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Systematic Review of Sustainable Knowledge Transfer Process in Government-Industry-Academia Consortium

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Abstract The purpose of this case study is to understand the sustainability practices of knowledge transfer process at the Malaysian government-industry-academia consortium. At this stage in the research, the R&D consortium is defined as an established entity by two or more organizations that pool resources and shared decision making for cooperative research and development activities. In attempts to understand the formation, outcomes and sustainability of the sustainable knowledge transfer process, this paper conducted a systematic literature review based on Gough, Oliver and Thomas systematic reviews protocol. From the review, the data were enriched and enhanced with a better understanding of sustainable knowledge transfer process. The systematic review resulted in identifying six factors including internal and external perspectives. However, key sustainability factors are not only directly influencing KTP, and the consortium, but are also mediated by other organisational variables.

Keywords Knowledge Transfer Process, R&D Consortium, Sustainability, Framework

I. Introduction

Knowledge transfer process (KTP) within the context of university-industry collaboration (UIC) can interact either in a formal or informal activity, depending on the presence of a contract (Azagra-Caro et al., 2017). Informal activities rely on the idea of establishing the university as knowledge and intellectual creator to produce scientific theories and experimental and statistical. The role of the universities here was to produce a cadre of learners and researchers trained to solve the dilemmas and address the problems and address the various issues with the acquired science and experience in scientific analysis and what they have learned from basic science (Vedovello, 1997). Formal

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activities imply contractually regulated exploitation of the knowledge, expertise and available equipment between the university and industry. The increased recognition of the value of collaborative research for driving innovation and economic growth as part of a formal KTP activity (Azagra-Caro et al., 2017), lead to a change in the strategies of the educational institutions to achieve its mission, including the establishment of UIC centers specialized in cooperation with the industries to conclude agreements with industrial companies as part of formal mechanism of KTP.

Government-industry-academia consortium(GIA consortium) is considered as one of the channels facilitating knowledge transfer activities (Villani et al., 2017). GIA consortia are increasingly used to conduct applied scientific research, often for simultaneously implementing multiple studies that work towards a common goal (Kamps et al., 2017; Rao, 2017). As a result, KTP has emerged to facilitate the integration stage of the created innovation from consortium to the end user. KTP has been studied in a variety of contexts. One of the prominent studies was the one by Szulanski (1996) that has developed a generic conceptual framework to describe the various stages involved in any KTP. Other past studies, such as Autio and Laamanen (1995), Ambrosio (1995), Novak (1992), Rhea (1991), Al-Ali (1995), and Cusumano and Elenkov (1994) have introduced a number of models to address the concept of KTP in an 'organizational' context within the purpose of a GIA consortium. However, sustainable KTP requires active effort from all parties involved. Schiele and Krummaker (2011) proposed a "consortium benchmarking" to support academic-industrial conversation and its relevance to sustainable knowledge creation and transfer. The study also argues that the applicability of sustainable KTP approach is limited by its complexity, time commitment, the cost required, and sustainability factors. Thus simpler, clearer, and feasible mechanisms are needed to promote a sustainable KTP (Schiele and Krummaker, 2011).

II. Research Approach

According to Gough et al. (2012), systematic reviews employ explicit, rigorous, and accountable methods to inform new research questions. Reviewing research systematically involves three key activities: (1) identifying and describing previously published relevant research, (2) critically appraising the research methods, and (3) bringing together the aggregated findings into a synthesis of research findings (Gough et al., 2012). In general, a systematic review is rigorous as compared to a traditional literature review because it uses a systematic approach to search, select, and appraise the produced evidence (Akobeng, 2005; Dixon-Woods et al., 2006), while a traditional literature review

often presents a summary of published research related to a topic of interest without a sorting based on the quality of the study design and methods identified (Boland et al., 2008; McGowan and Sampson, 2005). Following Gough et al. (2012) systematic reviews protocols, this study focuses on KTP and consortium and shedding light on it by examining consortium, KTP in GIA consortium, Sustainability Indicators and Key Sustainable Factors of KTP in GIA. This study also may set the field for an informed debate on using the systematic review as a useful and acceptable research method to analyse the KTP and identify its key sustainable factors.

