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FOREWORD

Let me extend my heartiest welcome to the first issue of the Journal of Research Management and Governance (JRMG). JRMG is beginning its journey in December 2018 with the University of Malaya – the premier research university in Malaysia – as its host.

In the past couple of decades, research efforts in Malaysia have intensified to a great extent. Research outputs in term of both quality and quality has been improving significantly. The number of research publications and patents has been on the rise. Other countries in the ASEAN region are also putting great efforts to improve their research performance.

Building and sustaining the momentum of research require an effective research ecosystem. Well trained professionals in research management and governance are a key element of such an ecosystem. The scope of research management and governance is wide. At the micro-level, it may involve managing individual research projects. At a bigger scale, research management is carried out at the institutional level, in a university or a research organization. At the macro-level, research management encompasses at national and international level efforts. Effective research management and governance or administration at different levels is vital to ensure the effective use of research funding and other resources, so as to achieve the intended outcome and impact.

In advanced countries, research management has, to a great extent, taken the shape of a profession on its own. It is recognized that professionals working in the area of research management are required to have unique blend of skills and experience in areas which can be grouped into: research-related, management- and communication-skills; and transferable skills. They may get involved in wide ranging activities such a science funding, project management, science communication, technology transfer, partnership and networking, outreach, lobbying, science policy, lab management, research support services, etc.

A few universities in advanced countries offer postgraduate degree and certificate programs in research management, administration or governance. Professional societies in different countries and regions are putting great efforts for research management professionals to excel. Some of these active societies include Association of Research Managers and Administrators, UK (ARMA); Australasian Research Management Society (ARMS); European Association of Research Managers and Administrators (EARMA); National Council of University Research Administrators (NCURA), USA; Research Manager and Administrator Network Japan (RMAN-J); Southern African Research & Innovation Management Association (SARIMA) and West African

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Research and Innovation Management Association (WARIMA).

Research management, in this part of the world, is yet to emerge as a profession. In order to help research management profession to flourish in Malaysia and in this region, we need to start building a community of practice. The Journal of Research Management and Governance, the first of its kind in Malaysia and perhaps in the South East Asian region, intends to provide a platform for research management practitioners and administrators, and researchers to exchange knowledge, share their experience and views to order to achieve excellence in their professional pursuits. The journal publishes both scholarly research work and articles to share best practice and viewpoints. I take this opportunity to invite you and your colleagues to submit your contributions to JRMG in the following categories: 1. Full-length article, 2. Short communications, 3. Case Studies, 4. Opinions, 5. Book Review/Conference Report.

It is my hope that this journal will act as an effective scholarly platform for research management professionals in this region and beyond in the years to come.

A.S.M.A. Haseeb
Editor-in-Chief
University of Malaya

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PREFACE

It is my pleasure to welcome the publication of the 3rd volume of the Journal of Research Management and Governance (JRMG). University of Malaya as the premier university in Malaysia realizes the importance of research management and governance in supporting the whole research ecosystem. Research, as an integral part of academia has been progressing at an unprecedented rate in this part of the world with many institutions from emerging economies making their marks in global rankings. In the course of evolving into research-based institutions and coping with the flux of resources, information and research output, the need for professional management of research processes has become inevitable. The birth of JRMG is aimed as a platform for exchanging ideas and sharing strategies in the management and governance of research by those who are involved in research management, for the advancement of research in their respective organizations. Good practices of research management and governance significantly influence the various aspects of research including financial management, employment of appropriate talents, output management, and translation of research to the society. I would like to extend my gratitude to Prof. M.A. Haseeb and his team for their efforts in publishing JRMG. It is my greatest hope that JRMG will be recognised as a channel to connect research communities globally to communicate on matters pertaining to research processes be they issues or solutions.

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DESCRIPTION

The Journal of Research Management & Governance (JRMG) (eISSN: 2637-1103) is an official journal of the University of Malaya. It is an international, peer-reviewed, open access journal with readership throughout the field of sciences and non-sciences. The JRMG was established to provide a platform for scholars, experts, researchers, practitioners, and students from various fields to come together under a common interest in the field covering all aspects related to management and administration of research in universities, research organizations and funding agencies including strategies and policies in research management and administration, development of research management professionals, management and storage of research output, impact and implication of research and the changing research environment at both national and international levels to publish original research, review papers, and other scholarly works that are freely accessible to the whole scientific community, locally and internationally.

AIMS AND SCOPES

The main objectives of this journal are to publish quality articles in research management and governance, and to discover and advance best practices in this area.

Articles published in JRMG cover all aspects related to management and governance of research in universities, research organizations, funding agencies and governments. This includes (but not limited to) research ecosystem, study and practice of research management profession, strategies and policies, research policy and ethics, changing research environment, quality and innovation in research administration and management, human resource management and development, full economic costing and research funding, knowledge transfer from research to application, data science and data curation as applied to research management, impact of research, developments within higher education environment and implications of major external influences on research management.

The Editors will consider papers for manuscripts based on novelty and contribution to the advancement of research management. JRMG publishes full-length articles, short communications, case studies, opinions and book review/conference report.

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RESEARCH ARTICLE

Hypothetical Aspect of Crowdfunding as Alternate Finance for University Spinoffs and Quadruple Helix

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ABSTRACT

In this study, we address the finance gaps that threaten the operations of University Spinoffs (USOs), by examining the financing options available to sustain their activities. The study thus discusses crowdfunding as alternate finance to address these financial gaps using the quadruple helix model of innovation. The study combines theoretical perspectives of the quadruple helix model with the practical aspects of USOs raising finance using the crowd. We examine the internal and external financing sources for USOs and explain theoretically, why USOs can rely on crowdfunding as alternate finance. The key concepts of the concept are critically considered, and the study is thus conducted in the form of a review of literature and expression of opinion. Accordingly, the empirical justification of the concept presented is not within the scope of this paper.

Keywords: Spinoff; Crowdfunding; Quadruple Helix; Alternate Funding; Innovation

1. Introduction

In recent years, researchers have investigated a variety of approaches to funding University spinoff (USOs) companies but there is limited research on using crowdfunding as an alternative source of funding USOs and the linkage of that to the Quadruple Helix model of innovation. Our study reviewed the defining literature on current funding streams for USOs and explored crowdfunding as an alternative source because existing research suggests most startup companies struggle to raise fund from the banks and other traditional sources.

Firstly, within this paper we made some theoretical contributions by providing novel insights into the crowdfunding as an alternative financing for USOs and the financial challenges of USOs. Secondly, we explained the theory of Quadruple Helix in the context of commercialization of university technology, which involves industry and end users and their financial contributions to the success of technology commercialization, (Miller et al., 2018).

The paper commences with an overview of extant literature in the subject area and therefore limited empirical evidence is available specifically on the justification of the theory presented in our study. We also limited our study generally to the field of crowdfunding as an alternate source of finding for USOs and the commercialization of university technology using the Quadruple Helix model.
hared values. A more formal relationship, professional networks, are established through academic and research activities such as contacts known during attendance to conferences, workshops and seminars. On the other hand, interactions with potential customers, suppliers, investors and competitors constitute networks from the business community.

2. Conceptual Framework

The study sought to explore factors that influence growth of USOs and to suggest crowdfunding as an alternate finance for USOs. Accordingly, it integrated one main underpinning theory, which is Quadruple Helix Innovative theory to develop the research framework. This theory was chosen because it considers the relationship between the various stakeholders in the quadruple helix and the roles they play in the commercialization of innovation (Miller et al., 2018). The study looked at the concepts of Quadruple Helix model and its relevance to USOs and crowdfunding. The Quadruple Helix model, which is a successor to the Triple Helix model, is centred on the idea of the coming together of government, academia, business and societal based innovation users to foster innovation and economic prosperity as shown in Figure 2 (Kolehmainen et al., 2016). However, the 4th helix, which is community, was a new addition as seen in Figure 1.

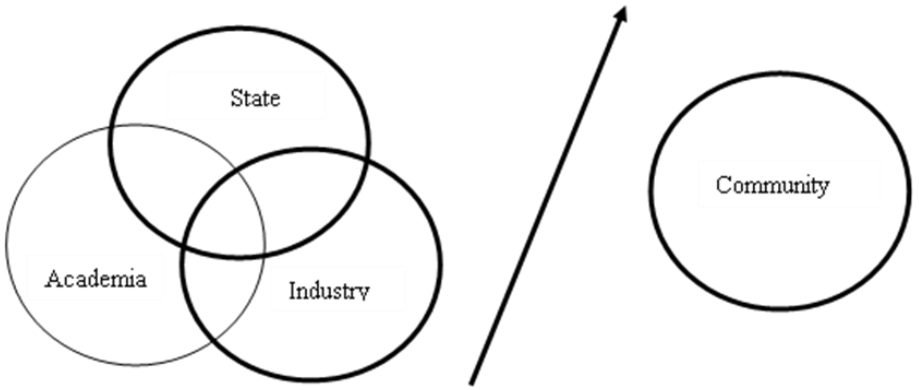

Figure 1: Triple Helix Models of Academia – State – Business Relations
(Etzkowitz and Leydesdorff, 2000).

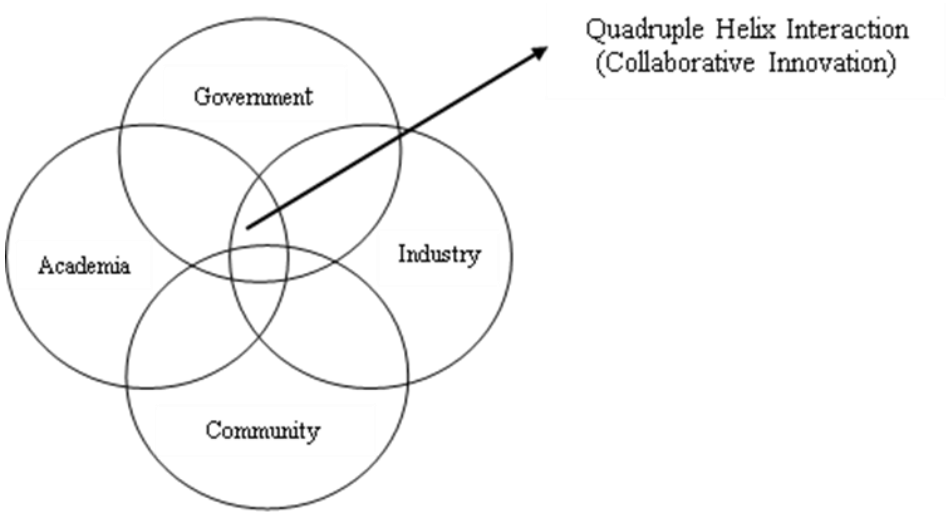

Figure 2: Quadruple Helix Model of Academia – State – Business- Community Relations (Carayannis et al., 2016).

2.1 Quadruple Helix Model, Crowdfunding and USOs

The Quadruple Helix model, adds to the Triple Helix, a fourth helix, which is societal based innovation users (community) and thus, bringing the number of stakeholders in the helix to four (Carayannis et al., 2012; Miller et al., 2018). Interestingly, the concept of crowdfunding is related to the model because innovation involves the interaction between organizations, individuals, communities and the government (Belleflamme et al., 2014). Crowdfunding therefore is a way for USOs to raise funds from unlimited groups of people within the helices to enable them commercializes their innovations as can be seen in Figure 3. The community therefore becomes the source of funding for the other stakeholder in the helix. (Carayannis et al., 2012).

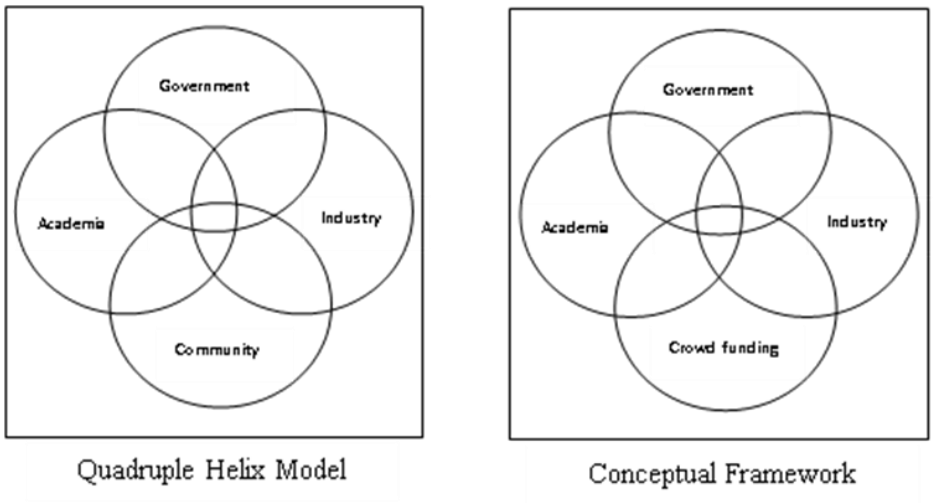

Figure 3: Quadruple Helix Model and the Conceptual Framework (Carayannis and Campbell, 2019a).

