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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

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 2nd 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.

Professor Dr. Shaliza Ibrahim
Associate Vice-Chancellor (Research & Innovation)
University of Malaya

## 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.

# TABLE OF CONTENTS

JRMG JOURNAL OF RESEARCH MANAGEMENT & GOVERNANCE

Vol. 2, Issue 1, pp. 1-9

RESEARCH ARTICLE

# The Significance of Professional, Personal and Business Networks to Academic Entrepreneurs

Noorlizawati Abd Rahim[1,*], Zainai Mohamed[2], Astuty Amrin[2], Maslin Masrom[1]

[1] Department of Science, Management & Design, Razak Faculty of Technology and Informatics, Universiti Teknologi Malaysia, 54100 Kuala Lumpur, Malaysia

[2] Department of Engineering, Razak Faculty of Technology and Informatics, Universiti Teknologi Malaysia, 54100 Kuala Lumpur, Malaysia

*Corresponding author email: noorlizawati@utm.my

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## ABSTRACT

The degree of informational support academic scientists acquired from social network is associated with greater perceived feasibility that may influence their involvement in the research commercialization. Social capital has been commonly assessed by measuring the number of direct contacts from business and industry networks as well as the frequency of establishing new contacts. These approaches, however, have not adequately explained how social capital is beneficial to their entrepreneurial endeavor. This paper attempts to validate social capital as a formative construct using partial least squares structural equation modeling (PLS-SEM) to explore the relative importance of personal, professional and business networks to academic entrepreneurs in their technology transfer pursuit. A sample of 115 academic entrepreneurs of a Malaysian public research university was surveyed. In comparison to early career researchers, it was discovered that academic entrepreneurs among senior researchers benefited more support from their social network. The analyses of formative measurement model to evaluate construct validity, collinearity and significance of indicators revealed that personal network is the most important social resource that facilitate and encourage their technology transfer pursuit, followed with business partners and potential investors. Although scientists have a large professional network through their attendance to conference, workshops and seminars, however, these platforms are often themed to focus more on sharing scientific knowledge rather than on academic entrepreneurship.

**Keywords:** Academic entrepreneurship; formative measurement model; partial least square structural equation modeling; research commercialization; social capital

## 1. Introduction

A large body of literature has focused on the contribution of social capital to the academic entrepreneurship, specifically to the formation of entrepreneurial intention among academic scientists (Landry et al., 2006; Sequeira et al., 2007; Prodan and Drnovsek, 2010; Aldridge and Audretsch, 2011; Goethner et al., 2011; Karlsson and Wigren, 2012; Fernández-Pérez et al., 2015). Indeed, social capital is found to be the most important influence among other factors of personal characteristics such as gender and age (Aldridge and Audretsch, 2011). Social capital is made up of contacts to whom an individual relates on a social level (Sequeira et al., 2007; Karlsson and Wigren, 2012). Specifically, social capital is described as, "resources individuals obtain from knowing others, being part of a social network with them, or merely from being known to them" (Baron and Markman, 2000:107). In the academia context, these social networks range from personal, professional and business linkages that the scientists have with other individuals. Friends, close family and colleagues constitute the personal network whom scientists have informal relationships with trusts and shared 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.

Different authors have operationalized social capital in a variety of ways. Traditionally, social capital has been assessed by measuring the number of direct contacts from business and industry networks (Renzulli, 2000; Prodan and Drnovsek, 2010; Goethner et al., 2011) as well as the frequency of establishing new contacts (Greve, 1995; Prodan and Drnovsek, 2010; Nielsen et al., 2015). These approaches, however, have not adequately explained how social capital is beneficial to academic scientists in pursuing entrepreneurial endeavour. Notable exceptions are studies that examine specific resources which scientists obtain from social capital such as information and moral support that encourage them to commercialize research discoveries (Sequeira et al. 2007; Obschonka et al. 2011; Fernández-Pérez et al., 2015). Based on the Theory of Planned Behavior, this study postulates that the degree of informational support that scientists acquired from their social network is associated with greater perceived feasibility that may influence their involvement in the technology transfer activities. This study attempts to conceptualize and validate social capital as a formative construct to explore the relative importance of personal, professional and business networks to academic entrepreneurs in their technology transfer pursuit.

## 2. Literature Review

Through social network, scientists benefit both tangible and intangible resources needed in the academic entrepreneurship process. For instance, business network helps to provide information relating to market, new opportunities (Prodan and Drnovsek, 2010) and consumer needs (Fernández-Pérez et al., 2015), which are useful to scientists as they are generally not business and market-oriented. Indeed, Karlsson and Wigren (2012) asserted that scientists have not traditionally been involved in starting up a business and therefore, having contacts from the business community could facilitate them to pick up the idea and competencies through shared experiences. Furthermore, these business contacts can provide positive referrals that facilitate scientists in getting labor (Karlsson and Wigren, 2012) or funds from venture capitalist (Baron and Markman, 2000). On the other hand, professional networks or contacts from within the academic community allow exchange of ideas and information sharing that benefit the scientists to gain further technical knowledge in their field (Ozgen and Baron, 2007), thus advancing the scientific progress (Kalar and Antoncic, 2015). In facing the challenges of both academic and entrepreneurial endeavour, reliance to close friends and family members for emotional support encourage scientists to keep pursuing their goals (Fernández-Pérez et al., 2015). Apart from enhancing access to information, social capital provides scientists the needed technical support, emotional support as well as financial resources.

The importance of social capital exceeds the role of human capital such as years of education, which apparently brought insignificant impact on the propensity of scientist to get involved in the entrepreneurial activity (Ramos-Rodríguez et al., 2010). Consistently, another study on the influence of social capital on the intention to create start-ups among Swedish scientists (Karlsson and Wigren, 2012), made an interesting discovery that scientists' relationship with contacts outside the university established during participation in a product development or contract research actually has an impact on scientists' intention to market their research through business.

In contrast, Prodan and Drnovsek (2010), who compared two European academic settings, found only a partial support to explain a positive relationship between scientists' business network and their entrepreneurial intention to starting a business. Results from their structural equation model indicate a significant and positive path coefficient for University of Ljubljana and a positive but non-significant path coefficient for University of Cambridge. Nonetheless, these results may be affected by cultural determinants and they further suggested for comparison to be made with samples from both developed countries as well as developing countries.

Overall, most of these studies have focused on the impact of social capital towards entrepreneurial intention to create business and there is limited research on the relationship between social capital and scientists' actual engagement in the technology transfer. One notable exception is a recent study by Kalar and Antoncic (2015) to examine scientists from four different European universities regarding their involvement in different types of entrepreneurial activity. Results indicate that scientists' desire to participate in the interdisciplinary projects with industry is stimulated by their social capital. Kalar and Antoncic (2015) also found a positive relationship between such desire and scientists' actual interaction with the industry, which is significantly related to scientists' further engagement in scientific publishing, patenting and creation of start-ups. In terms of comparison between different types of entrepreneurial activities, Audretsch et al. (2006) made an interesting discovery that scientists with strong business networks ended up in licensing activities whereas those who are not active in social networking less likely to patent through TTO and ended up venturing it out through spin-offs.

## 3. Methodology

### *3.1 Construct Operationalization*

The construct social capital provides measure on the degree of informational support that scientists acquired from their social network. Fernández-Pérez et al. (2015), who differentiated different kinds of social networks following the works done by Ozgen and Baron (2007), developed 10-items scale to operationalize social capital. They measured social networks from the perspectives of business network (4-items, $\alpha=0.831$), professional forums (3-items, $\alpha=0.865$) and personal networks (3-items, $\alpha=0.830$). These items were modelled as reflective measurement. In contrast, the social capital construct was designed as a formative measurement model in this study because the combination of indicators SC1-5 represent causes to the construct and are not mutually interchangeable (Hair et al., 2014). Respondents were asked to rate their agreement or disagreement on the 5-items according to a 6-point Likert scale ranging from (1) strongly disagree to (6) strongly agree.