III. Consortium Analysis

The concept of consortium in government, industry and academia is not new. Theoretically, the idea of consortium relies on collaboration theory (Wood and Gray, 1991) where it introduces the process of collaboration and the formation of collaborative alliances. Moreover, as stated earlier, the consortium as part of the UIC was carried in shape of formal and informal activities (Azagra-Caro et al., 2017). These activities trigger the argument about the existence of a clear definition of R&D consortium (Todeva and Knoke, 2005). The majority of the informal activities were carried as Joint Venture, hence the definition introduced as "two or more firms create a jointly owned legal organization that serves a limited purpose for its parents, such as R&D or marketing", while the formal activities were clearly carried as R&D consortia and introduced as "inter-firm agreements for research and development collaboration, typically formed in fast-changing technological fields" (Todeva and Knoke, 2005). Scholars also define R&D consortium as "legal entity established by two or more organizations that pool resources and share decision making for cooperative research and development activities" (Doz et al., 2000); "an organization or unit within a larger organization that performs research and also has an explicit mission (and related activities) to promote, directly or indirectly, cross-sector collaboration, knowledge and technology transfer, and ultimately innovation" (Lind et al., 2013); and "a structured communicative process of linking scientists with selected actors that are relevant to the research problem at hand" (Roelofsen, et al., 2011).

Creating R&D network necessitate the involvement of both academia and industries. However, a complex R&D collaboration, a consortium, in particular, necessitates the involvement of not only the universities and industries, but also includes the government as motivator and moderator. Considering R&D consortium as a rational platform would help academia, in particular, to carefully select their business partners, and set the limits of their involvement in terms of

resources and responsibility, which would protect the academia, especially with the existence of the government, against the risk of losing legitimacy if its business partner's reputation deteriorates as a result of social or environmental misconduct. According to Ranga and Etzkowitz (2013), supported by Ankrah and AL-Tabbaa (2015), in principle, the institutional consortium formation between the academia, industry and government has three main configurations, (1) government leads the consortium by defining objectives and putting limitations on the interaction between academia and industry, (2) industry becomes the driving force for the consortium, where both academia and government have limited roles, (3) the three actors act as partners aiming for the knowledge transfer to community, where the academia can take the lead in this configuration. Whitley's (2006) study discusses the consortium by its types through comparing the contextual conditions surrounding consortia formation as categorized as emergent or engineered and the predominant perceived benefits of the participants as either networking benefits or risk-sharing benefit, Eisner et al. (2009) carried out with findings and introduce motivation-process matrix of consortium formation Table 1.

Table 1 Motivation-Process Matrix of consortium formation

Consortia Formation Process	Consortium Formation Motivation: Network Cooperation	Consortium Formation Motivation: Risk Sharing Community
Emergent	**Community Builders** No dominant player and no one player can do it alone	**Gamblers** Fears over appropriable of R&D need to be balanced by the lack of resources
Engineered	**Visible Hands** Concerns for legitimacy outweigh lack of technological democracy	**Opportunists** Pay or bribe firms to share vision or have firms pay to explore that vision

Source: Eisner et al. (2009)

The literature review also highlights a different argument about R&D consortium that it cannot be classified in one formal shape (Pinto et al., 2011). This argument started after the pioneer studies of Koza and Lewin (1998, 1999, 2000), where these three studies discuss the abilities of the cooperative

collaboration to support in term of new technologies discovery or can assist on new products commercialisation. An explanation of this argument was through the example given by Rosenkopf and Nerkar (2001) where the study notice that business external business research, away from the organizational borders, might add potential innovation far away from their traditional markets, with business expansion opportunities; while the Rothaermel (2001) study explore the product development integration by including the technological perspective of venture alliances where the study shows the benefits of such external business research on the pharmaceutical industry and the satisfactory results in spite of the core organizational changes happen due to cooperative collaboration.