2.2 Relationship between Quadruple Helix Innovation theory and USOs

Consistent with theoretical arguments, our main proposition is that USOs serve as a vital link between the academia and the community, which is another stakeholder in the helix. The academia is capable of establishing USOs which can boost economic growth by creating employment which is knowledge-based and improves the growth capacity of a region, (Clausen and Rasmussen, 2013; Ramaciotti and Rizzo, 2015). Interestingly, other scholars have also pointed out the fact that USOs can help in commercializing research findings that may have not been developed (Miller et al., 2018). Several other researchers have investigated the role of universities in knowledge spillovers from university educational to economic and social development in the form of establishing spinoff companies, which help in the development of a particular region (Dzisah and Etzkowitz, 2008).

3. University spinoff companies (USOs)

USOs are vital mechanisms for transmitting knowledge to industry because they are avenues for promoting economic development (Civera et al., 2019; Miller et al., 2018). Essentially they are noted for creating knowledge-based employment and dissemination of new technology to improve the regions in which they are located (Mathisen and Rasmussen, 2019). Existing research thus suggests USOs have the capacity to commercialize underdeveloped research results when they get financial support particularly from the government (helix 4) (Miller et al., 2018; Shane, 2004). The government thus tries to often support USOs created by the academia (helix 1) with the hope of enhancing their capacity to commercialize scientific research (Mathisen and Rasmussen, 2019).

Even though USOs are not a new phenomenon (Etzkowitz and Leydesdorff, 2000), they have gained prominence in the recent times because of their strong economic impact on society (Shane, 2004). For instance, research and technology developed by universities are known to have played pioneering role in firms like Genentech, Lycos and Google (Bonardo et al., 2011). In addition, USOs are greatly involved in the creation of biotech industries. According to Bonardo et al. (2011), about a quarter of all IPOs in high-tech industries in Europe are owned by USOs. They explain that USOs in Europe have high shares in most start-up biotech industry, thereby creating high regional impacts. Similarly, Lawton Smith and Ho (2006) indicate that USOs from Oxford University accounts for at least 3.5% of employment in the local area (Smith and Romeo, 2012).

3.1 Definition of university spinoff companies

After setting out a review of the literature on the various definitions of USOs, it has become clear that there is some ambiguities characterising these definitions (Mathisen and Rasmussen, 2019; Sipe, 2012; Yusoff, 2012).

From the perspective of it being an intellectual property and patent for universities and research institutions, Di Gregorio and Shane, (2003) define USOs as “firms that exploit intellectual property or patented inventions generated from university research.” Taking it from a viewpoint of technological transfer and focusing on the former employees, Steffensen et al., (2000) define USOs as “a new company that is formed by individuals who were former employees of a parent organization, and a core technology that is transferred from the parent organization.” In contrast, Etzkowitz and Klofsten, (2005)

emphasize on the autonomy and legal identity of USOs by giving describing them as "new business (autonomous entity from the university) with its own legal identity".

Ferri et al., (2019) and Mathisen and Rasmussen, (2019) emphasize on job creation and economic boost by defining USOs as enterprises that "boost economic growth by creating employment which is knowledge-based and also improve tax revenues, through transmission of new technology, while also improving the growth capacity of a region." Wright et al., (2006) describes USOs as enterprises that create wealth and therefore the governments should provide them finance and provide them access to venture capital. According to Wright et al (2006), this is because finance is the main obstacle faced by these companies. They explain that commercialization of university research has become very relevant because it promotes the business growth abilities of technology of the university. It also enhances the resource stocks as well as developing technology capabilities of the universities (Wright et al., 2006).

Table 1: Definition of university spinoffs (USOs).

Author	Definition
Mathisen and Rasmussen, (2019)	USOs are new ventures commercializing research results and scientific knowledge from universities and PRIs.
Ferri et al., (2019)	In some industries, such as the biotech industry, USOs represents a high share of all start-ups.
Di Gregorio and Shane, (2003)	University spinoff ventures are firms that exploit intellectual property or patented inventions generated from university research.
Steffensen et al., (2000)	A new company that is formed by individuals who were former employees of a parent organization, and a core technology that is transferred from the parent organization."
Wright et al., (2006)	Enterprises that create wealth and therefore the governments should provide them finance and also provide them access to venture capital.
Lockett et al., (2005)	Development of USOs is achieved through pooling together individuals with matching forms of human capital.

4. Funding Streams for University Spinoffs and the Quadruple Helix

In order to address the challenges in the study, we focus not exclusively on crowdfunding as the main sources of funding for USOs because our aim is to suggest crowdfunding as an alternative funding to USOs. We looked at the different ways USOs could raise funds among the various stakeholders in the helix for their operations including internal funding, loans or debt, equity finance and crowdfunding.

Countervailing evidence shows that more often than not USOs rely on their own internal sources of fund (helix 1), debt and equity (helix 3) to fund their activities (see Table 2), (Wright et al., 2006). In addition, studies have shown that access to finance is the key success factor for USOs, (Walthoff-Borm et al., 2018; Ko and McKelvie, 2018) because a company's success or failure hinges largely on its initial financing decisions (Ahlers et al., 2015). The study therefore looks at each of these funding in details and then suggests crowdfunding as an alternative source. The study extends this further by investigating the role quadruple helix plays in this concept.

4.1 USOs' internal funding

A number of empirical studies suggest that based on the Pecking Order Theory companies first fall on their internal funding before going in for external funding (Bhama et al., 2019; Kuma and Effandi Yosuff, 2020). This is because internal financing is cheaper compared to external (Myers and Majluf, 1984; Vanacker and Manigart, 2010).

To explore this further, we apply the quadruple helix model to our discussions because the academia which is helix 1 in the model plays a vital role in raising fund internally to provide innovation to the community which is helix 4 and a new addition to the model (Carayannis and Campbell, 2019b). The same argument can be put forward for government, helix 2 in the model, which provides subsidy to the universities (Miller et al., 2018) (Figure 2).

Extant research to date, albeit limited suggests that internal fund generated by universities from their research contracts, consultancies and government subsidy forms about 70% of their initial capital (Carayannis and Campbell, 2019b; Miller et al., 2018; Mustar et al., 2008). They depend on these sources to provide funding for the early stage developments of their startups to provide innovation to societal based users (Wright et al., 2006). Due to this, they lack the financial capacity to sustain their USOs. This is particularly true for USOs in developing economies like ASEAN and African countries (Mensah et al., 2019; Zhang, 2014). USOs in these economies struggle to commercialize their innovations and other research findings because they have limited access to capital (Hoegen et al., 2018). In order to address this challenge, we suggest that these universities need to look for other alternative sources to overcome these financial gaps.

4.2 Debt finance

Similarly, applying the quadruple helix we found out that the banks, which provide debt finance to USOs fall within the helix. This is a clear indication of the strong links between the stakeholders on the quadruple helix model and how they are interrelated (Ferri et al., 2019). Extant literature suggests that inadequate funding compels USOs to rely on bank debt as a major source of external funding for their business activities, (Carayannis and Campbell, 2019b; Keasey and Watson, 1994). This is because obtaining debt finance is more flexible, less complicated, and less expensive. Again, USOs' obligations to the banks or lenders are only for the loan-servicing period. After the repayment period, the USOs become completely free from their loan obligation.

However, the challenge is that a high gearing ratio will undeniably affect the credit rating of the USOs and this could result in paying higher interest rate on issued bonds to attract investors because they

would be measured as risky particularly when they have expressively larger amount of debt than equity financing. The payment of high coupon rate on such bonds would give the USOs future cash flow problems (Hoegen et al., 2018; Keasey and Watson, 1994).

4.3 Equity finance

Furthermore, we present the same applications of the quadruple helix model based on the literature reviewed and we found out that equity finance providers fall within the helix. Equity finance providers such as business angels and venture capitalists strongly feature on the model (Carayannis and Campbell, 2019b; Carayannis et al., 2012; McAdam et al., 2016). Equity finance is an external source of finance that the USOs fall on because business angels and venture capitalists provide equity finance by investing in USOs. However, they have challenges in accessing this type of funding because of their inability to convince venture capitalists to buy their shares (Keasey and Watson, 1994). Venture capital firms are noted for detailed scrutiny of USOs proposals (Lockett and Wright, 2005), before investing their money into them. This scrutiny therefore discourages USOs because of the cost involve in their evaluations (Caiazza, 2014).

For instance, a study by Wright et al., (2006) explains that in the early 1990s, venture capital firms in the UK were reluctant to invest in new technology based firms because of the risk associated with such investments. The challenge of accessing equity finance for startups was recognized in Europe years ago; due to this, government funding initiatives were introduced to support new high-tech firms (Clarysse et al., 2007; Wright et al., 2006).

The positive side of equity finance is that it is less risky because of the absence of regular loan repayments. Again, with equity finance, surplus cash is retained in the business and this can be reinvested to enhance the growth of the business.

4.4 State funding

Extant literature suggests that USOs depend largely on the state for funding to support their spinoff activities. The state, which is in helix 2 therefore, plays important role in transferring innovation to end users. The assertion is confirmed by a study conducted by Wright et al., (2006) on funding intitiaves provided by the state to the high-tech firms in Europe (Clarysse et al., 2007; Wright et al., 2006). This reaffirmed the claim that the state (helix 2) contributes significantly to the development of USOs particularly in the developed countries (Ayensu et al., 2016; González Cacheda, 2018).

Table 2: Funding streams for university spinoffs based on Quadruple Helix .

Finance	Literature	Sources based on Quadruple Helix Stakeholders
Debt finance	Keasey and Watson (1994), Vanacker and Manigart (2010)	Helix 3 Banks (Businesses)
Equity finance	Lockett et al., (2005), Muscio et al. (2013)	Helix 3 Business angels Venture capitalists (Businesses)
Internal funds	Mustar et al. (2008), Smilor et al. (1990)	Helix 1&2 Universities-Research contracts and consultancies Government –subsidy (Academia& Govt.)
Crowd-funding	Mollick (2014), Cox and Nguyen (2018)	Helix 4 Crowd/Platform- (Societal end-users)

5. The Concept of Crowdfunding

Our study primarily contributes to the existing literature on the broader definition of crowdfunding as a concept and then examines the relationship between this concept and its practical applications to USOs. Although we discuss the definition of the crowdfunding as an alternative source of funding, we also recognize the contributions of the other stakeholders of the Quadruple Helix in providing finance for USOs as illustrated in Table 2 above.

Crowdfunding refers to fund raising activities from a large group of people using online platforms to fund start-up projects (Cumming et al., 2019; Mollick, 2014; Ordanini et al., 2011). This takes the form of an open call (Crosetto and Regner, 2018). One most important thing about crowdfunding is that it is not limited by geographical boundaries, (Agrawal et al., 2011).

There are three main players involved in crowdfunding appeals and these are the project initiators who propose the project or business ventures to be funded (Kaartemo, 2017; Cordova et al., 2015), individuals or group of individuals who back the project or business venture by making financial contributions, and the internet platforms, which launch the project or business venture (Vismara, 2016). While the study recognizes that crowdfund can serve as an alternative source of funding, perhaps even more of concern is that lack of information between project initiators and backers can result in the project's inability to meet the project goal (Belleflamme et al., 2014).

5.1 Definition of Crowdfunding

The overall evidence emerging from literature suggests that there are variations in the definitions of crowdfunding among scholars. The study therefore presented the following prevailing definitions (Cumming et al., 2019; Block et al., 2018; Belleflamme et al., 2014; Mollick, 2014).

Taking it from the perspective of making appeal to backers for a donation in return for a reward (reward-based), according to Belleflamme et al. (2014), "Crowdfunding involves an open call, mostly through the Internet, for the provision of financial resources…." Steinberg and DeMaria (2012) on the other hand, placed emphasis on crowdfunding as an alternate funding for new ventures by defining crowdfunding as "the process of asking the general public for donations that provide start-up capital for new ventures."

Viewing it from a different angle and contrasting Belleflamme et al. (2014) and Stenberg et al. (2012) definition, Wheat et al. (2013) saw crowdfunding as a possible avenue for individuals to raise start-up capital by defining it as "A new internet-based method of fundraising in which individuals solicit contributions for projects on specialized crowdfunding websites" (p.1). Mollick (2014) expanded the definition of crowdfunding by placing emphasis on how minimal contributions from a large number of people could constitute a substantial capital for start-ups. He defined crowdfunding as "The efforts by entrepreneurial individuals and groups – cultural, social, and for-profit – to fund their ventures by drawing on relatively small contributions from a relatively large number of individuals using the internet, without standard financial intermediaries."

5.2 Crowdfunding Platform

A striking feature of crowdfunding is the platforms, which are the mediums that help to bring all the three parties together (Mollick, 2014). Individuals or backers making financial contributions normally select and support projects that attract their interest. These could be social projects or business ventures. The backers would donate to these social projects in the form of supporting a good course for altruistic purposes (Moon and Hwang, 2018). In the case of business ventures, the backers would buy shares in the venture for capital gains purposes or for dividend purposes. Raising funds from the crowd has very little restriction in the sense that unlike the more traditional sources like the banks and equity finance (Ahlers et al., 2015), smaller amounts of money can be paid by the crowd during a call for crowdfunding appeals. The crowd plays an important role because they provide the needed funds and they act as an alternate source of finance for projects or business ventures (Cumming et al., 2019).