Table 1: Formative measurement indicators of social capital construct.

| Construct | Label | Indicators (Items) |
|---|---|---|
| Social Capital | **SC1** | My contacts from ***professional forums** have been facilitating me with information and support that encourage to commercialize research findings |
| | **SC2** | My contacts from ****personal network** have been facilitating me with information and support that encourage to commercialize research findings |
| | **SC3** | My contacts or discussion with **potential customers or potential suppliers** have been facilitating me with information and support that encourage to commercialize research findings |
| | **SC4** | My contacts or discussion with **new partners or investors** have been facilitating me with information and support that encourage to commercialize research findings |
| | **SC5** | My contacts or discussion with **potential competitors** have been facilitating me with information and support that encourage to commercialize research findings |

*professional forums: Conferences/Workshop/Seminars

** personal network: Friends/Close Family/Colleagues

### *3.1 Construct Operationalization*

The sample consisted of academic entrepreneurs of one public research university in Malaysia (Universiti Teknologi Malaysia). The size of the target population is 1453. Based on a power analysis (Cohen, 1988; Hair et al., 2014) using G*power software (Faul et al., 2009), the minimum sample size was determined as 92, with the maximum number of predictors set as five, effect size set as medium (0.15) and power as 0.80 (Gefen et al., 2011). The maximum number of predictors was set as five since there were five dimensions of social capital being assessed. Invitation mails to participate in the survey questionnaire were emailed to the entire list of academic scientists obtained from the official website as well as from the administrative office of engineering and technology departments. Only academic entrepreneurs or scientists who have been involved in the technology transfer pursuit were selected as sample. To ensure a valid response, respondents who scored 'never' to a questionnaire item that enquire if they have developed potential prototype, product, technology or process that can be commercialized by the industry were disregarded. Respondents must first qualify this item (at least answer 'very rarely involved') before their responses as academic entrepreneurs are valid to be considered. Finally, 115 valid questionnaires were received, exceeding the minimum sample size to proceed with data analysis. Table 2 shows the demographic profile of respondents. These respondents were a mixture of 34.8 % Professors, 33% Associate Professors and 32.2% Senior Lecturers. In terms of research experiences, 72.2% of them have more than 10 years' experiences. Only 2.8% of them have research experiences less than 10 years (early career researchers).

Table 2: Profile of Respondents.

| Variable Name | Frequency (n=115) | % of sample |
|---|---|---|
| **Academic Position** | | |
| Professor | 40 | 34.8 |
| Associate Professor | 38 | 33 |
| Senior Lecturer | 37 | 32.2 |
| Lecturer | 0 | 0 |
| **Faculty** | | |
| Chemical Engineering | 13 | 11.3 |
| Civil Engineering | 24 | 20.9 |
| Electrical & Electronic Engineering | 22 | 19.1 |
| Mechanical Engineering | 32 | 27.8 |
| Petroleum Engineering | 0 | 0 |
| Biosciences & Medical Engineering | 5 | 4.3 |
| Chemistry | 4 | 3.5 |
| Computer Science | 3 | 2.6 |
| Physics | 1 | 0.9 |
| Geo-information & Real Estate | 9 | 7.8 |
| Others | 2 | 1.7 |
| **Research Experience** | | |
| Below 10 years | 32 | 2.8 |
| More than 10 years | 83 | 72.2 |
| **Gender** | | |
| Male | 83 | 72.2 |
| Female | 32 | 27.8 |

## 4. Data Analysis and Results

An independent sample T-test was conducted to compare between groups of early career researcher and senior researcher on the degree of support these academic entrepreneurs acquired from social network. As shown in Table 3, there is a statistically significant difference (t=-3.696, p= 0.000) in the scores for early career researcher and senior researcher groups. The magnitude of difference in means is large (effect size = 0.108).

Table 3: Difference in social capital score by categories of academic entrepreneur.

| | Early career researcher (Mean) | Senior researcher (Mean) | t-value |
|---|---|---|---|
| N | 32 | 83 | |
| Social capital | 3.34 | 4.05 | -3.696* |

*p< 0.01

Construct validity, collinearity between indicators and significance/relevancy of indicators were evaluated using SmartPLS 3.0 and IBM SPSS software to validate social capital as a formative construct based on guidelines (Andreev et al., 2009; Lee et al., 2011; Hair et al., 2014; Lowry and Gaskin, 2014). The MTMM (Table 4) shows that the composite scores or indicator-to-construct correlations for SC1(-0.263), SC2 (0.960), SC3 (0.625), SC4 (0.731), SC5 (-0.580) were significant at the 0.01 level. All inter-indicators have significant correlations. These observations met the convergent validity criterion (Loch et al., 2003).

**Table 4:** Inter-indicator and indicator-to-construct correlation matrix.

| | *SC1* | *SC2* | *SC3* | *SC4* | *SC5* |
|---|---|---|---|---|---|
| *SC1* | | | | | |
| *SC2* | -.444** | | | | |
| *SC3* | -.419** | .624** | | | |
| *SC4* | -.293** | .590** | .557** | | |
| *SC5* | .284** | -.542** | -.544* | -.599** | |
| *SC _CS* | -.263** | .960** | .625** | .731** | -.580** |

(SC1, SC2, SC3, SC4, SC5 Indicators' weighted scores; SC_CS Composite scores for social capital construct) p<0.01

The collinearity statistics (Table 5) show that the variance inflation factors (VIF) for all the indicators were below 3.3, indicating the absence of collinearity (Diamontopoulos and Siguaw, 2006). Since the VIF check confirmed no critical levels of collinearity, the formative measurement model for social capital construct was adequately validated without the need to remove any indicators to proceed with interpretation of relative contribution of each formative indicator (Hair et al., 2014).

**Table 5:** Collinearity statistics for social capital construct.

| **Indicators** | **Collinearity Statistics** | |
|---|---|---|
| | **Tolerance** | **VIF** |
| *SC*1 | 0.77 | 1.30 |
| *SC*2 | 0.48 | 2.09 |
| *SC*3 | 0.51 | 1.96 |
| *SC*4 | 0.52 | 1.92 |
| *SC*5 | 0.56 | 1.79 |

The outer weight and loading significance testing results are shown in Table 6. Two indicators SC3 and SC5 did not have significant outer weights but their outer loadings were above 0.5 and significant. The outer weights were the results of multiple regression between indicators and the construct with coefficient of determination (R2) value of 1.0. This implies that the indicators explain 100% of the construct and thus the outer weights can be compared to determine their relative contribution to the construct. The relative effect of each indicator was interpreted based on the guidelines by Cenfetelli and Bassellier (2009). Significant indicators with positive weights (SC2 and SC4) were compared based on their magnitudes. On the other hand, since the outer weights for SC3 and SC5 were not significant, their effects cannot be compared with the other indicators within the same construct. Significant indicator with negative weight like SC1 (professional forums) was interpreted as having negative effect when the effects of other indicators within the same construct are controlled. Therefore, the results showed the relative effect of indicators towards social capital construct is given by personal network (SC2=0.897) as the strongest, followed by new partners and potential investors (SC4=0.261).

**Table 6:** Outer weight and loading significance testing results.

| Construct | Indicators | Outer Weights | Outer Loading |
|---|---|---|---|
| Social capital | SC1 | -0.216* | 0.263** |
| | SC2 | 0.897** | 0.960** |
| | SC3 | 0.016 | 0.625** |
| | SC4 | 0.261* | 0.731** |
| | SC5 | -0.009 | 0.580** |

*p < 0.05 (t >1.645), **p <0.01 (t >2.33)

## 5. Conclusions

This paper attempts to conceptualize and validate social capital as a formative construct to explore the relative importance of personal, professional and business networks to academic entrepreneurs in their technology transfer pursuit to complement the literature in explaining how social capital is beneficial to academic scientists in pursuing entrepreneurial endeavor. In comparison to early career researchers, it was observed that academic entrepreneurs among senior researchers benefit more support from their social network. The analysis of formative measurement model revealed that personal network, which is made up of close family and friends is the most important social resources that facilitate and encourage their technology transfer pursuit. The second most important social resources are obtained from contacts that they have with business partners and potential investors. These observations are consistent with the earlier findings (Sequeira et al., 2007) that a supportive and strong relationship with personal network brings a stronger effect to the formation of entrepreneurial intention than the effect of relationship with non-affective contact like business networks.

Interestingly, a significant inverse relationship was found for the effect of scientists' professional network to their involvement in the technology transfer activities, which is in accordance with the earlier findings by Fernández-Pérez et al., (2015). In general, scientists are likely to have a large number of contacts from professional network through their attendance to conference, workshops and seminars, which supposed to relate closely to their task as academician. However, these conferences, workshops and seminars are often themed to focus more on sharing scientific knowledge rather than on academic entrepreneurship. Therefore, the inverse relationship results in this study is justifiable by the fact that knowledge sharing platforms that are specifically themed on academic entrepreneurship or how opportunities could be exploited from academic research are still not widely practiced in the academia. This outcome is contrary to that Aldridge and Audretsch (2011), who found that scientists with higher levels of social capital from the professional network, specifically if they have co-authored articles with another scientists that are working with a company, are more likely to get involved in the technology transfer activities.

