Original Article

Determinant Factors of Productivity and Innovation Capabilities of Technology Alliances; the Perspective of Knowledge and Technology Alliances in Egypt

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ABSTRACT

Knowledge partnerships, networks, and clusters of businesses and research institutions are all responses to current market potential and need. A broad range of theoretical and empirical research studies have been credited with developing a clearer understanding of the incentive processes for collaboration. In this context, collaboration models differ depending on the scope, stage of development, and kind of collaborative formal or informal economic model chosen. This work reviewed various tested hypotheses of cluster initiatives that utilized a hybrid approach integrating the active involvement of specialized institutions with inclusive grassroots participation. Various factors have been identified that would affect each stage of development including the alliance configuration and the adopted business model as well as the partnerships, type of provided services, type and effectiveness of stimulating interactions and exchanges, business climate and economic situation in the addressed region. Alliances devised by key collaborating institutions with a complementary approach in terms of service or products were found to be more sustainable and scalable than those that attempt solely top-down or bottom-up approaches. The Egyptian model entitled "knowledge and technology alliances, following a hybrid model of collaboration showed coherence with international practices and potential for scalable businesses.

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INTRODUCTION

Innovation alliances and networks have been the key driver shaping the economic development theory and practice since the concept was re-defined in the 1990s with the emergence of more dynamic innovation ecosystems. The terminology of ecosystem originated from biology and environmental sciences and was widely coined into business and economic practices by Moore (1993) using IBM innovation capability as a reference case. The emergent innovation ecosystem concept has then been used by many researchers as well as industrialists and strategists. The developed concept stemmed from a research question "How a predefined business community could drive a specific sector to higher profitability and more defined competitive advantages". This concept is mainly used to assess innovation models, the relationship among several actors within the system and the added value of collaboration ***(Cirera and Muzi, 2020)***.

A large number of theoretical and experimental studies have helped to establish a better comprehension of collaboration incentive mechanisms. The economic development theories among others have significantly influenced businesses and policymakers worldwide in their efforts to re-engineer their economic development concepts. The smart specialization theory proposed by national cluster policies boosted the competitiveness of clusters and even single organizations. The development of new technologies, products, and processes, in partnership with other independent entities, showed to facilitate accessing new markets ***(Amuzu- Sefordzi et al., 2018)***. The innovation partners could be universities, public central labs, other firms across the value chain and startup companies. Several factors are driving a growing embrace of collaborative innovation. Among these factors is the need for technology integration of multiple technologies where no one firm can focus on all development components ***(Mohamed Ramadan A.Rezk, 2016; Radwan and Sakr, 2018)***. The key to success at frugal innovation lies in many factors including the customer-centric approach in designing or redesigning core functionalities and identifying the target end price in addition to leveraging and optimizing the existing infrastructure to achieve cost-effective operations. In this respect, assessment of the entire value chain and redesign of a few particular components could be an essential contributor for exploring pivot opportunities to induce impact on cost, customer value, or cycle time from order to delivery ***(Cirera and Muzi, 2020)***. In this work, the Egyptian model entitled "knowledge and technology alliances (KTA)" is used as a

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reference study for exhibiting the potential of a multi-actor cooperation model that involves civil societies and large corporations together with startup companies and research institutions. Egypt has launched this program a few years ago through the Academy of Scientific Research and Technology and the program gathers at the moment more than 135 small businesses and industrial organizations and a large number of universities, municipalities, non-governmental organisations and local authorities, all in well-structured and organized 14 industry-driven alliances. The program adopts open innovation and frugal innovation principles in supporting cluster operations and stimulates knowledge spillover effects within the quadruple helix innovation model ***(Radwan and Sakr, 2018)***. The program considered scared resources or limited R&D capabilities as an opportunity and driver for effective partnerships which contributes to circular economy practices among firms and also universities and external innovators ***(Radwan and Sakr, 2017; Radwan, 2019)***.