In line with this argument, Pinto et al.'s study (2011) introduces a few consortia models, namely (1) Learning Collaborative R&D Organizations (LCOs) which "established to explore territories where technologies are either immature or very expensive to develop" (Rothaermel and Deeds, 2004), and its main focus is on pre-competitive R&D (Aldrich and Sasaki, 1995). (2) Business Cooperative R&D Organizations (BCOs) as a model to "help founding firms to establish a successful commercial position in a new market through applied research and commercialisation stages" (Lavie and Rosenkopf, 2006), and its main focus is on competitive and downstream R&D development (Alic, 1990). This model reports some issues as competency issues (Leonard-Barton, 1992) familiarity issues, maturity issues, and propinquity issues (Ahuja and Morris Lampert, 2001). (3) Hybrid R&D Cooperative Organizations (HCOs) model seek to "simultaneously maximise opportunities for both value creation and value capturing" (Koza and Lewin, 2000). HCOs model infect combines the properties from both LCOs and BCOs together with the features of ambidextrous organisations; hence its main focus is in both pre-competitive and competitive, downstream R&D development (Alic, 1990; Hagedoorn et al., 2000). (4) Dysfunctional Cooperative R&D Organizations (DCOs) is a model that "suffer from an effort dispersion expressed in fragmentary activities and unfinished projects" (Copani et al., 2006). The dysfunctional nature of this model reflects some issues like stuck in the middle (Porter, 1980), consensus issues (Fiorino, 1997), low local peaks (Siggelkow and Levinthal, 2003), lack of slack resources (Floyd and Lane, 2000).

Table 2 Design details of Consortia Models

Category	Design Type	Design Context	Supporting Literature
LCOs	Loosely coupled structures, decentralised units and informal relations intended to facilitate creativity, capability development and long-term growth (He and Wong, 2004; Jansen et al., 2006; Nielsen, 2010).	Singular, dominant or dominant set of functions (Gresov and Drazin, 1997). Engineered pattern (Doz et al., 2000)	Aldrich and Sasaki (1995); Mowery et al. (1996); Doz et al. (2000); Mothe and Quelin (2001); Branstetter and Sakakibara (2002); Miotti and Sachwald (2003); Rothaermel and Deeds (2004); Lavie and Rosenkopf (2006).
BCOs	Hierarchical structure, centralised decision making and formal controls and communication to decrease the risk of undesired spillovers and information leaks (He and Wong, 2004; Jansen et al., 2006; Nielsen, 2010).	Singular, dominant or dominant set of functions (Gresov and Drazin, 1997). Emergent pattern (Doz et al., 2000)	Aldrich and Sasaki (1995); Doz et al. (2000); Mothe and Quelin (2000); Rothaermel (2001); Mathews (2002); Argyres and Silverman (2004); Rothaermel and Deeds (2004); Powell and Grodal (2005); Lavie and Rosenkopf (2006); Dodgson et al. (2006).
HCOs	Ambidexterity (Duncan, 1976; O'Reilly and Tushman, 2004; Tushman and O'Reilly, 1996). Combination of Mechanic and organic structures (Burns and Stalker, 1961). Compensatory fit (Gulati and Puranam, 2009)	Multiple, conflicting set of functions (Gresov and Drazin, 1997). Emergent pattern (Doz et al., 2000)	Koza and Lewin (2000); Lavie and Rosenkopf (2006).
DCOs	Implies trade-offs between alternatives.	Multiple, conflicting set of functions (Gresov and Drazin, 1997). Emergent pattern (Doz et al., 2000)	Miles and Snow (1992); Porter (1980, 1998); Lin et al. (2007).

Source: Pinto et al. (2011)

IV. KTP in GIA Consortium

A simple analysis of any GIA consortium recognises the importance of KTP as the main source of competitive advantage, and emphasise the consortium's role as an "innovation creator and economy driver" (Rao, 2017). Considering this need to understand the links between KTP and GIA consortium, this systematic review of relevant literature is an attempt to provide an up-to-date understanding of this research field. The reviewed studies conceptualise knowledge creation in different manners. Shu et al. (2012) consider the two dimensions of knowledge exchange and knowledge combination, to test the influence of knowledge creation on the process innovation. The results from a cross-sectional survey of 270 Chinese companies show that knowledge creation, particularly knowledge combination, positively influences product and process innovations.