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RESEARCH ARTICLE

# Escaping the Middle Innovation Trap: Case Studies of Two Successful Spin-off Companies from a Malaysian Research University

Mohd Shahir Shamsir[1], Azlin Abd Jamil[2,*]

[1] Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia (UTHM), Pagoh Higher Education Hub, 84600 Muar, Johor, Malaysia

[2] UTM Innovation and Commercialisation Centre, Industry Centre, Technovation Park, Universiti Teknologi Malaysia, 81300 Johor Bahru, Johor, Malaysia

**[*]Corresponding author email:** azlinjamil@utm.my

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## ABSTRACT

The concept of the "middle innovation trap" has been proposed as a phenomenon of a "failed transformation from implementation based to concept design based capability" (Lee et al., 2019). Over the past two decades, many countries have been caught in the middle income traps. The same phenomenon can possibly be observed in institutions of higher learning, especially government-funded institutions that are a microcosm of the country as their development and wellbeing are intricately linked to the country's finances. Institutions are often well funded with significant capital expenditure during their inception, enabling them to possess the latest technologies with good teaching and research capabilities which in turn could stagnant and degrade if the government switches to fund other inception projects. Hence, these institutions are left to fend on their own, creating a technological and innovation trap that is insurmountable without repeated investment effort to bridge the gap created by rapidly advancing technologies or narrowing of the long tail of scientific research. In this study, two cases from Universiti Teknologi Malaysia (UTM) are described; robotics and skin-care innovation that has been successfully commercialised, hence "escaped" the middle innovation trap. In both cases, the commercialised innovation was very dependent on self-driven extraordinary inventors who developed extensive industrial insights acquired by additional training not accessible to their peers. Their products are not novel and utilise existing technologies that are shaped into commercially available products or services. Although UTM technology transfer office is known for its support and flexibility towards academics pursuing commercialisation, the role of the extraordinary individuals who possess exceptional drive is the key factor in escaping the trap. In conclusion, escaping from the middle innovation trap would only be successful by providing significant and continuous support to the correct type of academic staff.

**Keywords:** Middle Innovation Trap; commercialisation; innovation commercialization; social capital

## 1. Introduction

Since the introduction of the term “middle income trap” by Gill and Kharas (Gill and Kharas, 2007), governments, policymakers, and academics have been actively discussing this concept in policy discussions as well as aiming to test the hypothesis rigorously. The concept itself managed to raise sufficient concerns among economists that reforms have been implemented by government onto their economic policymaking and political processes in affected countries. World Bank data have shown that among the 101 countries that have passed the lower threshold of the middle income level from the 1960s, the majority (84), have failed to surpass the upper threshold of middle income (Gill and Kharas, 2015). The term ‘middle income trap’ describes a situation where a middle income nation, for example, in South East Asia like Malaysia and Thailand (Kanchoochat and Intarakumnerd, 2014) have used the latecomer’s advantage where at the first stage of economic development, low-cost labour from the agricultural sector is shifted towards the higher productive manufacturing sector which increased its cost competitiveness and productivity due to rapid adoption of foreign technology and knowledge. However, as the economy hits middle income, the latecomer’s advantage disappears; at the same time, rents are diminished by competitors who are equipped with lower labour cost and advanced technology as well as facilities; thus gradually slows the growth (Lee et al., 2019). The advent of “middle income trap” has researchers expanded the concept to “middle technology trap” and “middle innovation trap” as its causality (Gill and Kharas, 2015). The perspective of looking at middle income trap from the prism of innovation can be summarised as the state of being trapped due to the inability to transition from the implementation capability to the design capability of the country (Figure 1).

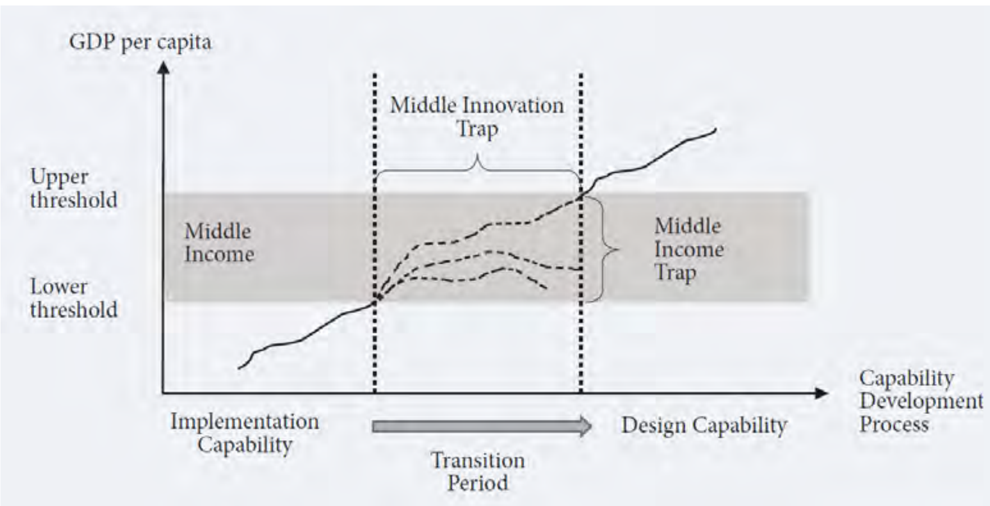


**Figure 1:** Conceptualisation of the middle innovation trap within the middle income trap framework (Lee et al., 2019)

According to the proponents of middle innovation trap, all product and service productions require two types of capabilities that are important to the consumer, (i) the design capability to outlay the required specifications and functionality of the product, and (ii) the implementation capability to produce the product and deliver them (Lee et al., 2019). In a national level of economic development, both of these phases require substantial investment where a developing country began its development with the implementation capability to manufacture products that are based on the concept designs imported from developed countries, e.g. Malaysia producing electronic products based on concept design developed in Japan in the 1980s. When the country succeeded, it would have reached the lower level of the middle income economic boundary. As the country improves its implementation capability and starts to perform concept design successfully, it will reach the upper level of the middle income economic boundary. If the country accumulates sufficient design capability, it will become a high-income country, thus escaping the middle-income trap (Lee et al., 2019).

### *1.1 Describing the Trap in the University*

Similar to a country, it is proposed that the middle innovation trap would afflict universities. Universities having similar features of a country, are a microcosm of the state of innovation of the nation. The evolution of innovation, from the early ideation stage during the research formulation should culminate to the final revenue-generating commercialisation of applied innovation that mimics entrepreneurial activities or concept design capabilities of a country. In education, especially science & technology and engineering, there is a requirement for substantial capital investment in the latest teaching or research laboratory equipment, i.e. technological capability in order to successfully deliver the latest product, i.e. latest education required by the clients, i.e. students. The government usually budgets initial capital expenditure for a new university in order to successfully fulfil the intended capabilities in delivering the education, similar to the implementation capability described in pre-middle innovation trap. For example, the latest high-end equipment such as scanning electron microscope in sciences; nuclear magnetic resonance, crystallography in material sciences; wind tunnel, quantum high-performance computing and high-end CNC machinery are often budgeted from the annual national allocation. Purchasing of this expensive R&D equipment tends to peak during the first two years of each five-year cycle of the Malaysia Plan. For example, the Malaysian Government invested RM 285 million under the 9th Malaysia Plan (2006-2010) and RM741 million under the 10th Malaysia Plan (2011-2015) (Latif et al., 2016).

The proposed middle innovation trap is akin to the “valley of death” of innovation, a concept describing the large and sometimes insurmountable gap separating ideation and commercialisation. The presence of such trap or gap is evident as only 5% of the Malaysian university research outputs are successfully commercialised (OECD, 2013). Cumulatively, only 8.3% of national research and innovation products implemented during the 9th and 10th Malaysia Plan (MP) were commercialised (54 projects commercialised versus 1,675 approved) (Bong, 2015). While the failure to commercialise is the typical outcome of the presence of “valley of death” and “middle innovation trap”, it differs in the causality of the failure. In the case of the “valley of death”, the failure is mainly a financial gap (Markham, 2002) as opposed to the “middle innovation trap”, the failure is due to experiential gap; tacit expression and accumulation of knowledge of trial and error (Lee et al., 2019).