Any business who wants to raise a fund from the crowd will first have to approach crowd funding platform owners (Kraus et al., 2016). The owners will sign a contract with the initiator and then place their projects or ventures on their platform (Belleflamme et al., 2014). They would then launch a campaign by advertising the project to the public (Kuppuswamy and Bayus, 2013). Because the campaign is done online, it attracts funders from across the globe (A. Agrawal et al., 2015) . For instance, a campaign for a project in Ghana or Malaysia can get backers from the USA or Europe.

5.3 Types of Crowdfunding Platforms

The study focused on two main types of crowdfunding platforms in support of its attempts in suggesting crowdfunding as an alternate source of funding for USOs. The platforms are the Reward-based and Equity based platforms.

Reward-based platforms: Existing research thus suggests that empirical research on reward-based crowdfunding emphases on the effects of contribution dynamics of projects, social capital, founder quality, linguistics, and gender. Regarding dynamics of reward-based crowdfunding, Kuppuswamy and Bayus (2013) argue that over a time, contributions from backers for a project shows a u-shaped pattern instead of a non-linear one. This is because the early and later stages of a project's live time attract more funding from funders (Kuppuswamy and Bayus, 2013). The findings of Kuppuswamy and Bayus, (2013) are similar for the various categories of projects, regardless of size or objectives goals or the success story. They attributed the pattern formation to the role played by family and friends in the early and final days of projects (Cumming and Hornuf, 2018; Kuppuswamy and Bayus, 2013).

Furthermore, touching on herding behaviour, they are of the view that funders are influenced by the amount of money raised during a particular funding campaign. Herding therefore plays a vital role in funding campaigns (Kuppuswamy and Bayus, 2013). This is because projects which can generate higher figures from backers outside social media and other institutions are likely to be fully funded (Mollick, 2014). Qiu, (2013) found support for this argument by saying that projects, which featured prominently on the homepages of crowdfunding platforms, receive greater contributions from backers. Mollick (2014) on the other hand, pointed out that funding success is determined by social network size. The two most popular reward-based crowdfunding platforms are Kickstarter and Indiegogo.

Equity based platforms: Due to the unique nature of equity-based crowdfunding, fund raising is conducted on platforms designed for that purpose. These platforms are regulated by laws in most countries with the exception of some African countries where there are no regulations or lack of regulation clarities to govern them (Hiller, 2017).

A number of empirical studies find support for the fact that there is limited research on equity crowdfunding (Hemer, 2011; Mollick, 2014). The lack of adequate research on equity crowdfunding is due to the fact that it is an evolving concept, which has many legal constraints in some countries (Hiller, 2017; Mollick, 2014). Distinctive from previous research that focuses on other aspects of equity crowdfunding Ahlers et al. (2015) explores the significance of signals in equity-based crowdfunding. Accordingly, they concluded that signals about quality of start-ups and uncertainty levels, relate positively to their funding success. Ahlers et al. (2015) focus specially on the parts played by the worth of equity on offer, viz., human capital and financial forecast in increasing the chances of raising adequate funding. In contrast, intellectual capital and social capital has no relation to funding success of start-ups (Hiller, 2017). The two most popular equity based crowdfunding platforms are Crowdcube and AngelList.

6. Crowdfunding as an Alternative Finance and the Quadruple Helix

To explore our argument further, we begin by focusing on the role of societal based innovation users (community), i.e., helix 4, which is a new addition to the helix in providing an alternate source of funding

to USOs (Figure 2). The community (helix 4) constitutes the crowd that could provide funding for USOs to commercialize their innovations. To support this assertion, our study advances the current literature on crowd funding as another source of funding for USOs. Studies suggest that peer-to-peer and equity crowdfunding has expanded rapidly in recent times. Scholars have attributed this phenomenon to the fall on interest rates on savings. Individuals would therefore rather contribute as lenders in peer-to-peer debt crowdfunding market rather than save their money at the banks. Again, some individuals would rather prefer lending money to companies through peer-to-business on crowd funding platforms than save it in the bank (Cox and Nguyen, 2018). Peer-to-peer lending which is an uncollateralized loan for profit purposes is well established in most developed economies and is gaining recognition in developing economies like the ASEAN countries as well (Duarte et al., 2012).

Crowdfunding platforms can therefore provide USOs the access to investors who could invest in the early stages of their business. Comparatively, the threshold amounts for investment on crowdfunding platforms are low, so ordinary investors can be part of the process. More importantly, these investors do not have any control of the business and the servicing costs is quite low (Cumming and Groh, 2018; Vanacker and Manigart, 2010). Again, studies have shown that a quarter of crowdfunding projects do deliver on time and reward-based crowdfunding support USOs, (Block et al., 2018). Finally, empirical research shows that start-ups that are more innovative tend to attract greater interest from crowd investors (Schwienbacher, 2019).

7. Challenges of Spinoffs

A study conducted by Oliveira et al. (2018) and Beraza-Garmendia and Rodríguez-Castellanos (2015) suggests that the positive effects of the spin-offs on society is contingent on the growth and ability of the USOs to perform creditably. They further explained that the growth and performance of USOs is therefore not automatic because there are certain factors that affect the growth process.

Other scholars argued that USOs are mostly small firms, which are not significance and have growth challenges and a limited economic impact (Rodeiro-pazos et al., 2017). Therefore, there is no justification for the support they receive from the public, (Ferri et al., 2019). These divergent views according to scholars show a complete misunderstanding of the growth, advancement, and eventual performance of USOs.

Again, another study by Berbegal-Mirabent et al. (2015) explains that there is a limited research on the effects on the performance generated by the incorporation of knowledge transferred by the parent university in the USOs business process. Availability of financial resources can therefore help in the creation processes of USOs. The availability of these resources varies from country to country. For instance, while the state (helix 2) provides adequate funding support for USOs in Europe and the America (Hoegen et al., 2018), there is lack of support for USOs in most African and Asian countries (Aryeetey, 2005). USOs in these developing economies experience static growth compared to their counterparts in the developed economies (Mathisen and Rasmussen, 2019; Mustar et al., 2008).

In recent times, one of the greatest challenges faced by USOs is the capacity to provide state of the arts technology that the market needs. With the emergence of artificial intelligence and other high-tech

technology, the USOs struggle to meet the needs of the industries as well as innovation end users (Cordova et al., 2015; Kaartemo, 2017). This therefore affects their ability to compete favourably on an already saturated market. They hence become unattractive to business angels and the venture capitalists who are risk averse (Cordova et al., 2015).

Table 3: Challenges of spinoff companies.

Challenges	Literature
Skills and networks	(Tengeh and Rorwana, 2017) (Vanacker and Manigart, 2010)
Future research	(Leyden and Link, 2015)
Inventor involvement	(Beraza-Garmendia and Rodríguez-Castellanos, 2015), (Rassenfosse and Fischer, 2016)
Team development	(Markman et al., 2016)

8. Success Stories of Crowdfunding

Even though there is limited information on the contributions of crowdfunding to the growth of USOs, there is ample evidence to suggest that it has contributed immensely to the growth of start-up businesses (Ko and McKelvie, 2018). The following are the success stories of how crowdfunding platforms have helped startups to capitals for their business ventures.

For instance, AngelList, a US-based equity based crowdfunding platform was formed in 2010. It was initially established as social network, which connects start-ups with business angels and job seekers; it has been able to assist start-ups raise $450 million in equity funding since its inception (www.angel.com). Again, Crowdcube which is a leading UK equity crowdfunding platform funded in 2011, has over 225,000 investors raising £115 million on the platform (Walthoff-Borm et al., 2018; Vismara, 2016). Furthermore, Funding Circle which is another UK based peer-to-peer crowdfunding platform that was funded in 2010 permits investors to lend out money directly to start-ups as well as medium size firms (Mateescu, 2015). The platform has about 71,000 retail investors, banks, financial institutions as well as the UK government (Forbes and Schaefer, 2017). Funding Circle platform is estimated to have given out about $5 billion loans to 40,000 businesses worldwide. The loans offered by Funding Circle ranges from $25,000 to $500,000 payable within 5years (www.fundingcircle.com).

Finally, Kickstarter is a USA based reward based crowdfunding platform, which was founded in 2009. The first project that was launched on the platform was known as Drawing for Dollars project launched by a New York based artist known as L.J. Ruell. His target was to raise $20 for his art project but he ended up raising $35 from three backers. L.J. Ruell is thus credited with being the first project launched on Kickstarter (www.kickstarter.com). In addition, the platform successfully launched a project known as the Coolest Cooler created by Ryan Grepper (an American product developer) which was able to raise

$13.8 million. It became the most funded project on Kickstarter in 2014. The coolest cooler is a multi-function cooler, which can store up to 60 drinks that be kept cold for 5 days.

9. Conclusion

As far as we know, our study is the first to conceptually integrate quadruple helix, crowdfunding and USOs in a team of stakeholders working together to harness and commercialize innovation. Our paper therefore enhances the academic debate on the coming together of government, business, academia, and societal based innovation users to foster innovation and economic prosperity.

After critically reviewing the role of the community (crowd) in providing funding to USOs to commercialize their innovations, we conclude that there is the need for closer partnership between the stakeholders in the quadruple helix to commercialize innovation. We therefore propose a research agenda that will enhance the practical and theoretical concepts of the financing gaps facing USOs. We are also of the view that there is a need for a clear-cut alternate funding for USOs to address these gaps. Overall, based on evidence emerging from the literature, we propose that USOs should rather adopt crowdfunding as an alternative finance in order to avoid their current disjointed funding streams.

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CASE STUDY

Institutional Innovations for Management and Commercialisation of Fishery Technologies in India - A Case Study

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ABSTRACT

India is a country with unique market dynamics and high entrepreneurial spirit. During recent years, the country's industry sector is dominated by innovation led business enterprises that are found to achieve high profits within a short span of time. This paradigm shift is mainly influenced by the significant role played by technology-based business incubation support systems and expert mentorship programmes. It is observed that start-up companies emerging from these incubators are becoming machines of rapid and tremendous growth. In support of this growing trend and with the aim of laying the foundation for innovation-based businesses and knowledge-driven economy in agricultural sector, the Indian Council of Agricultural Research (ICAR) – an apex public research organization in India, established a network of Agri-business incubation (ABI) Centres linking its R&D Institutes across the country. Through this initiative ICAR brought into place novel policies and programmes, to maximize technology commercialization, establish public private partnerships and handhold entrepreneurs. This paper portrait the activities of such an ABI Centre attached to ICAR - Central Institute of Fisheries Technology, and presents an overview of the new systems of business incubation and support services to entrepreneurs. The clients registered at the ABI Centre are given necessary guidance to choose a suitable technology with the help of Technology Readiness Levels (TRL) and given an opportunity to commence business operations using the semi-commercial pilot plant facilities attached to the institute. A case study of a client who adopted the ICAR-CIFT technology for 'Hybrid Solar Dryer' is also included in this paper.

Keywords: Agri-business; Entrepreneurship; Innovation; Fisheries; Research; Technology; Commercialisation

1. Introduction

In India, agriculture research and agrarian economy has evolved over the last decade in a much more dynamic and innovative manner. In the changing socio-economic context and global market-driven economy, innovation is increasingly recognized as a driving factor that enhances business competitiveness. Technologically empowered businesses are found to be key players in the industry and most profit-making entities. The country is giving much attention to promoting Agri-based innovations that promise solutions to many of the current challenges faced by the sector. The National Agricultural Research and Education System (NARES) is a major stakeholder in agricultural research, which focuses on technology creation and its delivery to other stakeholders such as farmers, producer groups, retailers, corporations, civil societies and private players (Srinivas, 2018). NARES has always been responsive to the current needs of the stakeholders and maintains a more pluralistic innovation system addressing the needs of the consumers. The successful adoption of the technologies arising out of this system has significantly enhanced the incomes of the stakeholders including farmers.

The Indian Council of Agricultural Research (ICAR) is the apex public research organization which has been playing a key role in the innovation processes concerning agriculture in the NARES system. ICAR harnesses and synergizes the innovative research mechanism and business support ecosystem by utilizing the efficient scientific manpower and vast resources. This ensures the efficient utilization of innovative technologies, processes and products, thus leading to significant enhancement of the agri-economic system as a whole. As part of this drive and to ensure dissemination/commercialization of its research outcomes and knowledge base, ICAR created an institutional mechanism connecting its 101 Research & Development (R&D) institutes, serving diversified fields like fisheries, horticulture, crop science, animal science and natural resource management. This chain of Agri Business Incubation (ABI) centres across India, became one of the successful initiatives of ICAR, where scientific knowledge is translated into innovation led commercial ventures developing market-driven products (ICAR, 2006). Taking into consideration the vast potential of the fisheries sector and the needs to promote techno-entrepreneurship among fishermen community, ICAR started India's first fisheries Business Incubation Centre at ICAR-Central Institute of Fisheries Technology, Kochi, Kerala, for establishing sustainable businesses in fisheries and allied agricultural fields. Numerous technologies have been transferred by the Institute through this incubation mechanism and one of them is the technology for Hybrid Solar Dryers. The technology achieved so much popularity due to its economic feasibility and easy adoption by fishers, micro, small and medium scale entrepreneurs and women Self Help Groups (SHG). This technology goes in tandem with the flagship programmes of the Government of India such as Atma Nirbhar Bharat, Swatch Bharath and National Mission for Green India. It effectively contributes to the country's commitment in reducing carbon emission, and aids in improving the livelihood of fishermen community by assuring returns even during off-season period.