I. Agglomeration and Specialization

Marshall (1919) identified three main factors that could shape the external economies of scale which are specialization, labour pooling, and knowledge spillover. Knowledge and Technology Alliances in Egypt are shown to have a speciality focus including textiles, deepening local manufacturing of pharmaceutical raw materials, solar energy, desalination among other specific industrial fields. The Egyptian model is aligned with the conclusion of Ascani et al. (2020) when they investigated similar practices in Italy. He further indicated that specialization is a key driver to stimulate regional innovation as well as internationalization. On the other front, knowledge spillover together with technology transfer activities are more likely to occur between firms in geographic proximity or networked structures ***(Stanko and Olleros, 2013)***. However, empirical evidence showed that accessibility of services and facilities is more impactful than only geographic proximity. The knowledge and technology alliances in Egypt showed to emphasise the importance of access to facilities and services rather than geographic proximity. Key actors within a specific value chain are commonly considered among the right target groups for soliciting effective partnerships in a specific alliance or cluster. In developing countries and the developed world alike, gaps persist across the value chain in many sectors especially with current dynamics and rapid technology development processes. This wastage created an opportunity for reengineering key elements of the value chain. Furthermore, overlooking the transformation of one element of the chain may require transforming one or more other activities in the chain ***(Stanko and Olleros, 2013)***. This is because, over the last fifty years, value chains across firms have extended beyond national borders often resulting in supply chains spanning through multiple countries. This means that the traditional boundaries that previously existed between firms are now much more fluid.

Agglomeration effects through specialization, labour pooling and knowledge spillover are still prevalent and continue to be the key drivers for successful innovation. However, these three factors are not done in isolation but rather depend on other local elements such as governmental policies, local entrepreneurship and intrapreneurship. As a result, this has to be supported through technological advancement that addresses economic development. This is in line with the concept of smart specialisation when Mr. Jean-Claude Juncker; president of the European Commission, coined the term "smart specialization" in his 2015 State of the Union address. The term refers to the idea that countries should not compete on standards but rather aim to be the best in a few areas, not all. Smart specialization is implemented by building upon regional evidence by supporting higher education institutions that can conduct applied research and develop prototypes. This would allow for the widespread development of the technology and its applications and later, promote its transfer to enterprises (in particular SMEs) in the region

The size of the alliance has been considered by many authors are a key factor affecting the effective agglomeration process and hence the sustainability of the alliance operation ***(Radwan, 2019; Ramadan et al., 2019)***. Agglomeration asymmetry showed also to be sector-specific and oversized alliances and clusters showed less productivity than small to medium size alliances. The Egyptian program for knowledge and technology alliances is shown to have a specific size limit ranging from 10 to 20 members which are aligned by many existing models ***(Ganesh Pillai and Bindroo, 2020)***. Folta et al. (2006) found that the performance of large clusters of biotechnology companies declined significantly with marginal benefits compared to a smaller cluster size of biotech companies in other regions. Similarly, clusters of a high number of competitive firms might result in significantly fewer benefits and hence profitability. Arthurs and Busenitz (2006) found that the older the alliance or cluster doesn't necessarily mean higher profitability but rather several factors are required to enable continuous growth including leveraging further value-based partnerships rather than organic size increase ***(Cirera and Muzi, 2020)***.

II. Spinoffs and entrepreneurial ecosystem

The chances of success of a newly established business are not much different from newly established alliances. Both face particular challenges with respect to growth, operations and acquiring new market niches ***(Amuzu-Sefordzi et al., 2018)***. Radwan (2018) showed that Egypt as well as most North African countries set ambitious goals in their relevant strategic and economic agenda to mitigate the challenges facing alliances and clusters. The impact of new regulatory measures in these regions will not be automatic and it requires stimulus and incentive packages to speed up the development process ***(Ascani et al., 2020)***. The Egyptian model of technology alliances benefited from the central management office for all 14 alliances

which is highly supported by the government through the Academy of Scientific Research in Egypt. The central office provides technical support and more importantly coordination support, evaluation and monitoring as well as technology transfer services. The central office also provides opportunities as well as incentives such as free consulting and training to enable technology firms to increase their capabilities and make their businesses more competitive.

Several researchers assessed innovation clusters in Canada and concluded that small firms with remarkable less fixed assets and qualified specialized personnel could bring additional innovation value compared to highly intense technological facilities. Furthermore, the effects of firm heterogeneity on innovation potential might be non-linear ***(Pe'er and Keil, 2013)*** while the heterogeneity of resources is a viable factor in the active interactions among cluster members. Another important driver is the rapid pace of technology development and the increasing voracity of competition. Many companies find that even in their core areas they need to partner with other companies. On the other front, startups and small enterprises benefit from defined growth paths and survival chances. Coad et al. (2013) analyzed financial statements and sales records of 6247 startup companies in the UK and reported that the more time required for growth, the significant effects on survival chances for startup companies. The Egyptian model for Technology alliances is aligned with the abovementioned approaches with respect to applying open innovation principles and active involvement of small businesses, startups and external entrepreneurs.