In the context of Universiti Teknologi Malaysia (UTM), opened on September 16, 1985, RM1 billion was invested as the cost of the initial development of its campus in Johor Bahru. Subsequent investments that have been made to meet the needs of research activities at UTM soon had made UTM the leading university in engineering education. The large initial investment during the early years equipped UTM with the latest facilities that allowed for leading-edge teaching and research. Thirty years later, with the advent of exponential technological developments that usher in Industry 4.0, there are signs that UTM is wallowing in a middle innovation trap. A significant number of academic staff who were recruited in the 1980s contributes to this problem when they reached their mandatory retirement age, en-mass 30 years later. These seniors generally comfortable exploiting their démodé knowledge and abilities garnered during their early career development whilst only a small number continue to innovate. Hence this state of affairs had the staff aged obsolete with the technology they acquired. The problem is compounded with the erosion of capabilities, failure to disseminate tacit knowledge and exponential changes in the technology and innovation landscape.

Furthermore, the nature of public universities in Malaysia is de rigueur where recruitment is strictly governed from the federal level, cannot be fully controlled by public universities like UTM. Since the technological and innovation capability of the university is dependent on its academic abilities, the advancement is often trapped within the capabilities of the recruited staff, where mostly was screened for their technical capabilities, rather than entrepreneurial skills which should be of the highest quality in liberating institutions from the innovation trap. A significant technological investment of equipment 30 years ago would possess endowed advantage during its early years but would wane as technology progresses and new more advanced equipment is needed to produce novel results in the long tail of scientific research. Unless new substantial investment is made, the researchers are trapped with a piece of outdated equipment that would severely limit potential discovery and innovation. Apparently, these issues will become critical without proper monitoring and supervision of UTM's one-stop centre for technology innovation and commercialisation set up in 2010, the Innovation and Commercialisation Centre (UTM ICC). Being the best practising technology transfer office in public institutions, the UTM ICC with its proven credibility by winning at least four times of the "National Intellectual Property Award (AHIN)", works strategically with the faculties, research alliances, and centres of excellence in UTM to identify, develop and commercialise viable innovations (Aziz et al., 2011).

### *1.2 Escaping the Trap*

The testament of a successful escape is the successful commercialisation of the innovation produced by the entrepreneurial academic. In order to escape the trap and produce innovations that are able to be commercialised and accepted by the industry, academic staff or a researcher would have to adopt approaches not common within the academic community and even in extreme perception, deemed as acts of betrayal of the scholarly function of an academic (Martinelli et al., 2008). Generally, scholars are expected to find value in discovery and push the frontiers of knowledge, while entrepreneurial academics will monetise their discovery into products to sell and often consider the value of discovery as theoretical and useless (Markham, 2002). The conventional approaches taken or implemented include change of mindset or paradigm (Martinelli et al., 2008), increased academia-industry exchange and networking (Boehm and Hogan, 2014), creation of official structures (Ambos et al., 2008), and creation of robust Technology Transfer Office (Siegel et al., 2007). Previous studies on Malaysian academics have shown similar factors to ones identified in other countries; competency of the academic researcher, innovative research product and active collaboration between university and industry (Ismail and Sidek, 2019). Most of these are insular perspective and are not sole determinants in commercialisation success. External factors such as low business investment in R&D and the consequent low technology absorptive capacity (Yencken and Gillin, 2006), must also be taken into account in order to overcome the technological and capacity limitations or “innovation trap” within the university, besides the measure of success in commercially sold products or services. In this study, two academics staff, a.k.a. entrepreneurial academics that have been allowed to form a private company and commercialised their products are discussed.

## 2. Methodology

The selection of commercialised products produced in UTM is based on the screening of UTM researches, which were conducted through the commercialisation projects in December 2019. There are at least 5649 IPs from UTM which are registered from 2010 until 2019. Registered in all categories, including both local and international, these IPs are produced from 10,000 research projects, which are conducted within the same period of time. Narrowing scope of segmentation, 2161 was identified to have been further exploited to be successful commercial-ready prototype development utilising various sources of funding from the government, Government Link Companies (GLCs), Government-Linked Investment Companies (GLICs), Small and Medium-sized Enterprises (SMEs), and Multinational Corporations (MNCs), locally and internationally. From this range, only 156 IPs have been declared as commercialised referring to the criteria set by the Malaysian Research Assessment (MyRA®), product have been licensed out to a third party companies, subset with IPs that have been reaching accumulation amount of sales of more than RM20,000. The latest commercialisation rate achieved by UTM stands at 7.22%, a higher rate compared to national average, probably due to UTM focusing on engineering and technology. In general, all products that have been commercialized by UTM involved a variety of commercialisation categories including consultation, outright-sales and licensing to spinoff and non-spinoff companies. The final selection process towards two academic entrepreneurs selected for this study is based upon the criteria of an academic staff who have created their spinoff company as a commercialisation vehicle and has achieved more than a million RM turnover; defining their status of having escaped the “middle innovation trap” successfully. Refer Figure 2 below for projection value of UTM's commercialisation rate.

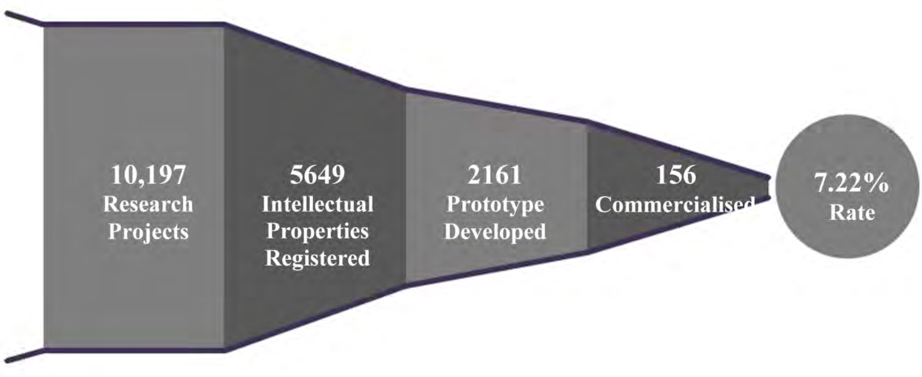


**Figure 2:** Projection of UTM's commercialisation rate

Summarizing interviews conducted with respondents, three basic Research Questions (RQs) were asked in order to understand how the companies survived the middle innovation trap; 1) How do you commercialise the technology that was licensed from the university to your spin-off company? 2) How do you utilise the technology to succeed and survive the commercialisation? and, 3) What are the challenges to commercialise your technology and how do you overcome it?

## 3. Results and Discussion

The summary of the innovation capabilities is summarised in Table 1 and a detailed description of the findings is described.

**Table 1:** Innovation capabilities employed by "Company A" and "Company B".

| | **Company A** | **Company B** |
|---|---|---|
| Industry | Robotics manufacturing | Skin-care solution |
| Idea Investigation | Both possess PhD output | |
| Feasibility | Both have more than ten years of research development and product validation | |
| Business Model | Licensing the technology through their own spin-off company after receiving a large-scale first order from a prominent local company | Licensing the technology through their own spin-off company after the establishment of prototype and a few efficacy studies |
| Market Embarkation | Installation for the first version of the Auto-guided Vehicle (AGV) for a well-known local company | Unit sales of the skin whitening serum using the social media platform |
| Growth | Niche market where customisation is the unique selling point. The product ability to lift heavier load transfer from 100 kg up to 1 ton. | Boost the production of α-mangostin, expand the product ranges to include skin lightening, anti-ageing, collagen synthesis, serum and moisturiser |
| Product Novelty | The novelty level is modest in the saturated robotics industry but critically creates an untapped AGV market that requires customisation options untenable to more prominent market players. | The novelty level ion is modest in the saturated skin solutions industry but capturing the validation of nanotechnology research and riding the wave of cosmetics and halal trend in Malaysia. |

The first researcher is the one who sets up a robotics company that specialises in designing and manufacturing Automated Guided Vehicle (AGV) system for industrial and commercial use, providing a total solution for improving and automating production material handling via utilising automated guided vehicles that possess greater flexibility than a static conveyor belt, which in turn decreases the reliance on labour and allows cheaper customisation of work processes on the factory floor. The company has won various awards at the national and international level, e.g. Frost & Sullivan 2017 Malaysia Entrepreneurial Company of the Year for Automated Guided Vehicle Market with the company recently won the Best Innovation Platinum Award at Star Outstanding Business Award (SOBA). Other innovation competitions awards include the IR 4.0 Robotic Solution in Mexico in June 2019, the Best Innovation at Star Outstanding Business Awards (SOBA), 2018, the Microsoft Imagine Cup, 2017, the King Sejong Inventor Order of Merit and the Korea Inventor Award Festival (2013). Incorporated in 2012, the company has employed not less than 40 employees with a turnover of RM10 Million annually. The researcher has built a strong team, engaging with former students and collaborators to expand the business. He believes that the robotic arena must be championed by the strength of a team of experts rather than be driven alone, hence has encouraged him to gather smart, creative, and competitive young talents whom shown interests in raising the business, often identified from bright and interested students in the faculty. This formation of team-based entrepreneurial has been shown to be a positive contributing factor in commercialising innovation form universities (Chen and Tjosvold, 2002; Sawyer, 2006).