2. Start-up Policies in India

In India, agriculture and its allied sectors, is the prime source of livelihood for the majority of the population. 70% of its rural households still depend mainly on agriculture and allied activities, which includes 82% of small and marginal farmers (FAO, 2019). India's economic growth has accelerated considerably in 2019 owing to the improved performance in both industry and services. India is the world's 3rd largest by purchasing power parity (PPP) and 6th largest economy by nominal GDP. The

country ranks 139th in per capita GDP (nominal) with $2,134 and 122nd in per capita GDP (PPP) with $7,783 as of 2018 (World Bank data). Agriculture sector employed 59% of the country's total workforce in 2016 and contributed to 23% of GDP (OECD, 2018). In the last two decades, powered by the government policies and strong engagement of the industry and institutions, Indian agriculture sector has rapidly evolved into agribusiness in terms of innovations, technology adoption, approach and structure.

With the aim of building a strong ecosystem to promote startups and entrepreneurs across the country, Government of India launched the Startup India Policy in January 2016, supported by other initiatives like Skill India, Start Up India, Stand Up India, MUDRA, ACABC scheme and Udaan (ICFA, 2019) to help budding entrepreneurs start and scale new ventures. These schemes have significantly addressed the crucial skills gaps in the employment sector and are aiming to equip citizens with industrial training and skills. Under the Skill India Mission, nearly ten million people, particularly youth, are trained under various programmes every year (NSDC,2020).

3. Role of ICAR in promoting entrepreneurship in agricultural sector

The processes of technology transfer from academic institutions to industry have emerged during the last two decades following the “Bayh-Dole Act of 1980”, an amendment to the patent code of the United States. It paved the way to claiming ownership in intellectual property on research funded by the U.S. Government. Soon this led to similar initiatives in India. In the Indian NARES, ICAR has taken the stewardship of technology commercialization through the promulgation of IP and technology commercialization policy. Being a public funded research organization, ICAR often faces difficulty in categorizing its technologies into public and proprietary technologies as the ultimate stakeholders are poor and marginal farmers and fishermen. Big industrial houses and investors are generally reluctant to invest in agriculture and allied technologies considering its low rate of returns and high risk involved. Moreover, a few national/multinational companies are the major players in the agricultural input-output trading sector, making it a more monopolistic competition. However, to overcome these issues and to fetch both domestic as well as international seekers of technology, ICAR has devised the above said three-tier system of business incubation and established a global company like Agrinnovate India Ltd.

Constitution of Intellectual Property and Technology Management (IPTM) Division at Headquarters, and integration of aspects of intellectual property rights (IPR) in the technology management of R&D institutions was the initial step taken by ICAR (ICAR, 2014). They formulated the guidelines for Intellectual Property Management and Technology, and created a decentralized 3-tier IPR and technology management mechanism. The implementation of these guidelines helped in the systematic organization of IPR filings and commercialization intellectual assets developed by its research institutes catering to diverse and specialized fields of agriculture (ICAR, 2018).

The business incubation drive started by ICAR in 2009 through the World Bank funded projects, was specially designed for the benefit of Indian agricultural sector. It successfully promoted agribusiness programmes, reinforcing public-private partnerships in agriculture. Through these partnerships and technology transfers, ICAR was able to ensure the successful dissemination of valuable and diversified ICAR knowledge base to the end users. There are eight research institutes specialized in the field of

Fisheries under ICAR, with a large number of technologies ranging from harvest to post-harvest. ICAR adopted the concept of techno entrepreneurship to enable public-private partnerships benefiting larger sections of the society and utilize the innovations to compete in the global market. It is pertinent that the research outcomes are transformed into marketable products and services that can be leveraged to generate revenue and enhance R&D pursuits in ICAR. The Council implemented a scheme titled National Agriculture Innovation Fund (NAIF) in 2017, which essentially has three main components to promote innovation, incubation and sustainability (NAARM, 2019).

Innovation led entrepreneurship needs R&D backup, access to scientific resources, support functions and mentorship that would provide new enterprises a springboard to stability. It is observed that such entrepreneurial firms easily seize new business opportunities, become key players in the industrial sector and achieve high profit. This is applicable to both big enterprises and also small firms including start-ups. However, start-ups that are capable of utilizing innovation as an efficient tool may find it difficult to gain the advantages against bigger rivals due to their inexperience or incapability in innovation management/processes/tools, technology, human resources or incentives to implement innovation; or all (Quynh, 2016). This challenge can be easily addressed by becoming a part of a business incubation system.

3.1 Techno Entrepreneurship Initiatives of ICAR

ICAR institutionalized the concept of techno entrepreneurship through NAIF schemes and today novel agricultural ventures are created in large numbers and nurtured through appropriate interventions, incentives and investments. Through various programmes under the NAIF scheme, the institutional mechanism was reinforced to protect the innovations/IPRs generated and was able to transform Agri-business Incubation (ABI) centres as a hub for technology transfer and techno-entrepreneurship. The NAIF scheme contributed towards development of an IP environment in ICAR and all its institutes were empowered to handle technology management activities at the institute level itself and liaison with private clients for the commercial transfer of their technologies. The middle-tier of this mechanism consists of 10 subject-specific Zonal Technology Management Centres (ZTMC) for facilitating public-private partnerships. These zonal centres are entrusted with the promotion of technologies available at various institutes from their respective zones. The central IP and technology management mechanism is operational from the ICAR Headquarters, and it deals with the policy matters and techno-legal aspects that arise from various institutes (ICAR, 2019).

ICAR has set up a total of 50Agri-Business Incubators (ABI) in its various institutions during the past 10 years. Apart from these, many Technology Business Incubators (TBI), sponsored by the Department of Science and Technology (DST) are established at different State Agricultural Universities. As an institutional mechanism, independent units like Institute Technology Management Unit (ITMU) were constituted at each Institute, for better management and speedy process of IP protection, technology transfer and commercialization. ICAR also formed Agrinnovate India Ltd. (AgIn) as a "for profit" Company owned by Department of Agricultural Research & Education (DARE), Ministry of Agriculture, Government of India, to act as an effective interface between ICAR, ZTMCs and ABI Centres on one side and the stakeholders of agricultural sector on the other side. (Figure 1).

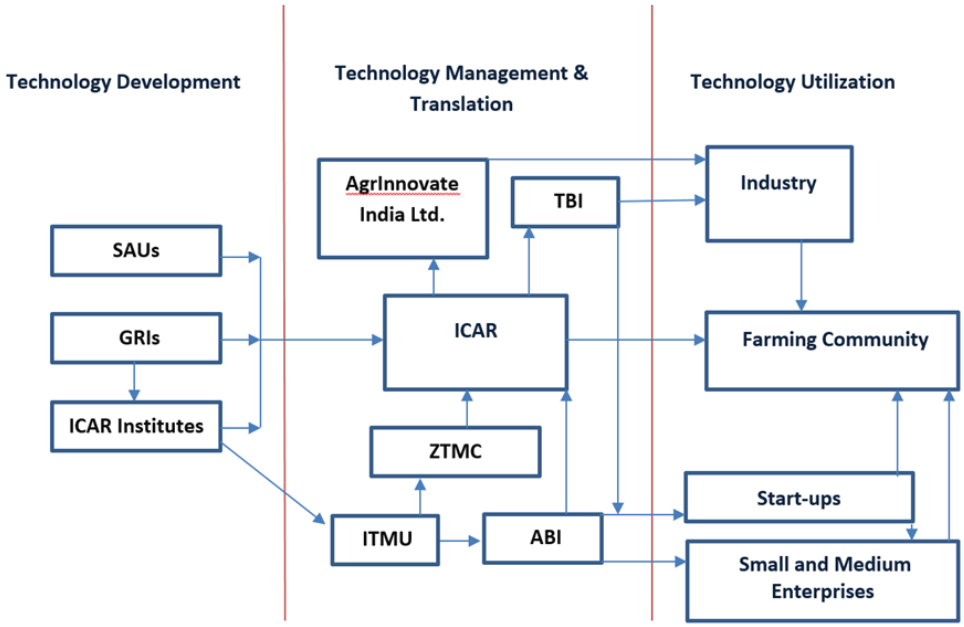

Figure 1: Institutional framework for Tech transfer and commercialisation

This framework provides the stakeholders easy access to the latest technologies/scientific know-how, and specialized training programmes for capacity building. Today ABI Centres under ICAR are recognized for their technology-led initiatives and speedy commercialization of innovations and research outputs. With their immense potential and state-of-the art facilities available, ABIs are improving the livelihoods of stakeholders in agri-production and consumption systems, even in rural regions. These Centres nurture the growth of new technology-based enterprises and also improve their survival rate by mustering support services like technology refining, validation, business strategy, planning, scale up operations, IP services, sourcing funds etc. that are essential for start-up firms.

4. Technology Management in Fisheries Research

4.1 Business prospects in Indian Fisheries sector

Fisheries and aquaculture, a sunshine sector in Indian agriculture is the prime source of income and employment generation for a large section of the economically backward population of the country, especially the fishermen community (GoI, 2019). The Indian fisheries sector contributes significantly to the food basket of the country, and has attained an annual production level of over six million tonnes of fish and shellfish, from marine and aquaculture sector. India is now the 2nd largest fish producing nation in the world and stimulates the growth of a significant number of supplementary industries. The total fish production is estimated to be 12.60 million metric ton during 2017-18 This constitutes around 6.3% of the global fish production. From India, more than fifty types of fish and shellfish are exported to 75 countries around the world. Fish and fish products have become the largest group in agricultural exports from India, with 13.77 lakh ton, in terms of quantity and value. This contributes to 10% of the total exports and nearly 20% of the agricultural product exports, and contributes to about 0.91% of the GDP (NFDB, 2019).

4.2 Agri-Business Incubation Centre at ICAR-CIFT

ICAR - Central Institute of Fisheries Technology (ICAR-CIFT) located at Kochi, Kerala state (India) started the ABI Centre as a platform for empowering the fisheries sector by creating new technology-based industries. ABI Centre is functioning at a location with high fish production and vital markets, which makes it easily accessible to clients. It operates an important networking mechanism between R&D institutes, private industry, government agencies, academia and funding agencies. This entrepreneurial support system caters to its clients through strong technical and advisory support, and assists them to orient their resources in the most optimized manner, thereby yielding high productivity and economic value (Mohamed, 2019). The Centre follows a facile technology dissemination procedure and it enables the entrepreneurs to explore new ways of doing business through a wide spectrum of activities. Pro-active and value-added business services are provided to registered incubatees in the form of technology transfer, contract research, consultancy, contract service, office space, certified state-of-the-art pilot level production facility, on-site guidance and specialized training to establish innovation-based business enterprises.

The Institute has developed a wide range of technologies pertaining to fishing technology, resource/ energy optimization, fish processing, value addition, high value by-products, packaging, customized processing equipment, health care products, aquaceuticals, etc. Some of the entrepreneur ready technologies developed by ICAR-CIFT are depicted in Table 1. These technologies are further classified according to their Technology Readiness Level (TRL).

Table 1: List of entrepreneur ready technologies developed by ICAR-CIFT

HARVEST	• Fuel Efficient Multipurpose Vessel for Deep Sea Fishing • CIFT Turtle Excluder Device (CIFT-TED) • Device for Juvenile Fish Excluder cum Shrimp Sorting • Fish Aggregating Devices • Foldable Traps • Square Mesh Codend • CIFT- Multi Seam Trawl • CIFT Semi-pelagic Trawl System (CIFT-SPTS) • Large Mesh Purse Seine • Short Body Shrimp Trawl • Cut-away Top Belly Shrimp Trawl • Treated Rubber Wood Canoe • FRP Coated Rubber Wood Canoe • Treated Coconut Wood Canoe • CIFT Sun Boat
VALUE ADDITION	• Microencapsulated Sardine Oil • Seaweed NutriDrink • Ready-to-serve / Ready-to-cook food products • Fish Kure - Extruded Product • Seaweed and Fish Enriched Noodles • Seaweed Enriched Cookies • Value Added Products - Fish Sausage / Battered and Breaded

	• Products / Cured and Dried Fish Products / Smoked Masmin Flakes / Fish Wafers / Pickles • Laminated Bombay Duck • Diversified Products from Black Clam / Mussels
ENGINEERING	• Solar-Electrical Hybrid Dryer • Solar-LPG Hybrid Dryer • Solar Tunnel Dryer • Solar-Electrical Cabinet Dryer • Solar Biomass Hybrid Dryer • Infra-Red continuous Dryer • Fish Descaling Machine with variable drum speed • Table Top Fish Descaling Machine with fixed drum speed • Hand Operated Fish Descaling Machine • Energy Efficient Effluent Treatment Plant • Modern and Hygienic Mobile Fish Vending Kiosk
WASTE UTILIZATION	• Fish Ensilage • Foliar Spray • Collagen Peptide • Collagen Chitosan Membrane • Chitin & Chitosan from Crustacean Shell • Carboxymethyl Chitosan • Fish Feed from Processing Discards • Surgical Sutures from Fish Gut Collagen • Succinyl Chitosan based Hydro-alcohol Hand Sanitizer
HEALTH CARE / QUALITY ASSURANCE	• Squalene and Squalene Powder • Oyster Protein Hydrolysate (CIFTOPEx) • Fish Protein Isolate from Bombay Duck • Glucosamine Hydrochloride • Natural Hydroxyapatite • Protein Hydrolysate from Tuna Red Meat • Deodorant for Seafood Processing Units and Fish Markets • Antiseptic Ointment for Prawn / Fish Handlers • Fish Calcium Capsules • Test Strips for Sulfite Residues • Chloritest Paper • CIFTest Kit for Ammonia and Formaldyhide Adulteration in Fish • Design and Development of Modern Hygienic Fish Markets

ICAR-CIFT allows start-ups as well as established business enterprises across the nation to register as incubatees at ABI Centre and get access to new innovations, cutting edge technologies and scientific know-how through direct as well as virtual incubation. The selective, comprehensive service offering and handholding accelerates the growth and sustenance of these incubatees.

