for a successful research products commercialisation: A case of Malaysian academic researchers. Procedia-Social and Behavioral Sciences, 195, pp.283-292.
15. García-González, A. and Ramírez-Montoya, M.S., 2019, October. Higher education for social entrepreneurship in the quadruple helix framework: co-construction in open innovation. In Proceedings of the Seventh International Conference on Technological Ecosystems for Enhancing Multiculturality (pp. 925-929). ACM.
16. Li, R. and Fang, W., 2019. University-industry-government relations of the Ministry of Industry and Information Technology (MIIT) universities: The perspective of the mutual information. PloS one, 14(2), p.e0211939.
17. Kimatu, J.N., 2016. Evolution of strategic interactions from the triple to quad helix innovation models for sustainable development in the era of globalization. Journal of Innovation and Entrepreneurship, 5(1), p.16.
18. Edmunds, L.D., Gluderer, S., Ovseiko, P.V., Kamerling, R., Ton, J., Vis, L., Jenni, M., Tutton, G., Lawton-Smith, H., Nadabán, M.V. and Rab, M., 2019. New indicators and indexes for benchmarking university–industry–government innovation in medical and life science clusters: results from the European FP7 Regions of Knowledge HealthTIES project. Health research policy and systems, 17(1), p.10.
19. Leydesdorff, L., Ivanova, I. and Meyer, M., 2019. Synergy in Innovation Systems Measured as Redundancy in Triple Helix Relations. In Springer handbook of science and technology indicators (pp. 421-443). Springer, Cham.
20. Carayannis, E.G. and Campbell, D.F., 2019. Sustainable Development, Social Ecology, and the Quintuple Helix. In Smart Quintuple Helix Innovation Systems (pp. 31-37). Springer, Cham.
21. Afzal, M.N.I., Sulong, R.S., Dutta, S. and Mansur, D.K.B.H.M., 2018. An investigation on triple helix model and national innovation systems: The case of Malaysia. Journal of Entrepreneurship Education.
22. Mêgnigbêto, E., 2018. Modelling the Triple Helix of university-industry-government relationships with game theory: Core, Shapley value and nucleolus as indicators of synergy within an innovation system. Journal of Informetrics, 12(4), pp.1118-1132.
23. Bhutto, A. and Lohana, K., 2018. Analysing Existence of University–Industry–Government Linkages in Sindh, Pakistan. Science, 37(1), pp.42-55.
24. Momeni, F., Yazdi, A.A.M. and Najafi, S.M.S., 2019. Changing economic systems and institutional dimensions of the Triple Helix model. Journal of Innovation and Entrepreneurship, 8(1), p.1.
25. Nam, G.M., Kim, D.G. and Choi, S.O., 2019. How Resources of Universities influence Industry Cooperation. Journal of Open Innovation: Technology, Market, and Complexity, 5(1), p.9.
26. Ashraf, R.U., Hou, F., Kirmani, S.A.A., Ilyas, M.,

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ISSN: 0193-4120 Page No. 10152 - 10162

Zaidi, S.A.H. and Ashraf, M.S., 2018. Student employability via university-industry linkages. Human Systems Management, 37(2), pp.219-232.

27. Hills, P.J., 2018. The self-teaching process in higher education. Routledge.
28. Zhu, W. and Xie, W., 2018. Evaluating instructional effects of flipped classroom in University: A case study on electronic business course. International Journal of Distance Education Technologies (IJDET), 16(1), pp.45-55.
29. Forest, J.J., 2018. University teaching: International perspectives. Routledge.
30. Burke-Smalley, L.A., Rau, B.L., Neely, A.R. and Evans, W.R., 2017. Factors perpetuating the research-teaching gap in management: A review and propositions. The International Journal of Management Education, 15(3), pp.501-512.
31. DUTTA, ER AMIT BIJON. "Study of risk in construction contracts." International Journal of Research in Engineering & Technology 2.2 (2014): 21-26.
32. Ihuah, PaulinusWoka, and A. Benebo. "An assessment of the causes and effects of abandonment of development projects on real property values in Nigeria." International Journal of Research in Applied, Natural and social sciences 2.5 (2014): 25-36.
33. HOSSAIN, MD MILAN. "Intellectual Properties: Bangladesh Approach." International Journal of Humanities and Social Sciences (IJHSS) 1.2 (2012): 11-20.
34. Kalyan, PALAKEETI NAVEEN, and K. JAYA Swaroop. "verification of AMBA-AHB based verifying ip using uvm methodology." International Journal of Electronics, Communication & Instrumentation Engineering Research and Development (IJECIERD) 5.4 (2015).
35. Manshani, Sapna, and Anjna Dubey. "Startup Women in Startup India: A Study Of Women Entrepreneurs in India." International Journal of Business Management (IJBGM) (2017): 91-100.
36. Patil, S. U. V. A. R. N. A., and A. R. U. N. Handa. "Counterfeit Luxury Brands Scenario in India: An Empirical Review." International Journal of Sales & Marketing Management Research and Development 4 (2014): 1-8.