The second researcher is an expert in extraction and bioprocess engineering technology who produces a skincare and cosmetics products that are based on active compounds extracted from mangosteen fruit, Garcinia mangostana. The product has been commercialised through a spin-off company that has a turnover RM11Million annually, achieved by selling cosmetics products; skin-care products, perfume and cosmetics. The company was founded by an entrepreneurial academic who is passionate about cosmetics to the extent of pursuing and completed her PhD studies in Korea, well known for its export of beauty and cosmetics industry in Asia (Choi et al., 2019). Her observation of the discipline and punctuality of the Korean had also inspired the entrepreneurial spirit to exploit the technology through the university's commercialisation platform. Her endeavour started with the formation of her spin-off company, protecting the necessary intellectual property and creating the necessary trademarks by licensing it from the university. The company strategy is to minimise spending on employee but focused on promoting and marketing its product via segmented the Business to Consumers (B2C) market, a well-known strategy in selling products such as cosmetics (Trainor et al., 2014) especially in Malaysia (Jusoh et al., 2012). Social media was the company’s primary marketing medium to reach out to customers with the company occasionally participating in limited exhibitions and conferences to expand the networking opportunity and market capture. The UTM ICC facilitated funding from internal and external grant sources, both public and private grants. The product range increased in tandem with the sales with sales doubling every year. Currently, the range of products has expanded to include niche products such as Intensive Brightening Cleanser, Intensive Brightening Skin Softener, and Intensive Refining Cream with SPF, a whitening and anti-ageing skin-care solutions for consumers as the beauty expectations and standards towards a fairer complexion in Asia has increased (Li et al., 2008; Chaipraditkul, 2013; Shankar and Subish, 2016)

Results of the interview revealed that UTM ICC technology transfer office has acted in accordance with its mandate and has been performing as expected. This is a positive indicator as a functioning structure and ecosystem within the university is critical in ensuring successful ideation and commercialisation of innovation (Siegel et al., 2007). The UTM ecosystem provides few critical differentiators compared to other public universities; offering RM 100,000.00 (USD 24,000) seed fund and allowing full salary entrepreneurial leave up to two years and the setting up of spin-off companies 100% owned by the academic entrepreneur (UTM has 43 spin-off companies). This exceptional support is designed to give an extra boost in motivating academics into entrepreneurship. Therefore, UTM structures and the ecosystem has not been an impediment factor in escaping the middle innovation trap.

Consequently, the academic entrepreneurs for both companies have been allowed to pursue independent effort to commercialise their expertise that stems from their prior researches and experiences. The robotic technology and accompanying knowledge was honed during the academic involvement in innovation contests; proven to solicit constructive criticism (Adamczyk et al., 2012) and robotic competitions, accompanying students allowed interaction with industry and producing exceptional teaching-research output geared to industry (Yudin et al., 2017). In the second case study, the skin-care company that was created after acquiring experience in PhD study in Korea, supporting the development of innovative ideas in accordance with Open-Innovation concepts that encourages the freedom to develop innovative business ideas beyond the usual domain (Chesbrough, 2006); relatively supporting the creation of spin-off companies to carry their own business risks (Lockett et al., 2005).

Adopting this strategy is useful if the originator institution is conservative and risk-averse, traits commonly attributed to government research institutions or public universities. Both academics were given extensive support through various schemes such as training abroad, funding and freedom to be active in commercialising their ideas. Although these support schemes are open to all academics, it is selective and tends to be comprehensive in nature, equipping academics with a range of skill sets and usually “eye-opening” commercialisation worldview (Kitagawa, 2005). Those selected would possess a higher than average success in commercialising their ideas. Each academic honed their skills further by participating in extensive external activities that brought them close contact with the market and industry. The first academic participated extensively in robotic competitions, accompanying students to exhibitions locally and abroad. The second joined a research institute and completed her research in Korea, gaining experience in the highly advanced cosmetic industry. Both academics are relatively young and in the early career phase, hence possessing the freedom to explore and are willing to take the risk by not pursuing the conventional career progression route in academia. Risk-taking (Khademi et al., 2015; Latif et al., 2016) and open-mindedness are traits often observed and needed by entrepreneurial academics (Engel and del-Palacio, 2009; Brunswicker and Ehrenmann, 2013; Ghio et al., 2016).

The commercialised products were developed with a specific niche in mind. The first product, an automatic guided vehicle (AGV) is an automaton that is a highly customisable robotic solution. The high degree of customisation and modular design of the product allowed penetration into small and medium enterprises and factories that would not want to purchase expensive and rigid large scale systems that cannot be downscaled. Deploying small scale systems below specified complexity or system sizes not profitable from the perspective of the larger and more established robotics and automation companies. Large companies would instead focus on large clients such as automotive production factories as it makes more commercial sense than to offer customised services to small companies. This created a market gap where the academic and his newly formed company can enter. The second product is a skin-care and cosmetics product that utilises an active ingredient from mangosteen (Garcinia mangostana). Malaysia has seen the rise of local cosmetic brands, spurred by the Halal and wuduk (ablution)-friendly elements (Badarudin, 2018) with the market expected to increase annually to reach a growth rate of 10.2% during the period 2015-2020. The product is the first such product that overtly markets its benefit using this specific fruit, promoting its benefit to the consumer. The market share for cosmetics in Malaysia is USD407 million (Azmi Hassali and AL-Tamimi, 2015) and has 269 companies listed on the National Pharmaceutical Regulatory Agency (NPRA) database, in the year 2020. This product was successfully promoted using the research credential to establish consumer trust and confidence. The use of mangosteen fruit is a departure from other herb-based products that are usually heavily promoted for its ethnobotanical benefits such as Eurycoma longifolia. The fruits ubiquity and familiarity with the consumer also made the marketing easier, easing the product into the already saturated market. In both cases, the commercialised products resulted from ideation to provide products the consumer wants and creating new yet familiar consumer products.

At the individual level, both academics managed to overcome tensions from their respective academic communities entrepreneurial academic who focus on commercial outcomes tend to be somewhat different to those who are accustomed to producing academic outcomes such as publications and students (Ambos et al., 2008). Both academics have scored exceptionally well in their annual performance appraisal and have yet to abandon their fundamental role as lecturers and project supervisors. Their involvement in entrepreneurial activities has actually added value to their student learning experience.

In both cases, the personal attributes of the academic is strongly relate to the success of innovation processes, including commercialisation. Previous studies have indicated that industrial experience has significantly contributed to innovation actors' capabilities in developing or implementing innovation strategies (Sharma et al., 2006). They have internalised that it is their responsibility and acts as their own product champion to drive the projects to successful commercialisation (Markham, 2002). Both have extensive external network that helped build a stronger entrepreneurial perspective, a key component of entrepreneurial success (Powers and McDougall, 2005). The industrial experience is particularly vital for those academics who have entrepreneurial intentions (Khademi et al., 2015). They did not suffer the lack of time and lack of incentive to develop contacts with and meet the expectations of industry and other research users for technology that works (Yencken and Gillin, 2006). Both received sufficient and comprehensive training related to research and commercialisation which contributed to their increased performance. (Ab Aziz et al., 2013). It is certain that both individual has the appropriate character to achieve their commercialisation goals. Research have shown that individual factors carried significantly higher explanatory power in relation to the entrepreneurial behaviour of academics. (Hossinger et al., 2020).