4.3 Stages of Business Incubation

The Centre possesses multi-tenant infrastructure facilities suitable to start a corporate level office for direct incubatees, within the premises of the Institute. Direct incubation is intended to handhold clients during their infancy period, where they can set up offices and production plants with no capital investment. Business Meets and industry-interface programmes are regularly conducted for sensitizing entrepreneurs, and identified candidates with viable business ideas are selected for incubation. The registered incubatees can meet scientists and business associates whenever required to discuss incorporating a business entity, understanding its legal aspects, product branding, intellectual property protection, finance management, market study, test marketing, etc. This ease of communication and networking helps in easy delivery of incubation services and guides the client to achieve successful outcomes. Incubatees are assisted in translating their idea to a technology and further to a market ready product or service. They can also select among the showcased technologies developed in the internal research laboratories and enter into a licensing deal.

Normally the residency period for direct incubatees is for one year, which may be extended on the basis of the nature of the business and progress of company development. As the start-up firms mature enough to operate a profitable business, the services and concessions provided are gradually withdrawn. The clients, apart from the registration fee to the Incubator, pay monthly payments for office space and pilot plant operations at a subsidized rate than the prevailing market rates. The business incubation center provides an array of services from idea stage to the product launch (Figure 2). After exiting from the incubator, incubatee mentoring is continued on need basis.

Figure 2: Techno-entrepreneurial support system of ABI

4.4 Technology Readiness Level (TRL)

Technology Readiness Assessments (TRAs) assumes importance in the incubation system, for the cost-effective management of technologies and research results, and has become an essential entity to ensure the success of new initiatives in a field (ESA, 2008). It assists in the decision-making process regarding the adoption of novel technologies concepts, even during the absence of perfect outputs. Technology Readiness Levels (TRLs) are a method for estimating the maturity of technologies during the acquisition phase of a program, developed at NASA during the 1970s. The use of TRLs enables consistent, uniform discussions of technical maturity across different types of technology (Mihaly, 2017). This set of management metrics helps in the assessment of the maturity period of a particular technology within a specific system and operational environment.

ABI Centre has devised a seven-point TRL scale to help the clients in decision making. This scale is developed on the basis of various categories of technology development stages and is very useful to clearly understand the project viability, maturity cycle and resource requirements. The TRL system calculates a technology's lifecycle, from Level 1 (Concept Evaluation) to level 7 (successful commercial application). The seven levels indicate a specific milestone in the concerned project where significant activities are performed (Figure 3). Most of the research and development projects pass through each of these seven levels until they are successfully integrated into the market, while some levels may not be applicable for certain technologies (Nolte, 2003). Each technology given in Table 1 is classified into various levels of TRL based on a few indicators and attributes (Table 2)

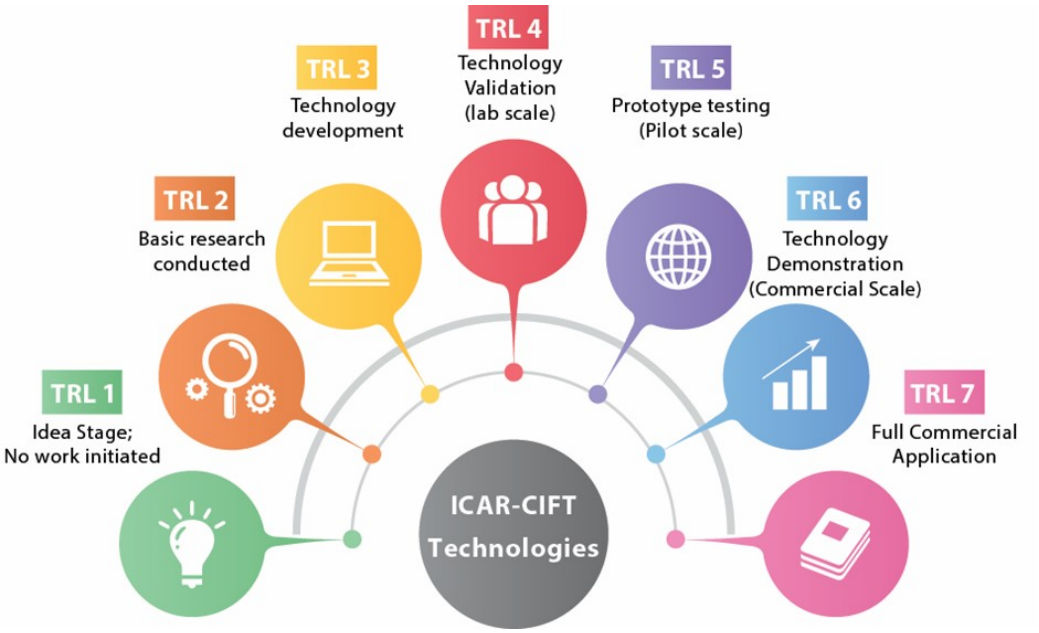

Figure 3: Categories of Technology Readiness Levels

Table 2: Attributes for classification of TRL

Technology Readiness Level	Activities	Risk level (Scale of 1-10; from less to high)	Level of Competition
TRL 1: Idea Stage	Valid concept, but unproven	10	1
TRL 2: Basic Research	Exploring the basic properties of a technology and translation of scientific results into applied research	8-9	2-3
TRL 3: Technology Development	R&D work starts and technological solutions are developed	7-8	3-4
TRL 4: Technology Validation	Integration of scientific principles, testing and validation of results in laboratory environment	5-6	5-6
TRL 5: Prototype testing	Development of prototype in an operational environment and addressing the performance issues	4-5	7-8
TRL 6: Technology Demonstration	Completion of testing phase and evaluation of technology performance under normal operating conditions	2-3	8-9
TRL 7: Full Commercial Application	Commercial application of a technology, in its final form, in industry scale conditions and real-time market	1	10

4.5 Linking innovation to business development

Public-private partnerships are the key factor that ensures the speedy and efficient commercialization of technologies. Increased rate of technology adoption by clients will in turn lead to increase in the production sector, farmers' income and employment (Mohamed, 2020). The key considerations for the process of technology transfer through commercialization are, national priorities relating to food security, sustainable use of natural resources, enhancing of farmers' income and employment generation. Translation process from innovation to business with respect to TRL is depicted in Figure 4.

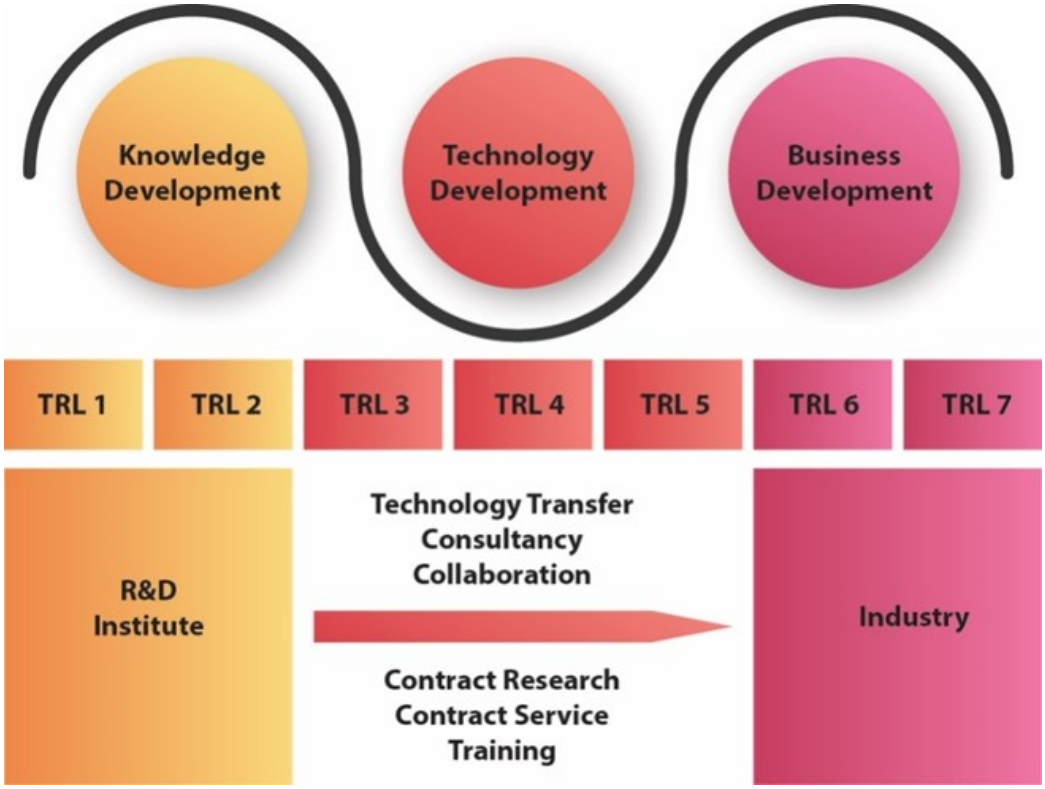

Figure 4: Transition from innovation to business

4.6 De-risking technologies for successful commercialization

Most of the time, the entrepreneurs find it difficult to up-scale the technologies, which are successful at laboratory level to industrial level. This is mainly due to the constraints with respect to the economies of scale, precision in process/protocols, management of big scale/sophisticated machineries/instruments, etc. To address this issue, ICAR-CIFT introduced a new concept of de-risking of technologies by using state-of-the art semi commercial pilot plant facilities set up as part of the incubation programme. By availing the facility, the incubatees can conduct trial production using larger machineries, with on-site guidance from ICAR-CIFT researchers. This helps the incubatees to accelerate their growth phase by launching their products, conduct test marketing and analyse the market behaviour even before establishing a production facility of their own. Once the product refinement and process optimization are completed successfully, incubatees can move out of the incubation support system. A flow chart combining mechanisms of technology development, management and commercialization is given in Figure 5.