Benefiting from network-like structures such as clusters and alliances provides access to nonfinancial resources and more importantly growth opportunities. Furthermore, Nanda and Rhodes-Kropf (2013) highlighted that the investment cycle of venture capital organizations and innovation investment funds is not common to yield significant advantage compared to the shorter investment cycle of partnered SMEs and startups which from one hand reduce operational costs and time for prototyping and experimentation and from the other hand expand further market opportunities ***(Arthurs and Busenitz, 2006)***. The high risk in technology-intensive products requires financial investments in the early stages of market penetration. Furthermore, the lack of sufficient financial resources can be overcome through open innovation networks, given that knowledge-intensive technological projects are more likely to be supported by large firms. In addition, the higher level of cooperation of technology alliances can be a vital source of new business opportunities for member companies.

III. Institutionalization of alliances and clusters

There is no universal code and one type of structure that dominates alliances and clusters formation and operation ***(Speldekamp et al., 2020)***. Formal institutionalization was perceived as an important factor for sustainability and significant impact for involved small businesses which is shaped by inter-dependency, regulated interactions and technology licensing agreements, predefined plans for intellectual property rights, infrastructure provision and capital access. However, informal settings showed also to have a positive impact caused by flexibility, knowledge spillover, openness, less bureaucratic burden and overhead costs. The agglomeration effect showed also to decay faster in informal settings while small businesses were deemed to be vulnerable in large size informal alliances in terms of knowledge absorption due to lower internal capabilities. Formal institutionalization showed also better recognition of alliances and clusters by policymakers, the banking sector and intermediary organizations. The influence of clusters and alliances in policymaking has been evident in many countries. Gautier et al. (2018) introduced earlier the concept of “Diffusion entrepreneurs” as a group of networks or institutions that aim to promote specific policy to maximize its gain. At this point, it is important to mention that a multilevel framework of collaboration also exists between clusters and inside clusters which are more prominent in sectorial and sub-clusters operations ***(Cirera and Muzi, 2020)***.

The design of the Egyptian program for knowledge and technology alliances was based on the results and identified weaknesses from innovation survey addressing 3000 manufacturing firms in Egypt which highlighted the lack of government support, adequate competitiveness policy, insufficient research and development activities and difficult access to resources and information ***(Mohamed Ramadan A.Rezk, 2016)***. The development approaches adopted in the Egyptian model is aligned with previous studies. Djoumessi et al. (2019) assessed the innovation capabilities of 54 firms in Australia and results indicated that the impact of agglomeration is dependent on firm characteristics in harnessing innovations and cultivating new knowledge rather than sole dependence on cluster operational or institutional models. Furthermore, Kim and Hwang (2019) conducted a longitudinal study on 588 firms from three different clusters in Korea and pointed out the importance of the role of research and development in network-like structures which could be indicative of maturity and institutionalized settings of alliances and clusters ***(Amuzu-Sefordzi et al., 2018)***.

IV. Innovation intermediaries

Despite limited evidence from developing countries in literature, industry intermediary organizations showed a central active role in the innovation process. The so-called innovation intermediary actors are shown to have an integral role within the open innovation dimensions either in stimulating knowledge production through research and development or its use through technology transfer ***(Amuzu-Sefordzi et al., 2018)***. This includes consulting firms, technology and business incubators, business accelerators and business development centres. This is in alignment with the Egyptian model of technology alliances

in adopting open innovation practices allowing Intra and inter-exchanges among firms, research institutions and intermediaries which could form the basis of an active local innovation ecosystem. Hendry and Brown (2006) assessed these intermediaries in the United Kingdom-based on their function in a way to resemble a local innovation system. Howells (2002) among other authors stressed on the importance of the variety of innovation intermediary actors, service providers within a local innovation system that would allow smooth interactions and speed up the development process ***(Folta et al., 2006; Aldieri et al., 2020)***. Other functions were identified as essential for technology development including business forecasting, prototyping and the test of novel ideas, the protection and use of intellectual property rights while on the other front standardization, accreditation and regulation support were deemed more essential for expanding operations and strengthening exporting capacity ***(Marshall, 1919; Speldekamp et al., 2020)***. V. Impetus from the government and institutions