## 4. Conclusions

Both case studies revealed that escaping the trap or successful commercialisation depended upon possessing a suitable academic candidate who is self-driven. Sufficient entrepreneurial training, especially getting exposure and building external networks with industry and other agents or actors in the industry, is important in turning these driven individuals into a success. In order to escape, novelty is not paramount for these two companies; it is adequate to utilise existing technologies that are shaped into commercially available products or services. Therefore, the role of the extraordinary individual who possesses the exceptional drive is the key factor in escaping the trap.

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OPINION

# The Need for Open Science

Noorsaadah Abd. Rahman[1,*]

[1] Deputy Vice-Chancellor (Research & Innovation)'s Office, University of Malaya, 50603 Kuala Lumpur, Malaysia

*Corresponding author email:
noorsaadah@um.edu.my

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## ABSTRACT

Open Science is about sharing knowledge where research data and its underlying methods and processes are made available "freely" for reuse, redistribution and reproduction by those other than the researchers themselves. The availability of these data publicly should promote the translation of research output into innovation and new technologies. In addition, making research data and knowledge publicly available to others would help to build trust on the research findings and could support public policies and further investments.

**Keywords:** Open Science; Open Access; Open Platform

## 1. Introduction

Scientific advancement has led to the economic, technology and societal progress of humanity. Many scientific discoveries and innovation such as vaccination for polio and invention of mobile phones have resulted in better life for humankind. The pace of science and its discovery is moving very fast with the advancement of modern science and technology. Particularly, computer and internet-of-things has enabled a vast number of scientific and research reports being published annually. However, most of these reports are not properly verified resulting in many non-reproducible results and data. For example, in an independent attempt to replicate selected results from a number of "high-profile" papers in Cancer Biology, researchers could replicate only 40 percent or less of the results reported (Davis et al., 2014). In a report in Nature Reviews Drug Discovery, Prinz and his co-workers questioned the reliability of published data on potential drug targets (Prinz and Asadullah, 2011). This "reproducibility crisis" has led many scientists to push for ways to improve scientific reporting to increase reliability. One way to do this is through "open science".

Open Science means that not just the scientists, but teachers, policymakers, journalists and other non-scientists, would have access to the research data and materials. Since most research is funded through public funds and tax-payers money, allowing anyone access to study these data would increase the value of every penny invested (Nielsen, 2011).

One of the earliest well-known examples of Open Science is the Human Genome Project which started in 1990 (Hood and Rowen, 2013). Throughout the course of the project, the scientific community widely shared the data on the human genome. In order to encourage optimal collaboration, they also kept a moratorium on publishing. Open Science has enabled the scientists involved to decode the human genome in less than 15 years. In another example of Open Science, "brain-sourced" research, Tim Gowers, a mathematician at Cambridge University started the Polymath Project where he took an unsolved mathematical problem, published it in his scientific blog and invited everyone to contribute in solving the problem (Polymath Projects, 2019). On-line contributors were able to solve not just Gower's original problem, but also harder problem that was included the original as a specific example in only 37 days after the start of the project.

European Union has funded several initiatives which have led to steady progress towards Open Science (Beagrie and Houghton, 2016). One good example is the 'European Lead Factory' project under the Innovative Medicines Initiative (IMI) (European Commission, 2019). In this project, academic and industry partners pooled together around half a million compounds (chemical molecules) which are made publicly and freely available in a repository to any scientist who wants to screen and validate potential new drug targets.

The ecosystem underpinning Open Science which began with the World Wide Web or WWW is evolving rapidly. There are many social network platforms available for scientists and researchers to use and validate research data in a "brain-sourced" way (Nielsen, 2011; Nielsen, 2012; Vignoli et al., 2014; Crouzier, 2015). Several platforms, which are available for open access for scholarly publications to facilitate Open Science eco-system, are shown in the Table 1.

**Table 1:** Some Platform for Scholarly Publications for Open Science.

| | |
|---|---|
| Academia.edu | A US-based platform for sharing of research papers. Academic.edu monitors the impact of these research and tracks the research of academics they follow. More than 30 million academics are signed up to the site by January 2016. A recent study reported that papers uploaded to Academia.edu receive a 73% boost in citations over five years. |
| Research Gate | This is a platform based in Berlin with virtually similar functions to Academia.edu and had about 8 million user and 80 million publications in January 2016. Research Gate generates a Research Impact Factor for the uploaded documents of researchers, based on factors such as 'classical' citations and on the number of downloads by other users. |
| Mendeley | An Amsterdam-based reference manager owned by the Elsevier publishing company has around 3 million users (June 2014). Mendeley allows for open annotation and generation of bibliographies. |
| Figshare | An online digital repository supported by Digital Science (a division of Macmillan Publishers). In Figshare, researchers can make their research outputs available in a citable, shareable and discoverable manner, including figures, datasets, images and videos. |

| | |
|---|---|
| F1000Research | This is an Open Science publishing platform for life scientists which offers immediate publication without editorial bias and publishes all scientific research within a few days. F1000Research uses an author-led process with open, invited peer review of articles conducted following publication of the research work. It focuses on scientific soundness rather than novelty or impact and all published research articles must be accompanied by the data on which the reported results are based. This is critical to enable reanalysis; replication attempts and data reuse. |

There are currently numerous data repositories worldwide to support Open Science. These repositories may be called data centers, data archives, or scientific databases and are often divided into three categories:

i) Institutional Repositories (IRs) are affiliated with an institution such as the Digital Repository (DR-NTU) at Nanyang Technological University, Singapore.
ii) Domain-specific or Disciplinary Repositories (DRs) are discipline-specific and usually operated by a professional organization, a consortium of researchers, or a similar group.
iii) General-purpose or Open Repositories (ORs) which allow researchers to deposit and make their data available regardless of disciplinary or institutional affiliation. Some examples of this category of repositories are listed in Table 2.

**Table 2:** Examples of General-purpose Data Repositories Supporting Open Science

| | |
|---|---|
| Zenodo (Zenodo, 2019)<br><br>https://zenodo.org | This platform was created in 2013 by OpenAIRE and CERN as an all-purpose, open repository for all scholarship, enabling researchers from all disciplines to deposit publications, datasets and other research artifacts such as code, posters, presentations and share their research outputs, regardless of size or format. Free to upload and free to access for researchers to upload files up to 50 GB. |
| The Australian Research Data Commons (ARDC) (Australian Research Data Commons, 2019)<br><br>https://ardc.edu.au/services/research-data-australia/ | The Australian Research Data Commons (ARDC) was formed on 1 July 2018 which is an initiative that enables Australian research community and industry access to nationally significant, leading edge data intensive e-Infrastructure, platforms, skills and collections of high-quality data. ARDC provides high capacity digital data storage for nationally significant collections, cloud computing, collection curation and data management resources, as well as national catalogue, identifier and vocabulary services. |
| OSF (Center for Open Science, 2019; OSF, 2019)<br><br>https://osf.io/<br>https://cos.io/ | OSF is a free, open platform to support research and enable collaboration developed by Center for Open Science (CoS) whose mission is to increase openness, integrity, and reproducibility of research. |

| | |
|---|---|
| European Data Portal (European Data Portal, 2019)<br><br>https://<br>www.europeandataportal.eu<br>/en/resources/training-<br>companion/open-data-<br>platforms | The strategic objective of the European Data Portal is to improve the accessibility and increase the value of Open Data. This portal also enables metadata of Public Sector Information available on the public data portals across European countries to be harvested. |
| Open Research Data Platform Switzerland - ORD@CH (ETH Zürich, 2019)<br><br>https://sis.id.ethz.ch/<br>researchdatamanagement/<br>service-ordch.html | ETH Scientific IT Services with collaboration of partners from academia and industry has developed a publication platform for open research data in Switzerland (ORD@CH), based on the open-source data publication system, CKAN. This platform has been made as a permanent infrastructure for sharing open research data in Switzerland since 2016. The ORD@CH platform provides a meta-data catalog for the publication of research data from life sciences, social sciences as well as humanities and other domains. |
| Peking University Open Research Data Platform (Peking University Open Research Data, 2019)<br><br>https://<br>opendata.pku.edu.cn/ | The Peking University Open Research Data Platform was developed based on the "standardization of property rights protection" and with the purpose of "advocating open science" by promoting openness, exchanging, and sharing of research data. This platform provides researchers with the management, release, and storage services of research data, encourages researchers to open and share data, and provides data users with browsing, retrieval, and download services for research data, and promotes the dissemination, reuse, and standardization of research data. |

## 2. Several Global Initiatives of Open Science Policies

On 22nd October 2003, The Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities were launched (Max-Planck-Gesellschaft, 2019). This Declaration asserted that scholarly research results and cultural heritage shall be freely accessible and usable for scientists and the public. Fundamental to the declaration is that Open Access (OA) is a responsibility of research performing organisations and research funding organisations, and that the publication and dissemination of research results are integral parts of the research process. Following this declaration, several initiatives on Open Access and Open Science were carried out by various communities and nationals around the world. A brief description of some of the initiatives are described below.