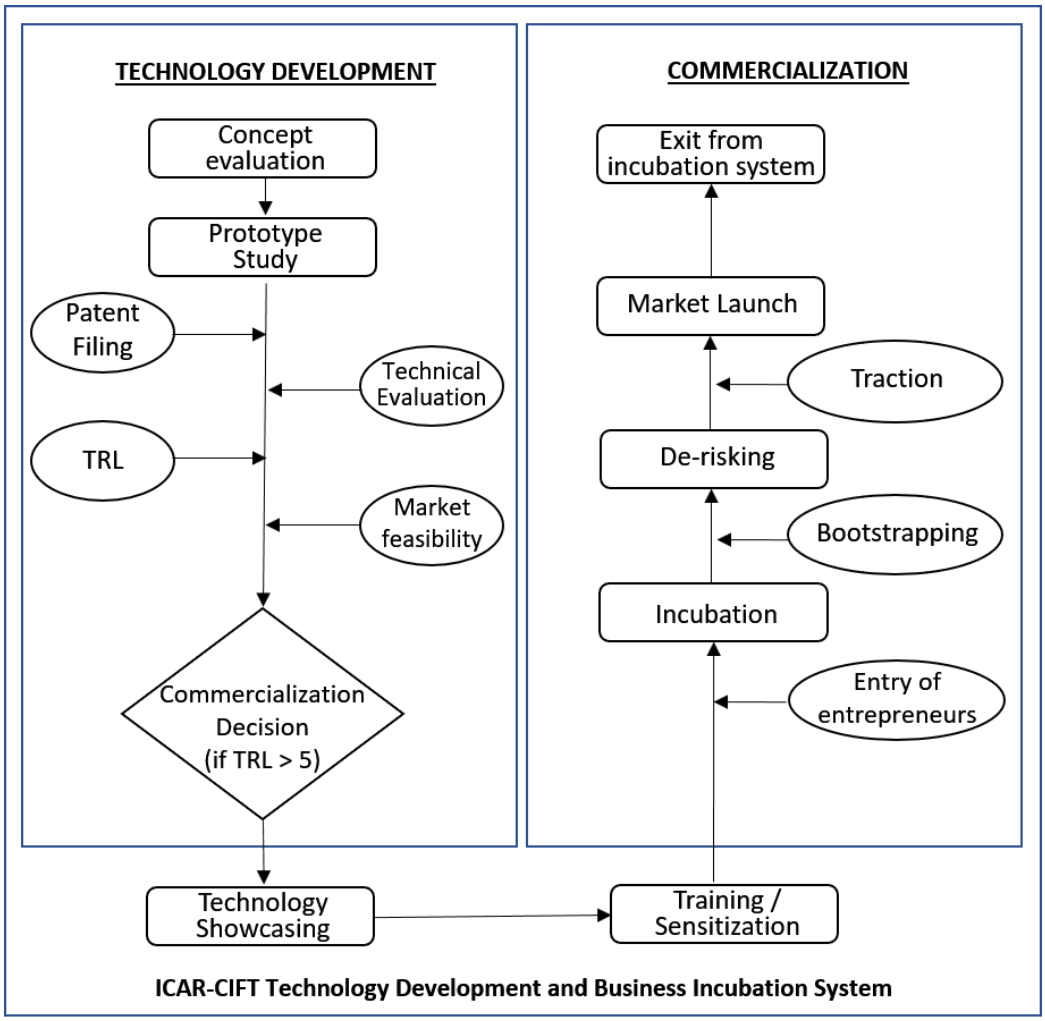

Figure 5: Mechanism of technology development, management and commercialization

4.7 Case Study of ICAR-CIFT Solar Hybrid Dryer

A case study of ICAR-CIFT Solar Hybrid Dryer, a successfully commercialized ICAR-CIFT technology showed the new institutional innovation in technology management and commercialization worked out well. Fishermen in India catch fish as a major aquatic product and it is intended mainly for domestic consumption and sale in the local market. However, in case of over catch, tremendous losses occur because the fishermen have neither access to markets in big cities nor to the international market. The sales are limited due to the perishable nature of the product and absence of a good marketing and distribution system. As an alternative, fishermen convert their catch into dried fishery products for additional benefits. Open air sun drying is the traditional method employed in India to dry fish and fishery products, infamous for higher microbial load and lower product quality. In this type of drying, fish is exposed in an open environment for direct sun light and natural wind for removal of moisture. But it often results in inferior quality of product due to its dependence on weather conditions and vulnerability to the attack of dust, rains, insects, pests, and microorganisms. Also, it requires longer drying time.

To address the challenge, ICAR-CIFT has designed and developed various types of low cost, energy efficient and eco-friendly solar fish dryers. They include solar-electrical hybrid dryer, solar-LPG hybrid dryer, walk-in type solar tunnel dryer, solar-electrical cabinet dryer, solar-biomass hybrid dryer and Infra -Red continuous dryer. The capacity of these hybrid solar dryers varies 10 kg to 500 kg with 6 to 110 m2 of tray spreading area. Solar dryers offer numerous advantages over the traditional sun drying method, apart from being environmentally friendly and economically viable. In solar drying, a structure, often of very simple construction, is used to enhance the heating effect of the solar radiation. Compared to the sun drying, solar dryers can generate higher air temperatures and consequential lower relative humidity, which are conducive to improve drying rates and hence lower moisture content of the final products. Apart from fishes, this dryer is also suitable for drying other agricultural products like fruits, vegetables, spices and condiments. All of these dryers are provided with alternative heating sources in order to continue the drying process during off sunshine hours especially during night time, cloudy and rainy days.

The products made using solar dryers are found to be better in hygiene, colour, taste and other quality parameters, and thus get a longer shelf life period. Chances of outbreaks of fish-borne illnesses are very less, as appropriate hygienic practices are followed during handling, drying and transportation. Being a clean, green and affordable technology, many fishers and entrepreneurs have taken up dry fish production using solar hybrid dryers and were able to set up many profitable commercial ventures. This technology also minimizes the post-harvest losses to the fishers and ensures very good returns. The Technology Readiness Level (TRL) for various Dryer Models is given in Table 3. Most oCAR - Central Institute of Fisheries Technology (ICAR-CIFT) located at Kochi, Kerala state (India) started

Table 3: Technology Readiness Levels (TRL) for various Dryer Models

1.	Solar Electrical hybrid dryer	TRL - 7
2.	Solar-LPG hybrid dryer	TRL - 6
3.	Solar Tunnel dryer	TRL - 4
4.	Solar-Electrical cabinet dryer	TRL - 7
5.	Solar Biomass hybrid dryer	TRL - 3
6.	Infra-Red continuous Dryer	TRL - 2

During the period 2017-2020, 34 incubatees have registered in ABI Centre for product standardization and further hand holding for taking up solar dryer technology for dry fish production. Apart from this, during this period, 30 solar dryers have been commercialized through the incubation centre, and established at different places of India for the benefit of Entrepreneurs/Self Help Groups/Government Institutions. Out of the 30 Clients, 94% people opted for technologies with TRL-7, considering its low risk (Table.2). However, some clients prefer to invest in technologies with TRL-4 or less by jointly developing, testing or customizing commercial level equipment. Though the risk is high, they prefer less competition and expect high return from a niche market. The number of incubates and entrepreneurs who adopted dryer technologies placed in various TRL levels (Table.3) are depicted in Figure 6.

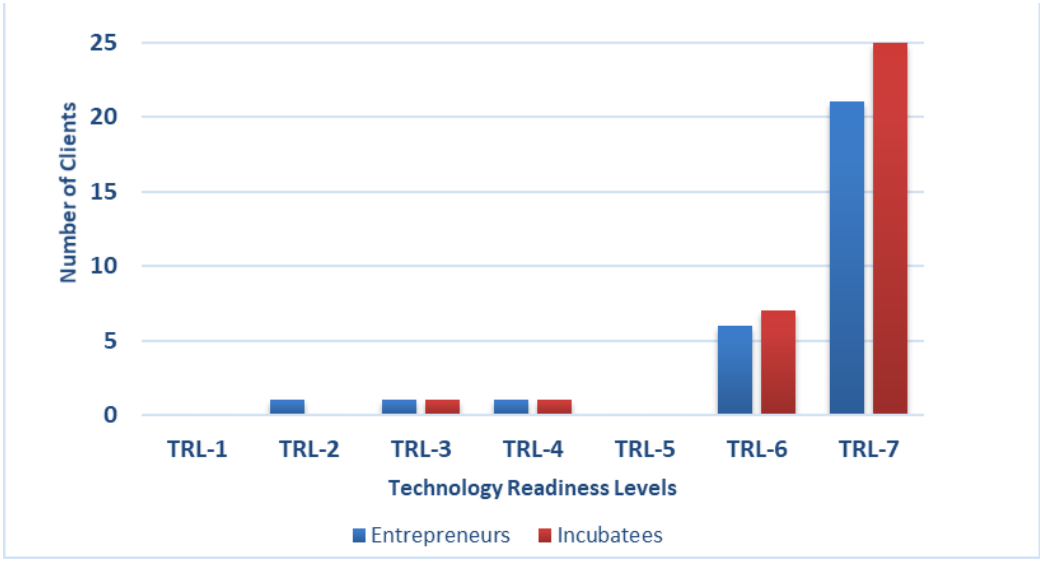

Figure 6: Adoption Pattern for Dryer Technologies

Nearly 30% of these incubatees adopted the technology after the incubation stage and set up their own production facilities. The Institute has identified and empaneled 10 manufacturing firms to assist the Incubatees for fabricating the dryers while setting up their own business ventures. The entire life cycle of Solar Hybrid Dryer Technology in an incubation system is depicted in Figure 7.

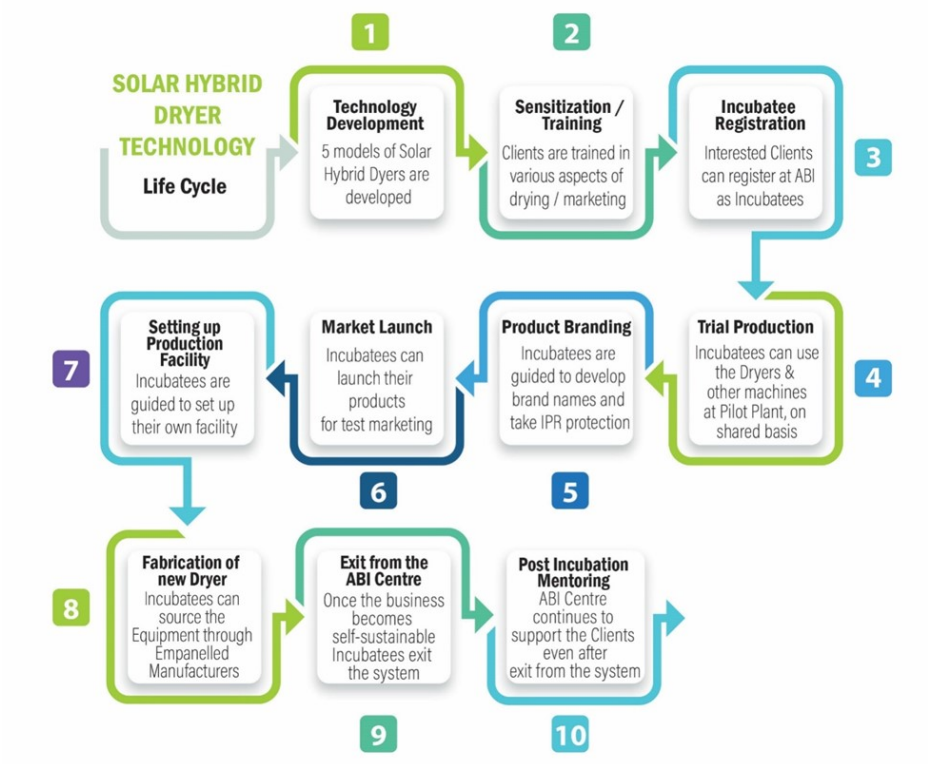

Figure 7: Life cycle of Solar Hybrid Dryer Technology in an incubation system

A specific case study on Emma dry fish products, which is a micro dry fish business venture revealed that the technology is suitable for micro and small-scale entrepreneurs. Mr. Martin of Kumbalangi, Kochi, Kerala was one of the fishermen trainees who attended the two-day training program on pre-processing and drying of fish conducted during October 24-25, 2017 at ICAR-CIFT. In light of the knowledge about the energy and cost efficient solar drying technology perceived during the training period, he approached ICAR-CIFT with a determined plan to start a venture in hygienic dry fish business. As he was naïve in dry fish business and unaware of the dynamics of market, he initially registered as an incubatee of Agri-business incubation unit of ICAR-CIFT and started drying fish using ICAR-CIFT solar fish dryers established in the Pilot plant facility for de-risking purpose. Shrimp, mackerel, lizard fish, silver croaker, sole fish, glassy perchlet, anchovy, etc. were the common fishes dried by him. He did test marketing of the solar dried fish, packed in an attractive polythene package with ICAR-CIFT logo under the brand name "Emma Dry Fish Products" in the local markets and nearby super markets. The customer feedback and demands for these products made him realize the potential of dry fish business. After successful test marketing of solar dried fishes spanning for a period of more than six months, he procured a solar-electrical dryer of 20 kg capacity (TRL-7) from ICAR-CIFT empaneled manufacturing firm under the technical support of the Institute. He preferred a technology placed in TRL-7 bracket as his priority was on repayment of the loan taken towards capital costs without taking much risks. In November 2017, the dryer was commissioned and commercial production started (Figure 8). Now, Shri. Martin is serving hygienic and solar dried fish products under the brand name of "Emma Solar Dried Fish Food-Premium Quality" in 31 supermarkets of Ernakulam district (Figure 9). Recently, he entered into fresh fish marketing with the technical guidance of ICAR-CIFT.