In the innovation alliances model, it is not enough for knowledge or technology to diffuse as a result of market forces alone. The government plays a pivotal role in creating an environment that would allow the diffusion process to take place, especially through facilitating access to resources and the development of human capital by removing policy barriers that would hinder such exchanges. In addition, universities play a pivotal role in providing state-of-the-art research facilities while the public sector provides funding for R&D activities, support agencies that provide expertise and advice, incubators that encourage entrepreneurship and provide venture capital. All of these elements are recognized as being necessary for the innovation process by other authors who emphasize the pivotal role of government in promoting regional innovation if not open to a variety of other stakeholders. The ideal partner in a specific alliance or cluster organization is one that is complementary and poses little risk of becoming a competitor. Sometimes, however, firms have little choice but to work with frenemies, firms that are competitors, as well as collaborators ***(Nanda and Rhodes- Kropf, 2013; Ascani et al., 2020)***. Apple and Samsung, even though they compete voraciously in the smartphone market, Apple also relies on Samsung for some smartphone components, such as display panels and memory chips. In terms of managing a collaborative relationship, having a clear framework agreement including technology transfer upfront agreements, regarding who will contribute what, who will own what, how the resulting intellectual property will be shared, and how decisions will be made, and conflicts resolved ***(Wonglimpiyarat, 2012; Holgersson et al., 2018)***. This could be facilitated by intermediary organizations in small-size alliances or through a central management and coordination office as being operationalized in the Egyptian model. It's also crucial to cultivate trust while keeping a coordination measure in place.

CONCLUSION

Alliances devised by key collaborating institutions with a complementary approach in terms of service or products were found to be more sustainable and scalable than those that attempt solely top-down or bottom-up approaches. The Egyptian model “knowledge and technology alliances, following a hybrid model of collaboration, showed coherence with international practices and potential for scalable businesses. Agglomeration asymmetry shall be carefully considered in the formation and operations of alliances. The Egyptian model showed that accessibility of services and facilities is more impactful than only geographic proximity. Size of alliances is a sector-specific requirement and oversized clusters could limit the chances of success. The performance of large clusters doesn’t necessarily yield more impactful results. Sustainability measures and exit strategies could be facilitated by the central management and coordination office. Policymakers are advised to factor in the characteristics of the local system while formulating strategies for improving the innovation capabilities of the manufacturing sector. The need for effective promotion of technology alliances or clusters is evident to ensure sustainable growth in technological production capacities with particular enhancements in performance and competitiveness of developing countries' manufacturing sectors. In this context, successful collaborations require a clear framework agreement, trust, and a coordination measure in place.

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CONFILECTS OF INTEREST

There are no confilects of interest

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الملخص العربى

العوامل المحددة للإنتاجية والإبتكار في التحالفات التكنولوجية، منظور تحالفات المعرفه والتكنولوجيا في مصر

عمرو رضوان ومحمود صقر

أكاديمية البحث العلمي والتكنولوجيا

تعتبر تحالفات وشبكات الابتكار المكونة من مجموعات من الشركات والمؤسسات البحثية رافد هام من خطط التنمية التكنولوجيا على النطاق القومي او الإقليمي وهي واحد الركائز الأساسية للاقتصاد القائم على المعرفة. وفي هذا السياق، تتفاوت نماذج إدارة تحالفات وشبكات الابتكار وفقا للنطاق الجغرافي واوجهه التنمية المختلفة ونوع النموذج الاقتصادي المعتمد للتعاون. يناقش هذا البحث الفرضيات المختلفة والمجربة لمبادرات دوليه واقليميه والتي استخدمت نهجا اداريا مختلطا يسمح بإدماج مشاركة المؤسسات الصناعية والشركات الصغيرة والمتوسطة بالإضافة الي منظمات المجتمع المدني والقطاع العام.

وقد تم تحديد عوامل مختلفة تؤثر على كل مرحلة من مراحل التنمية، بما في ذلك اوجه تشكيل التحالف ونموذج الأعمال المعتمد، فضلا عن الشراكات ونوع الخدمات المقدمة ومدي فعاليتها، ونوع التفاعلات المحفزة والتبادل التجاري والحالة الاقتصادية للمنطقة والقطاعات المستهدفة. وقد تبين أن التحالفات التي تخضع لنهج تكاملي لسلاسل القيمة بين الاعضاء في الخدمة أو المنتجات أكثر استدامة وقابلية للتوسع. وقد أظهر النموذج المصري المعنون "تحالفات المعرفة والتكنولوجيا" اتساقا قويا مع الممارسات الدولية بالاضافه الي إمكانية فعالة لتحفيز أنشطة ابتكاريه وتسهيل الأعمال التجارية.