### *2.1 The G8 Community* (G8 UK, 2013)

In June 2013, the G8 Science Ministers met in London approved of a statement which proposed the consideration of new areas for collaboration and agreement on global challenges, global research infrastructure, open scientific research data, and increasing access to the peer-reviewed, published results of scientific research. In order to address global challenges and maximise the social and economic benefits of scientific research, the G8 Science Ministers support the set of principles for open scientific research data which included publicly funded scientific research data to be opened with fewest constraints as possible; open scientific research data should be easily discoverable, accessible, assessable, intelligible, useable, and interoperable to specific quality standards, where possible and to maximise the value that can be realised from the research data. To ensure that open scientific research data principles will be adopted by the scientific communities, the G8 Science Ministers agreed for need of an appropriate policy environment to underpin the Open Science initiative.

***2.2 CODATA*** (CODATA, 2019)

CODATA is an interdisciplinary Committee on Data for Science and Technology of the International Science Council (ISC) established in 1996. Amongst its role is to promote global collaboration to advance Open Science and to improve the availability and usability of data for all areas of research. CODATA supports the principle that research data should be available and "open as possible and as closed as necessary". CODATA advocates for these data to follow the FAIR (Findable, Accessible, Interoperable and Reusable) principles. In its Prospectus of Strategy and Achievement 2016, CODATA has identified three priority areas in their Open Science initiative which are:

i) to promote principles, policies and practices for Open Data and Open Science;
ii) to advance the frontiers of data science;
iii) to build capacity for Open Science needed to support open data.

***2.3 Japan*** (Global Perspectives Cabinet Office Japan, 2015; Research Center for Open Science and Data Platform, 2019)

Japan Science and Technology Agency (JST) established an Open Access policy on research publication and research data management known as the JST Open Access Policy in 2013. The policy defines JST's stand on Open Access to research publications and management of research data resulting from research projects funded by JST and researchers who participate in projects awarded by JST are required to handle research results appropriately complying with this policy. This policy was recently replaced by the JST Open Science Policy.

***2.4 Australia*** (Houghton et al., 2009; Mizera, 2013; Australasian Open Access Strategy Group, 2019)

In January 2013, the Australian Government enacted a policy on Open Access. Under this new policy, all the results of research conducted with the financial support of the Australian Research Council (ARC) must be published in an Open Access model within 12 months of publication and that these materials should be published in specific institutional repositories. As stated in the ARC's website:

> "The overarching aim of ARC's Policy is to ensure that the findings of publicly funded research are made available to the wider public as soon as possible. Both the research community and the public gain from knowledge derived from ARC funded research, and both wish to derive maximum benefit from these outputs."

***2.5 China*** (Markin, 2018; Li and Zhang, 2019)

In May 2014, the Chinese Academy of Sciences published its Open Access policy calling for the free accessibility of publicly funded research results in the form of academic articles. In doing this, researchers are encouraged to adopt the Green or Hybrid Open Access in the framework of which scientific papers enter Open Access 12 months after their publication.

In October 2017, China joined the global OA2020 initiative that aims to accelerate the transition to Open Access around the world. Leading scientific institutions of China, such as the Chinese Academy of Sciences (CAS), China's National Science Library and National Science and Technology Library, have affirmed the importance of Open Access for scientific research and communication.

In May 15, 2018, the National Natural Science Foundation of China (NNSFC), which supports basic science, and CAS, a body that provides research funding for over 100 scientific institutions in China issued a policy statement on Open Access, mandating that research results of the projects they fund should be made openly accessible within 12 months of their publication.

***2.6 United States of America*** (National Institutes of Health, 2003; Nielsen, 2011; Noorden, 2013)
Since 2008, the US National Institutes of Health (NIH) has required research to be publicly accessible after 12 months. However, this new policy does not insist that every agency copies the NIH approach exactly. In 2012, John Holdren, the director of the White House office of science and technology policy (OSTP), told federal agencies to prepare plans to make their research results free to read within 12 months after publication following a petition urging the president to require free access to scientific journal articles from publicly funded research. In February 2013, the US government announced its Open Access policy which mandated all publications arising from taxpayer-funded research to be made free to read after a one-year embargo period.

***2.7 European Commission Initiative*** (Ramjoué, 2015; European Commission, 2017; European Open Science Cloud, 2017; European Open Science Cloud, 2019)
The European Commission has taken a big step towards open science in Europe and is probably the most matured initiative. For the European Commission, open science provides the context for open access to publications and open research data. Since 2008, the European Commission has been running the Open Access Pilot in their FP7 programmes. Currently, all projects receiving Horizon 2020 funding are required to ensure that any peer-reviewed journal article they publish is openly accessible and free of charge. In 2016, European Commission went one step further by launching the European Open Science Cloud (EOSC). EOSC is an initiative to build a competitive data and knowledge economy in Europe. At the first EODC Summit in June 2017, the EOSC Declaration was endorsed by more than 70 institutions.

***2.8 Singapore*** (Ooi, 2017; UNESCO, 2017)
Closer to home, Singapore contributes to the world of Open Access (OA) in the form of Institutional Repositories in some of the well-known Institutions in Singapore. As of May 2015, there are 3 OA repositories from Singapore registered in the Registry of Open Access Repositories (ROARMAP). They are "Institutional Knowledge" at Singapore Management University, "Scholar Bank" at National University of Singapore and "Digital Repository (DR-NTU)" at Nanyang Technological University. As of July 2014, the Singapore's National Research Foundation (NRF) requires research-performing institutions to have Open Access policies in order for researchers to access their grants.

*2.9 Malaysia* (Akademi Sains Malaysia, 2019)

Malaysia does not yet have an open science policy. However, recently, the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) and the Academy of Sciences Malaysia (ASM) launched the Malaysia Open Science Platform (MOSP) initiative. MOSP is to be a trusted data-sharing platform that enables accessibility and sharing of research data aligned with the national priorities and international best practices to strengthen science, technology and innovation (STI) collaborative ecosystem for Malaysia. The first phase of this initiative is aimed at connecting research data, researches and publication between five research universities, and 15 MESTECC research institutes and agencies.

## 3. Summary

Open science is a movement to make scientific research, data, and dissemination accessible to all levels of an inquiring society, amateur or professional. This includes open access to the outputs of scientific research, such as data and publications. It also provides opportunities for citizen science where the public can voluntarily participate voluntarily in the research process, thus enabling real-world problems to be addressed.

Open Science is about sharing knowledge as early as practically possible in the discovery process' which may lead to a boost in innovation. It does not, however, mean 'free science'. It is therefore essential to ensure that intellectual property is protected before making knowledge publicly available to others that would translate research output into innovation and new technologies.

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OPINION

# The African Academy of Sciences Research Management Programme in Africa

Allen Muyaama Mukhwana[1,*], Thomas Kariuki[1], Simon Kay[2], Angela J. Silva[3], John Kirkland [4]

[1] The African Academy of Sciences, Nairobi, Kenya
[2] Wellcome Trust, London, UK
[3] MultiCare Institute for Research and Innovation, USA
[4] National Institute of Economic and Social Research, London, UK

[*]**Corresponding author email:**
A.Mukhwana@aasciences.ac.ke

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## ABSTRACT

The Research Management Programme in Africa (ReMPro Africa) is an initiative of The African Academy of Sciences (The AAS) which aims to fill critical gaps in the African research ecosystem to support a vibrant research culture and leadership at universities and research institutions. The AAS recognizes that the business of doing research is all-encompassing and the lack of specialist research management profesionals threatens the integrity and quality of research coming out of African institutions. ReMPro Africa aims to transform research management at the institutional level by addressing the key interconnected strands of leadership, sustainability, standards and individual capacity development.

**Keywords:** research management; ecosystems; capacities; standards

## Introduction

The African Academy of Sciences (The AAS) (https://www.aasciences.ac.ke/) has identified research management as a critical gap in building the Continent's research and development ecosystems. In 2017, The AAS set up the Research Management Programme in Africa (ReMPro Africa). ReMPro Africa aims to transform research management at institutional level by addressing the key interconnected strands of leadership, sustainability, standards and individual capacity development.