Figure 8: ICAR-CIFT-Solar dryer commissioned at Kumbalanghi, Ernakulam, Kerala

Figure 9: Emma Foods-A new venture in dry fish business under ICAR-CIFT technology support

For this technology, all the financial viability criteria including B-C ratio, NPV and IRR were found to be positive. The fishermen turned entrepreneur normally takes up only a single batch drying in a day for effective utilization of solar energy resulting in reduction of operating expenses. He produces an average of 5-6 kgs of dry fish per day, considering 70-75% reduction in weight due to removal of moisture. Economic analysis showed that his average sale per day was about $42 - $50 and their additional profit per kg of dry product ranged from $2 - $3. The Cost-Benefit analysis of the Solar-electrical dryer unit established by the entrepreneur is given below:

ASSUMPTIONS FOR CALCULATION:	
Raw Fish Price	- $ 1.7/kg
Hygienically Dried Fish Selling Price	- $ 8.4/kg
Working Days	- Avg. 300 days
Investment on Fixed Assets	- $ 2,100
BENEFIT-COST ANALYSIS:	
Expenses:	
Working Capital for 300 days (@ 20 Kg/day)	- $ 10,200
Operating charges	- $ 200
Packaging and other miscellaneous charges	- $ 252
Interest on $2,800@15%	- $ 420
Depreciation on Dryer 10%	- $ 210
Total Costs	**- $ 11,292**
Revenue:	
Total Output for One Year (6000 kg x 30% recovery)	- 1,800kg of dry fish
Sales Return for One Year ($8.4 per kg x 1800)	- $ 15,120
Total Revenue	**- $ 15,120**
Gross Annual Profit	- $ 3,828
B—C Ratio	= 1.34

5. Conclusion

With the active participation and support from the Government of India, the country's R&D institutes are catering to the entrepreneurial collective through incubation mechanisms. Public-private partnerships are happening in great numbers, thus manifesting advances with widespread technological innovation at a breakneck pace. The Indian Council of Agricultural Research (ICAR) with 50 business incubation centres across India, has proven to be a great platform boosting techno-entrepreneurship and nurturing innovation eco-system. The Agri-business incubation (ABI) Centre operational at ICAR-Central Institute of Fisheries Technology has reached out to many clients including small and medium-sized technology-enabled enterprises and has helped to create a good number of jobs. The Centre provides value added business incubation and support services to help entrepreneurs, develop technology-based business ideas and establish sustainable enterprises. The innovative Technology Readiness Level (TRL) concept customized for the entrepreneurs helped in selecting the suitable technology by assessing its associated risks and returns. The ABI Centre has also successfully

implemented the concept of 'de-risking' by providing pilot plant facilities for entrepreneurs to test the attributes of a marketable product/service produced using lab-tested technologies of the institute in an up-scaled production scenario. It also aids in subsequent test marketing and economic viability analyses. A case study was conducted on a successful fisherman who turned into a micro-level dry fish businessman by adopting the TRL-7 technology of Solar-electrical hybrid fish dryer. He used the de-risking facility provided by the Institute, and successfully conducted test marketing for a period of more than six months before investing on the dryer technology. The cost-benefit analysis showed a B-C ratio of 1.34 for the adopted technology and it was observed that his average sale per day was about $42 - $50 with an additional profit of $2 - $3 per kg of dry product. The ABI Centre focuses on developing techno-entrepreneurship by linking public sector resources and private sector business initiatives within and across regional and national boundaries. This initiative is expected to sensitize the farmers, fishers and entrepreneurs on creating improved value chains of their products, guide and handhold them towards the same by adopting novel and affordable technologies, and ultimately fetch more profit and create more employment and livelihood opportunities.

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OPINION

The Development of Professionals for Research Management in Malaysia

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ABSTRACT

Research activities in Malaysian universities have increased dramatically since the year 2007. Since then, the role of the research management office has evolved due to the increasing demand internally and externally. Traditionally, academics are seconded to manage research at local universities. In view of the growing complexity and volume of tasks and responsibilities in managing research, the development of the research management profession is critically needed. However, the profession was only the initiative of individual universities and wasn't formally recognised at the national level. The turning point of this situation happened in 2015, where there was support from the Ministry when a two-phase project related to the enhancement of research management was initiated at the national level. The project studied the strengths and weaknesses of current research management practices in Malaysian public universities and the drafting of strategies and action plans for implementation. One of the recommendations from the Malaysian Research Management & Governance Project (MRMG) project was to develop a network for research managers and administrators in Malaysia so that this group of professionals can improve and learn from their peers via the sharing of best practices and exchange ideas. The first association of the profession was established in 2019 after three hardworking years since the Phase I concluded. The establishment of the association indicated that the acceptability of the profession into the academic communities and universities.

Keywords: Manager; Administrator; Profession; Newton Fund; Association

1. Introduction

Research management is an emerging field in Malaysian institutions and universities. The establishment of research support offices at the Malaysian institutions and universities started when the Malaysian Government increased its R&D budget since the 7th Malaysia Plan (RMK-7) in 1996.

Research activities within the Malaysian institutions and universities have been increased dramatically over time. This was reflected in the research performance of the Malaysian institutions and universities. As shown in Figure 1, the total number of Web-of-Science (WoS) publications published by the Malaysian universities has increased exponentially. The increment was mainly attributed to the Malaysian Government's aspiration to create a knowledge-based economy (Nasiibah, 2013). The

Government has allocated resources to the local universities to boost the research and innovation activities in Malaysia.

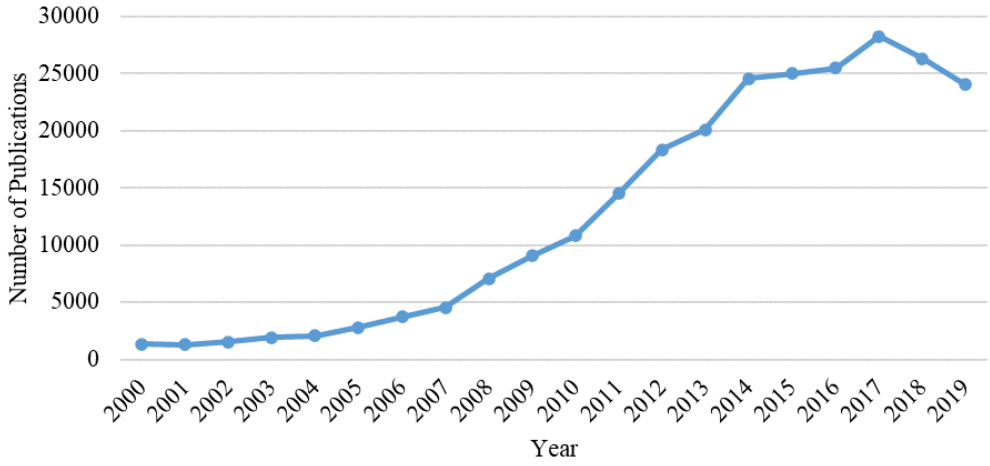

Figure 1: Total number of Web-of-Science (WoS) indexed publications published by Malaysian researchers since the year of 2000 (data collected as of July 2020).

Delivery of a large number of research activities successfully requires hard work by not only brilliant researchers but also excellent administrators who can provide outstanding services and supports. For this reason, the role of the research offices has evolved and become more complex to manage the challenging tasks efficiently. The type of services offered to support research has expanded, from the administration of research grants to management of research. However, the development of the research management profession did not receive much attention in Malaysia. This article discusses the traditional practice in managing research and its evolution within Malaysian universities.

2. Progression in Research Management

Traditionally, the management of research has always been the responsibility of academics and supported by supporting staff (non-academics) for clerical work. Academics are seconded to the university research office to carry out research management such as research grant management, institutional reporting, and stakeholder engagement, which include the communities and industries. There was a strong belief that academics are in touch with research and able to understand the complexities in carrying out research. Therefore, academics would be able to facilitate researchers better from first-hand experience. These academics are often excellent performers in teaching, supervising, and conducting research. However, the secondment of these excellent academics to administrative jobs on research management can cause a loss to the university.

As the emphasis of the knowledge-based economy in Malaysia were intensified since RMK-7, the country's had recorded a growth (Figure 2) in the gross expenditure in research development (GERD) as a percentage of gross domestic product (% of GDP) (Academy of Science Malaysia, 2017; UNESCO, 2020). The GERD by higher education as a % of GDP (Figure 3), on average, was always 20-30% of the

Malaysia overall GERD as a % of GDP from 2008. This data has further confirmed and reflected the volume of research activities carried out at the Malaysian Universities.

The increase in R&D investment at the universities also came with increasing funding agencies' requirements, especially in monitoring and reporting the funding's output, outcome, and impact. The massive amount of work to fulfill the increased requirements were loaded on the academics who were tasked to manage research. This has been a challenge because it affects not only the performance and quality of work of the said academics but also the university. The universities' management started to explore and search for potential solutions to overcome the challenge.

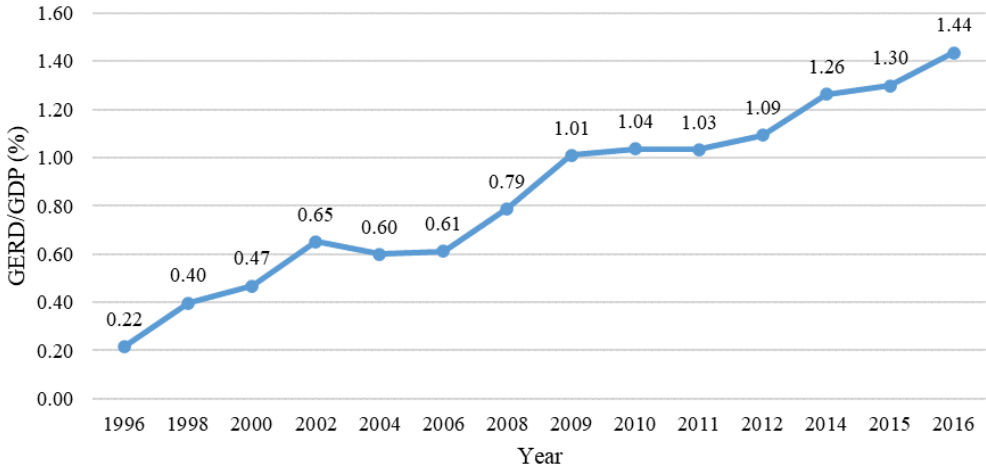

Figure 2: The Malaysia GERD as % of GDP from 1996-2016 (UNESCO, 2020).

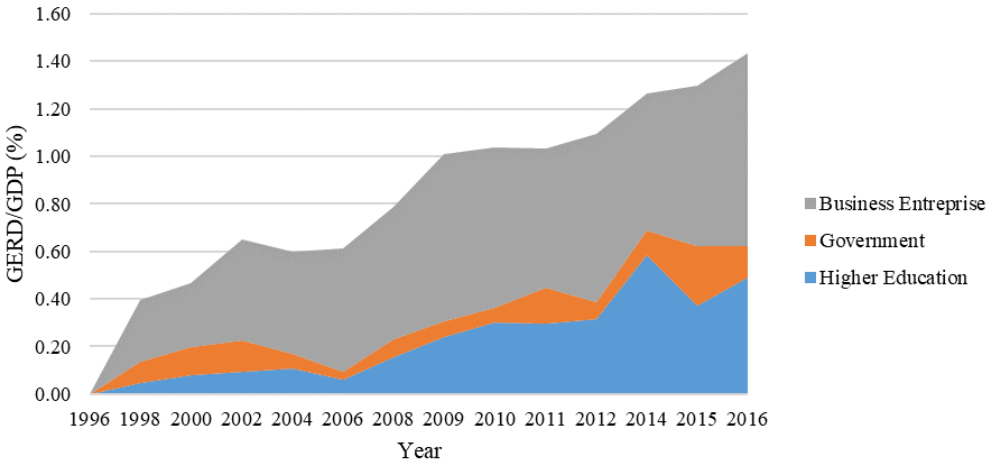

Figure 3: The Malaysia GERD by sector as % of GDP from 1996-2016 (UNESCO, 2020).

The concept of professionals for research management only came into the picture when the leaders of Malaysian universities attended research management conferences and forums. This concept was then slowly introduced into the Malaysian university research management structure, including the appointment of personnel with the related background to manage research fulltime. The recruits in research management include Ph.D. holders who are passionate about managing research. This move has addressed the concern in understanding the complexity of research work. However, it has been the initiative of individual universities without official recognition of the profession.

Today, there is support from the Ministry when projects related to the enhancement of research management were initiated at the national level. The first national project on research management entitled Malaysian Research Management & Governance Project (MRMG) started in 2015 and it was funded by the Newton-Ungku Omar Fund (NUOF) for Professional Development and Engagement. This project was conducted in two phases, 2015-2016 and 2016-2019. As the project owner, the Institutions of Higher Learning Excellence Planning Division (BPKI), which was then the Institutions of Higher Learning Research Excellence Division (BKPI) under the Ministry of Higher Education, had invited Universiti Malaya to participate and act as the project implementer to manage and deliver the project output.

Phase I of the MRMG project studied the strengths and weaknesses of current research management practices in Malaysian public universities, and Phase II prepared and drew the implementation strategies and action plans. Surveys were carried out to collect feedback from the academics, research administrators, and university management, regarding the research management practices at respective universities. The project concluded with several suggestions and areas for improvement, including strategies and plans for implementation. The suggestions and recommendations mainly fell within four topics. The development of the research management profession in Malaysia was one of the identified topics.

Amongst the recommended topics, the development of a network for research managers and administrators in Malaysia was one of them. The network should act as a platform that could encourage and bring this group of professionals together, and improve their knowledge of the research ecosystem, professional skills, and personal skills via sharing of best practices and exchange of ideas. It was a well-known fact that managing research adopts the on-the-job training method. Managing research is not a traditional subject that can be taught at the school due to the nature of work and changing needs from the stakeholders such as the funding agencies, the Government, etc. The scope of work can vary from developing proposals to the management of ethics, strategies, and policies. Therefore, knowledge and specific skills in managing research were often gained and developed via the sharing of experiences, best practices, and solving the challenges that occur during the performance of the tasks. As compared to the countries with a long history of research management, there are still gaps to be filled in the Malaysian research management such as official recognition of the profession, career development, support structure, training, certification, etc.