Zelaya-Zamora and Senoo (2013) analyse knowledge creation capability as a construct encompassing six dimensions (absorptive capacity, SECI performance, external ties, inter-unit ties, members' commitment and cooperation and trust), which is positively and significantly associated with innovation performance. Spaeth et al. (2010) case study analyses knowledge creation in the context of a push model of open innovation, which is defined as "knowledge creation by external contributors that is uncompensated by the firm , but that pushes knowledge into the open innovation process". Through examining explicit knowledge shared within discussion forums, the authors highlight knowledge creation in open innovation, which is enhanced by "lowering the entry barriers for external participants who seek to join and contribute" (p. 427). Another case study by Iacono et al. (2012) draws attention to inter-organisational relationships for knowledge creation and product and process innovation in the context of temporary project networks.

V. Sustainability Indicators

Nowadays, business, industrial, and even academic performance metrics are shifting from economic-centric performance measures to those of sustainability (Elkington, 1998; Spangenberg, 2004; Jovane et al., 2008). However, sustainability as a new phenomenon was introduced by Elkington (1998) and the study definition of sustainability phenomenology was discussed by adding new corporate perspectives to cover both the economic and the environmental aspects. Sequentially, sustainability began to appear in the operations, management, and business literature'. Similarly, corporates worldwide start to adopt the sustainability principles where, for example, in 2009, World Bank

statistics show that 68 percent of the surveyed corporates in the year 2004 is issuing a separate annual sustainability report to cover their economic, environmental, and social issues. Moreover, it is worth mentioning that sustainability phenomenology have been mentioned earlier in 1987, particularly by World Commission on Environment and Development, as they define it as "development that meets the needs of the present without compromising the ability of future generations to meet their needs", where the argument related to this definition kept confined in the range of the impact of economic and environmental of industries' activity (Erlich and Erlich, 1991), non-renewable resources conservation (Whiteman and Cooper, 2000), food security (Lal et al., 2002), and human rights and needs (Savitz and Weber, 2006), and due to this broad definition, corporate often unable to apply such concept, where the difficulties of identifying its role within the economic system (Shrivastava, 1995a; Stead and Stead, 1996).

The difficulties of applying the sustainability perspective from a macroeconomic view on corporates start to appear in similar time as mention earlier, according to the study of Hart (1995) where the study address the concerns of balancing between future and present needs, and the difficulties of determining the suitable resources required to meet those needs. Starik and Rands (1995) study add in addition to the previous concerns, the requirement of effective understanding of organizational responsibilities toward its stakeholders, employees, customers and suppliers. The focus within the management literature during that time was more one operational, managerial and engineering perspectives, where most of the produced conceptual definitions were related to ecological sustainability with minor recognition implicit of economic and social responsibilities (Jennings and Zandbergen, 1995; Shrivastava, 1995a). In line with these perspectives, Starik and Rands (1995) takes the long-term perspective' of defining the sustainability to be as "…the ability of one or more entities, either individually or collectively, to exist and flourish for lengthy timeframes, in such a manner that the existence and flourishing of other collectivises of entities is permitted at related levels and in related systems".

Shrivastava (1995a) describes sustainability as an offering, "the potential for reducing long-term risks associated with resource depletion, fluctuations in energy costs, product liabilities, and pollution and waste management". The implementations of this ecological perspective of sustainability definitions got popular within the management (Daily and Huang, 2001) and operations (Sarkis, 2001) literature, excepting the social aspects form the definitions (Hill, 2001). In contrast, engineering literature, in term of sustainability definition, have emphasized the organizational, economic, environmental, and social aspects to introduce a encompass definition of sustainability as "a wise balance among economic development, environmental stewardship, and social equity" (Sikdar,

2003:1928) and as including "…equal weightings for economic stability, ecological compatibility and social equilibrium" (Goncz et al., 2007).

The earlier discussion clearly presents the instability of the defining the sustainability where the reviewed definitions were introduced to serve a particular research rather than being a comprehensive definition. As such, the implementing of sustainability definition within the context of consortium shows a lack of explicit provision. This lack might simply be due to the fact the consortium is at the stage of expanding and has yet to reach its maturity (Carter and Rogers, 2008). According to Rothenbery (2007), the adoption of sustainable collaborative research can serve as a driver to improve consortium efficiency, which will increase the potential long-term objectives. However, this study adopts the definition of operational sustainability as the "method of evaluating whether a business can maintain existing practices without placing future resources at risk" (Nawaz and Koç, 2018), which is in line with Scheirer (2005), who proposes that a research collaboration is sustainable if it maintained after the initial funding or other impetus removed, which is as relevant definition to newly established consortium.