The development of research management in Africa has been uneven and has generally focused on a limited range of institutions and specific functions (e.g. financial and grants management). This means that other aspects of the research management spectrum, i.e. research strategy and governance, research integrity and ethics, intellectual property, project management, etc. are not developed. ReMPro Africa recognises that research management is strategic and has administrative functions; therefore, to strengthen capabilities requires insight into both dimensions. This means that while considering partnerships and governance, rethinking competencies and career pathways can clearly articulate research agendas which are supported by a research management strategy. To achieve research excellence, research management should be an integral component of the research enterprise.

The AAS recognizes that the leadership and administrative requirements of the research enterprise on the researchers go well beyond the actual conduct of research. These demands, as well as the very substantial obligations of scientific publishing, teaching, supervision and mentorship, are required of researchers in the conduct of their research programmes. Unless professional support is available, these demands threaten to, and in many cases do, overwhelm the quality and quantity of research output. This structure is ineffective and unsustainable.

ReMPro Africa aims to systematically create environments that nurture and leverage research. It is designed to build upon previous initiatives in research management and it was developed through comprehensive consultations with stakeholders across the Continent and the globe in workshops conducted by The AAS in February and June 2018 in Nairobi, Kenya and Edinburgh, UK respectively.

ReMPro Africa is based on five principles to address key systemic issues:

- ***Collaboration within and between African universities and research institutions.*** Such collaboration ensures the sharing of best practices and strategies to address systematic needs such as robust financial systems that serve the research environment. It is also essential to ensure that initiatives are leveraged, and systematic solutions are applied both broadly (across institutions) and ported forward for the long term.
- ***Capacity building using evidence-based benchmarks.*** To address issues that are common across the sector and encourage institutions to develop structures and systems that will affect change.
- ***African leadership supported by global expertise.*** To be effective in and for Africa, it must be a programme conceived and implemented in Africa.
- ***Building on existing structures and expertise.*** There has already been substantive investment to strengthen institutional research management by external funders and institutions themselves. ReMPro Africa will build on these, rather than seek to 're-invent the wheel'.
- ***A long-term approach.*** In some cases, there has been a 'stop-go' approach to research management, reflecting the changing priorities of institutional leaders, national governments and international funders. ReMPro Africa demands a longer-term approach in order to systematically transform research management on the Continent.

With these five principles in mind, four interdependent variables, which constitute the critical success factors for building effective, sustainable research management at an institutional level were identified:

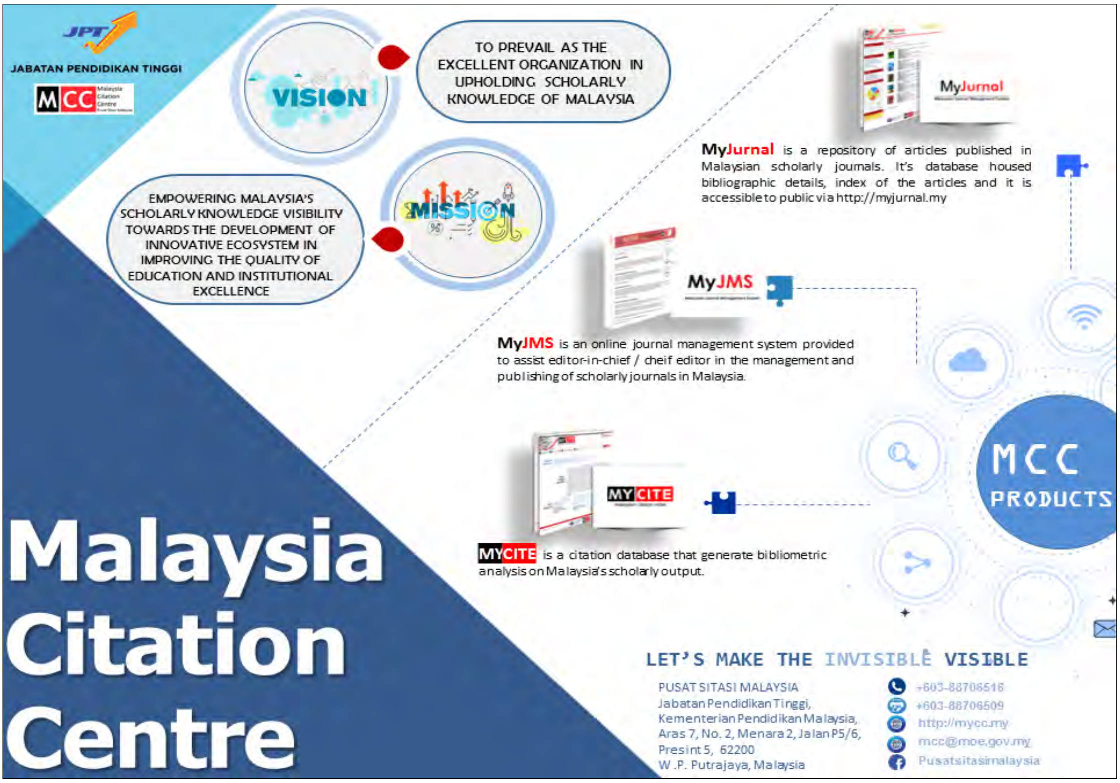
- ***Institutional leadership.*** Awareness and engagement at the leadership level is essential for the continuity necessary to strengthen research management functions across successive generations of institutional leadership and senior academic staff.
- ***Long term commitment.*** Resources must be committed for the long term to ensure sustainability. This includes not just financial resources, but the creation and investment in a career track for research managers in universities. Institutions must sustain research management functions with or without external (funder or government) support, aligning funder policies with research management practices.

- *High quality standards.* Coordinated, high-quality standards and good practices must be created and communicated to all stakeholders within and outside the research institutions.
- *Individual capacity development for research managers.* A respected career track must be established and maintained to promote the profession of research management, supported by an infrastructure of networks and training opportunities, to ensure that the field attracts and retains talent.


Figure 1: is an illustration of the four interdependent variables.

ReMPro Africa's value addition is in harnessing efforts from several initiatives, and where possible, utilising existing expertise to design interventions and tools that will assist institutions to identify their gaps and work to bridge these gaps. An early outcome will be the Good Research Management Practice Standard (GRMP) that is being developed by the AAS to provide a tool for efficient and effective management of research. This is being designed as a self-assessment tool based on pre-defined criteria (standards) and it allows reflection on the gaps and level of achievement. It is expected to be available for comment during the first half of 2020.

As African institutions increase their research activities; and with increased demand for the production of evidence to inform policy, innovations, etc., it is an opportune time to address the challenges in the research ecosystem. ReMPro Africa is providing a systemic solution to the protracted problem of lack of support for the researchers at African institutions by transforming research management.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+603-88706509
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mcc@moe.gov.my
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# INNOVATION AND TECHNOLOGY MANAGEMENT CONFERENCE 2019

ITMC'19
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## INTRODUCTION

ITMC2019 is an inaugural conference organized by the Innovation and Technology Managers Association (ITMA) Malaysia to promote and facilitate the technology transfer and commercialization activities. It aims to provide a platform for academics, researchers, technology transfer officers, industry players and governmental divisions dealing with technology transfer and legislation to share knowledge and ideas, widen networking, present their research findings, experience and expertise as well as to explore any other potential benefits that might contribute to the effective management and utilization of Intellectual Property. International participants from other parts of the globe are most welcome.

## CLUSTER

1. Intellectual Property Management
2. Innovation and Commercialization Strategy
3. Best Practices in Technology Transfer
4. Policy and Legal Commercialization Framework
5. Technopreneurship in the Innovation Ecosystem

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| Normal Presenter | : MYR 700 / USD 200 |
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## IMPORTANT DATES

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| Full Paper Submission Deadline | : 31 July 2019 |
| Camera Ready Paper Deadline | : 15 August 2019 |
| Payment Deadline | : 22 August 2019 |

## CONTACT

itma.malaysia@gmail.com
syedputra@utm.my
hafizb@uthm.edu.my

## SPEAKERS :

**Dato' Norhalim Yunus**
Chief Executive Officer
Malaysian Technology Development Corporation (MTDC)

**Prof. Dr. Samsilah Roslan**
President
Innovation and Technology Management Association (ITMA) Malaysia

**Prof. Dr. Mohd Shahir Shamsir Omar**
Director
Innovation and Commercialisation Centre, Universiti Teknologi Malaysia

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