3. The Profession and Association

On the 31 July 2019, the very first association, The Malaysia Association of Research Managers and Administrators (MyRMA), was officially established by a group of passionate researchers and research managers with a vision to pursue excellence in research management towards realizing impactful research. A launching ceremony of the MyRMA was held on 22 September 2019. It was launched by Y.Bhg. Datuk Ir. Dr. Siti Hamisah Tapsir, the Director-General Higher Education, Ministry of Education Malaysia. MyRMA shall be the catalyst to ensure Malaysia's research management heading in the right direction and in being on par with international players (Tan, 2019).

MyRMA aims to (i) facilitate impactful research by identifying and establishing best practices in research management and administration, and (ii) nurture excellence in the research management profession. It creates a platform for research managers and administrators from the public, private, academic, and research agencies, as well as donors, to interact, exchange ideas, sharing best practices and conduct collaborative activities (Figure 4). It is expected to contribute towards enhancing the effectiveness of research management, the quality of the research itself, and improvement in the return-on-investment.

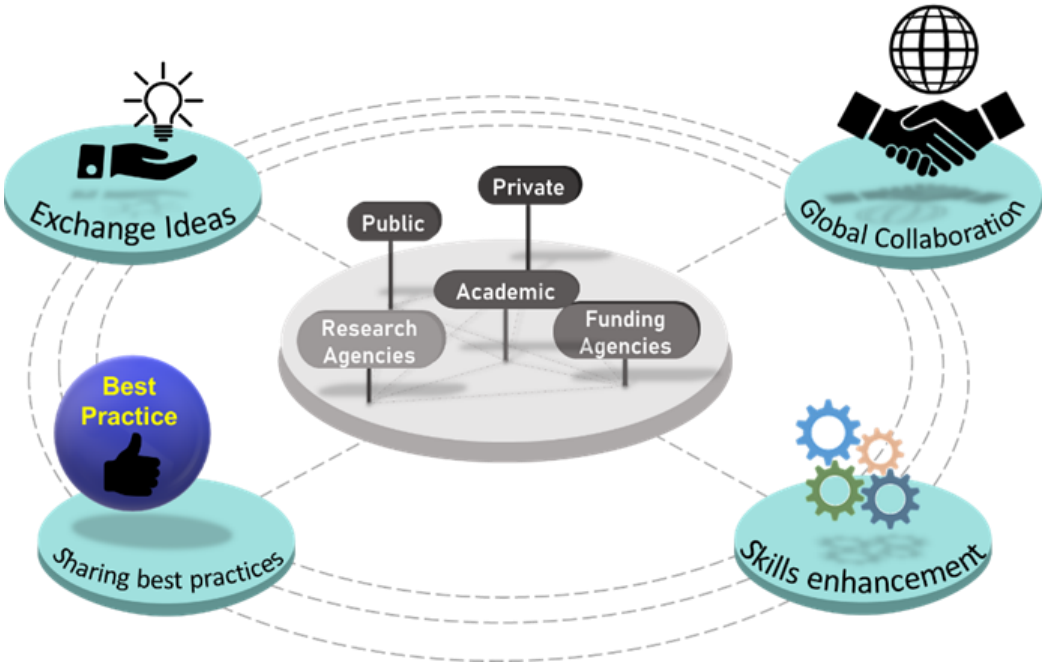

Figure 4: The Malaysia GERD as % of GDP from 1996-2016 (UNESCO, 2020).

4. Conclusion

As Malaysian research management progresses towards professionalism in research management, networking and benchmarking with international research management associations are important. Learning from the experts and working closely with them is crucial and would help in developing the skills for the Malaysian research managers and administrators.

The establishment of MyRMA provides an opportune time for all of the stakeholders in the country to make the first step towards the sharing and exchanging of knowledge, ideas, and experiences in research management. This can propel the country into a knowledge-driven society, and impulse the Malaysian research management to the next level.

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OPINION

How University Research can Create Impact

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ABSTRACT

Universities are under increasing pressure to demonstrate that research carried out by using public money creates significant impact beyond academia which are categorized as cultural, economic, environmental, social, health and well-being, policy influence and change, legal and technological developments. Research impact is complex, diverse and long term in nature. The linear Results Chain Model suggests that a research project can go through a few phases before it creates impact: 1. Inputs, 2. Activities, 3. Outputs, 4. Outcomes, and 5. Impact. In this long process, researchers have a greater role to play in the early phases. In the later phases, researchers alone cannot make much progress without engaging with appropriate stakeholders. Stakeholders may include industry, policymakers, NGO, etc. depending on the type of the project. Researchers need to deliberately aim at non-academic impact, in addition to their traditional intellectual contributions. Universities, on their part, have to provide a supportive environment for researchers to pursue impact. The presence of effective ecosystems at national and regional levels is a necessary condition for increasing the chances of creating impact out of university research.

Keywords: research impact; Results Chain Model; stakeholder engagement; research communication

Opinion

Research impact is a much talked-about topic nowadays. Universities are under increasing pressure to demonstrate that research carried out by using public money creates significant impact. This phenomenon is observed worldwide.

Academics in universities have long been required to demonstrate that their research activities create academic impact by making intellectual contributions such as generation of new knowledge, development of new theories, gaining increased understanding of phenomena, etc. Academics illustrate these by publishing research papers in high ranking journals. Academic impacts are nowadays measured using publication-based metrics such as citation count, h-index, etc.

However, academic impact alone does not satisfy funding agencies, policy makers and tax payers any more. They demand that research done at universities create impact beyond academia. The Australian

Research Council defines research impact as the contribution that research makes to the economy, society, and environment, beyond the contribution to academic research. Research impact outside academia can be very wide ranging. The UK Research Council categorises research impact into eight types: cultural, economic, environmental, social, health and well-being, policy influence and change, legal and technological developments.

Although impact beyond academia is not totally new to researchers, it is only relatively recently that they are facing tough demands to explicitly demonstrate the impact of their research. The 2010 America COMPETES Reauthorization Act of the Congress requires all research projects funded through the National Science Foundation (NSF) to demonstrate impact beyond academia. The UK has been evaluating impact of government funded research programmes under its Research Excellence Framework since 2014. Many of the programmes under the EU Horizon 2020 that started in 2014 require the delivery of impact by researchers. Excellence in Research Australia (ERA) has started assessing impact of publicly funded research since 2018.

Research impact is complex, diverse and usually long term in nature. The linear Results Chain Model is often used to describe the process that leads to impact. This model suggests that a research project can go through a few phases before it creates impact: 1. Inputs, 2. Activities, 3. Outputs, 4. Outcomes, and 5. Impact. In the first phase, researchers gather the inputs necessary to implement the project. Researchers then carry out activities directed towards achieving project goals in the second phase. Outputs, achieved in the third phase of the Results Chain Model, are the first level results which are direct and immediate. Outcomes are the second level or medium-term results achieved in the fourth phase. Outcomes can eventually lead to impact which is the longer-term beneficial consequence of research. In real life scenarios, the process is not necessarily linear, but is rather complex and iterative.

In the context of academic research, inputs include research funding, expertise, laboratory facilities, library, and research assistants. Activities are actual research undertakings like literature survey, experimentation, simulation, survey, data analysis, theory building, etc. Publications are most common outputs of research projects. Other examples of outputs include patents and prototypes. If a research project has come up with a prototype of a certain device, a company may show interest if it has a commercial potential. The company may invest technically and/or financially in developing it further towards a commercially viable product. Such an uptake by the company can be considered as an outcome of the research. If the commercialization of the product eventually succeeds and it generates revenue, creates jobs, etc., then this is a manifestation of the impact achieved by this research project.

In the case of a social science project, the research output can be a policy paper. If this policy paper generates interest among relevant stakeholders and leads to further discourse, then this is a desired outcome of this project. The policy paper, after further improvement through deliberation, may be accepted by the relevant authority, or by lawmakers to prepare a new legislation. If the eventual adoption of the legislation leads to the improvement of quality of life, public policy, etc., then this research project can be considered to have achieved an impact.

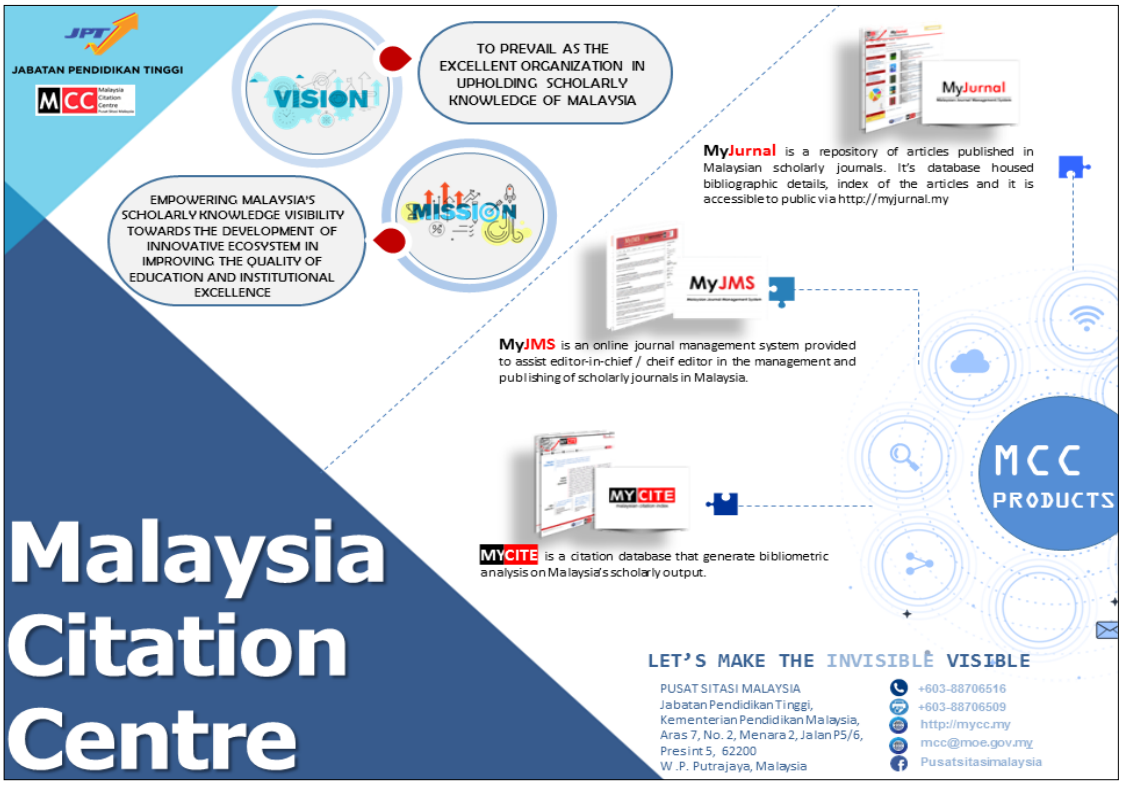
The above examples show that it may take time to achieve impact from depending on the type of research. In this journey, researchers have a greater role to play in the early phases. In the later phases, e.g., the outcome and impact phases in the Results Chain Model described above, researchers alone cannot make much progress without engaging with appropriate stakeholders. Stakeholders may include industry, policy makers, NGO, etc. depending on the type of the project.

Thus, researchers are not the only players in the process of achieving impact. In order to create impact, they must identify and engage with stakeholders. The earlier this engagement happens the better. Early interactions to define research questions jointly refer to the notion of co-creation of research theme by academia and stakeholders. If researchers engage with stakeholders at the conception stage of a research project, they are more likely to identify real life problems that are of genuine interest to the industry and society. Researchers should also keep on engaging with the stakeholders while implementing the project and continue to work with them further to achieve outcome and eventually impact.

Research cannot create real world impact if it does not reach the right people. It is therefore crucial that researchers communicate their research to potential research users beyond academia, e.g., business, public and other relevant sectors. Such communication should use broad range of formal and informal means such as workshops, bi-lateral meetings, public events, policy dialogues, field visits, conventional media, social media, etc. Research communication is not just dissemination, but rather engagement and should not be left to the end of the project.

Research can create impact in extremely diverse ways and is difficult to measure. Manifestation of impact can take a long time; it can be direct or indirect and can happen in unexpected ways. It is generally recognised that research impact beyond academia cannot be fully assessed by any standardized metrics or quantifiable indicators. Narratives and case studies backed by evidence have been used in the UK to assess research impact in a qualitative way. A combination of metrics and narratives have also been applied by others.

To summarize, impact beyond academia is an inevitability that academic researchers are increasingly going to face. Researchers therefore need to deliberately aim at non-academic impact, in addition to their traditional intellectual contributions. They may approach impact with a long-term career perspective, as impact may not result from a single research project. Impact is more likely to be a result of sustained and cumulative efforts in finding solutions to problems that industry and society have genuine interest in. Researchers have to recognize that they alone cannot achieve impact. They need to engage effectively with relevant stakeholders to achieve it. Universities, on their part, have to provide a supportive environment for researchers to pursue impact. Universities should have systems in place to train researchers on how to plan and achieve impact, support effective and fruitful engagement with industry and stakeholders, help disseminate research achievements through different media, and indeed provide incentives to researchers pursuing impact. The presence of effective ecosystems at national and regional levels is a necessary condition for increasing the chances of creating impact out of university research.



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