VI. Key Sustainable Factors of KTP in GIA Consortium

By combining conceptual and theoretical studies, review and research papers, this systematic review aims to answer the following general research question: What are the key sustainability factors of Knowledge Transfer Process? The multiplicity of views that discuss R&D consortium idea and the lack of a consistent perspective for such consortium eventually led to the adoption of its sustainability factors from the contractual type of R&D consortium (Joint Venture) and similar configurations of R&D consortium. Although the study of Schiele and Krummaker (2011) proposed a unique benchmarking to be applied within the consortium in order to provide a sufficient knowledge creation and transfer between the collaborator such as industry and academia, but the proposed benchmarking was criticised due to the time, commitment, and cost limitation. Thus, this emphasizes the need for clearer and simpler sustainability mechanisms for the consortium.

1. Internal Sustainable Factors

(1) It is obvious that the collaboration contract will consider as the core concern of any sustainability discussion. Parkhe (1993) study introduce the contract as partnership agreement where its completeness will usually be related to the firmness level of the agreement articles. However, the author also

highlights the effect of the contractual completeness on collaboration flexibility where it might affect the exploiting the arisen opportunities from the collaboration. Thus, the core role of the contractual completeness is to ensure the balance between the competitors' opportunistic behaviour and innovation creation. Although this is important, Kaufmann et al. (2006) study, however, carries contradictory results as no significant relationship was reported of contractual completeness and the collaboration as joint venture sustainability.

This argument is mainly about the efficiency of the contracts in research collaborations to limit the competitors' opportunistic behaviour. Hence, contractual completeness implementation in the context of KTP might be challenging, but that would not lose its importance due to the articulation of the contract from one consortium to another and the types of its stakeholders.

(2) Another key factor is the behavioral transparency where this factor actually correlated with the collaborator's behaviour as this behaviour is considered critical to any collaboration success (Buchel, 2003). The core argument of the behavioral transparency is about the absence of trust between the stakeholders due to lack of earlier relationship between stakeholders and to the nature of the peer-to-peer relationship among the heterogeneous collaborators' (government-industry-academia).

Moreover, Buchel (2003) highlight the concerns by providing an example of behavioral transparency when one stakeholder' behavior cause issues (opportunistic behaviour), that might negatively influence the subsequent stakeholders regarding the future of their collaboration (Hill, 1990). The consequences of such behavioral transparency issues eventually lead to either end the collaboration with the untrustworthy stakeholder or proceed with unstable collaboration with high assurances in order to protect themselves against potential risks. Schnaars (1989) study also emphasizes the reputational consequences where it might affect the future benefits of the collaboration. Buchel (2003) study argue the challenge of early identification of the behavioral transparency related issue that been undiscovered due to early failures of the collaboration.

In addition, Schnaars (1989) study also introduces the innovation uncertainty, which might provide the excuse for uneconomical venture happening due to the success probability. The challenges regarding the behavioural transparency are , although the big collaboration organizational structure covers the KTP activities, the project level mostly consists of smaller individual groups where detecting the behavioural related issues might be difficult and costly (Hill 1990). Hence, the method toward avoiding the potential behavioural issue is through the communication where stakeholders can express their concerns about the partner's behaviour. They receive as well a feedback on behaviour transparent, where such willingness, would pass the opportunistic behaviour detection

responsibility to the lower level as is faster and efficient and could prevent such behaviour to occur (Parkhe,1993).

(3) Consensually, the third factor is stakeholders' support where it is considered as the critical sustainability assumption, which is involved directly with the collaborators' perceptions' level, intentions, and actions in order to determine the partnership progress. Such progress in the context of collaboration will occur once the stakeholders succeed to translate the perceptions into useful intentions and actions and contrary the stagnates collaboration as result of poor perceptions translations. As such, the KTP sustainability might be affected by wider context factors, but the stakeholders' support should ensure the stability of such process (Buchel, 2003). Kaufmann et al. (2006) study also highlight the importance of stakeholders' support over collaboration phases due to the continuous varies of the collaboration model according to the project type and need.

2. External Sustainable Factors

Previous studies provide some indications for a direct impact of the external factors on the implementation of sustainability (Boot et al., 2010; Boot and De Vries, 2012). External factors refer in general to environmental factors that motivate R&D consortia and include competition, appropriability, and technological complexity.

(1) The competition was the main argument about the KTP, which according to Sakakibara (2002) is the critical motive of any organization to join the R&D consortia. The role of R&D consortia here is to enhance the organizational abilities through innovation to face the increases in outside competition or what Baum and Oliver (1991) refer to as survival advantages. Survival advantages, however, might be easily explained within a highly competitive industry organization where it vulnerates the organization strategic position (Shan, 1990). While collaboration it considered as improving the mechanism of such strategic position through accessing the collaborators' complementary resources (Mitchell and Singh, 1992), in order to share the costs and risks (Eisenhardt and Schoonhoven, 1996; Kennedy and Keeney, 2009). (2) The appropriability or "imitable and reproducible ability quality" (Hagedoorn, 1996), will mainly highlight the collaboration ability to reuse the outcomes of the generated innovation. (3) Taking into account the nature of the collaboration industry, technological complexity highly affects the firms with related products compared to firms produce and innovate lesser technological complex products (Mitchell and Singh, 1992). A KTP and consortium role here is to moderate the possible failure risk. In order to summarise the previous discussion, Figure 1 represents the conceptual framework resulted from the above discussion.

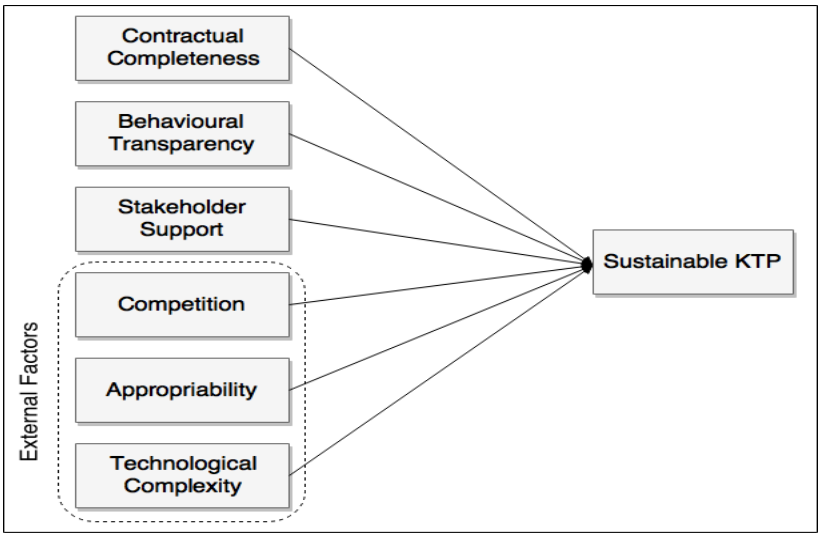

Figure 1 The conceptual framework of this study

VII. Conclusion

This systematic review aims to discover factors of sustainable KTP by considering a yheir relationship with a consortium, as well as to discuss the main literature surrounding it. The review shows that knowledge transfer processes are important to leverage innovation. However, key sustainability factors are not only directly influencing innovation, KTP, and consortium, it is also mediated by other organisational variables. This was evidenced by various case studies (Darroch and McNaughton, 2002; Lin et al., 2012; Zhou and Li, 2012). Otherwise, a newly-established consortium may depend on combinative capabilities, organisational dynamic capabilities, and organisational learning, for short-terms organisational sustainability's (Zhou and Li, 2012). Beside that, this systematic review also provides evidence that the KTP–R&D consortium relationship exists, but it is not always through a direct relationship. This is in line with Du Plessis (2007) who asserted that "knowledge transfer is not solely focused on innovation, but it creates an environment conducive to innovation to take place". This review is limited to published journals with a specific time frame, and further studies are needed to deeply understand and to verify the validity of this relationship and effect of sustainability factors to R&D consortium through sustainable KTP.

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