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The Ann Arbor SPARK - Network Intelligence as a driver for the emergence of a next generation science and technology park

Abstract

In this article, we review the evolution of the phenomenon known as science and technology parks (STPs) as an instrument designed to spur innovation and entrepreneurship at the level of a regional ecosystem. We develop a concept of the next generation of STP, or STP 2.0, as a network of co-located entrepreneurial firms and as a vital node in the value creation networks in a region. We build our definition based on diverse value creation networks such as examples in Triple Helix and Knowledge Triangle. We analyse the human and social factors related to the effectiveness of utilising networks for innovation towards diverse goals in the paradigm theorised as Network Intelligence Framework, Then, we describe the creation and evolution of Ann Arbor Spark as an example of SPT 2.0 focusing on its organisational design as a community platform, its culture of networking across the silos of research and industry and specific projects designed to accelerate time from labs to markets in the post-industrial region of the Rust Belt Michigan in the US. We end the article with a list of conclusions that can inform the design of new and the transformation of existing STPs designed and managed primarily as a real estate investment under the false assumption that the pure co-location of entrepreneurial agents in a physical location spurs innovation and entrepreneurship.

Keywords: Innovation, entrepreneurship, science and technology park, Triple Helix, Knowledge Triangle, Network Intelligence, Network IQ, Industry 4.0

Ann Arbor SPARK – Network Intelligence clau en l'emergència de la nova generació de parcs de ciència y tecnologia

Resum

En aquest article, revisem l'evolució del fenomen conegut com a parcs científics i tecnològics (STP) com un instrument dissenyat per estimular la innovació i l'esperit empresarial en el nivell d'un ecosistema regional. Desenvolupem un concepte de la pròxima generació de STP, o STP 2.0, com una xarxa empresarial de firmes ubicades en proximitat i com un node vital en les xarxes de creació de valor en una regió. Construïm la nostra definició basant-nos en diverses xarxes de creació de valor, com ara exemples a Triple Hèlix i el Triangle del Coneixement. Analitzem els factors humans i socials relacionats amb l'eficàcia de la utilització de xarxes per a la innovació vers objectius diversos en el paradigma teoritzat com el marc d'intel·ligència connectada, i després, descrivim la creació i l'evolució d'Ann Arbor SPARK com un exemple de SPT 2.0 centrat en el seu disseny organitzatiu com a plataforma comunitària, la seva cultura de xarxes connectant centres aïllats de recerca i la indústria i projectes específics dissenyats per accelerar el temps dels laboratoris als mercats de la regió post industrial de la Rust Belt Michigan als Estats Units. Acabem l'article amb una llista de conclusions que expliquen el disseny de nous parcs i la transformació dels STP existents dissenyats i gestionats principalment com una inversió immobiliària sota la falsa suposició de que la mera localització propera d'agents empresarials en una localització fisica és suficient per fomentar la innovació i l'esperit empresarial.

Paraules clau: Innovació, emprenedor, parc de ciència i tecnologia, Triple Hèlix, Triangle del Coneixement, Intel·ligència connectada, Xarxa IQ, Industria 4.0

Ann Arbor SPARK – Network Intelligence clave para la emergencia de la nueva generación de parques de ciencia y tecnología

Resumen

En este artículo revisamos la evolución del fenómeno conocido como parques científicos y tecnológicos (STP), como un instrumento diseñado para estimular la innovación y el espíritu empresarial en el nivel de un ecosistema regional. Desarrollamos un concepto de la siguiente generación de STP, STP 2.0, como una red empresarial de empresas situadas en proximidad, y como un nodo vital en las redes de creación valor en una región. Construimos nuestra definición basándonos en diversas redes de creación de valor como por ejemplo la Triple Hélice y el Triángulo del Conocimiento. Analizamos los factores humanos y sociales relacionados con la eficacia de la utilización de redes para la innovación, hacia objetivos diversos en el paradigma teorizado como el marco de inteligencia conectada, y después describimos la creación y evolución de Ann Arbor SPARK como un ejemplo de SPT 2.0 centrado en su diseño organizativo, como una plataforma comunitaria, con su cultura de redes conectando centros aislados de investigación e industria, y proyectos específicos diseñados para acelerar laboratorios en los mercados de la región post industrial de la Rust Belt Michigan en los Estados Unidos. Acabamos el artículo con una lista de conclusiones que explican el diseño de nuevos parques y la transformación de los STP existentes, diseñados y gestionados principalmente como una inversión inmobiliaria bajo la falsa suposición de que la mera localización cercana de agentes empresariales en una localización física es suficiente para fomentar la innovación y el espíritu empresarial.

Palabras clave: Innovación, emprendedor, parque de ciencia y tecnología, Triple Hélice, Triángulo del Conocimiento, Inteligencia conectada, Red IQ, Industria 4.0

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Introduction

Entrepreneurial innovation ecosystems spring from a combination of factors present in a region that when combined and cultivated can produce an environment that leads to spurring of entrepreneurial firms (Freeman 1987; Lundvall 1992; Tataj 2015; Granstand and Holgersson 2020). Entrepreneurial innovation ecosystems can be framed at different levels of territories (local, regional, national) and in certain economic sectors (Freeman 1987; Lundvall 1992). Heijs (2001) determines four groups of elements to consider. First, companies, their system of relationships and market structures; secondly, public and private infrastructures dedicated to supporting innovation; third, public actions focused on innovation and technological development, and related public policy actions; and fourth, the legal context.

An STP is a vital element of entrepreneurial innovation ecosystems. It is an instrument designed to accelerate the emergence of such ecosystems. In this article, we propose to analyse an STP as a node in the local innovation network of networks. This analysis is different from the intentional intervention when an STP is created solely as a physical environment, a set of buildings, or a campus, where a range of R&D services is provided to support start-ups and local industry. The prototypical STP, which we call STP 1.0, was originally conceived as a real estate investment where the co-location of industry and start-ups was expected in itself to co-create knowledge spillovers and accelerate the time from labs to markets. We firstly review the literature and the evolution of the phenomenon known as science and technology parks and then demonstrate that Ann Arbor SPARK is the next generation of an STP or STP 2.0 which we earlier conceptualised using network science approaches.

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

Literature review

Castells and Hall (1994) relate the territorial element of STPs to regional development and the creation of synergies, factors that can have a catalytic effect on regional and national economic growth (Link and Scott 2006). Other authors claim, however, that there is no evidence of a conclusive result for the role of STPs in regional development (Wallsten 2004). The lack of methodological homogeneity has been a limitation in measuring the value of STPs in the development of the local and regional knowledge economy. However, advances in proposals of useful performance measurement systems for understanding innovation ecosystems are underway (Dabrowska and Ferreira 2020).

Other studies consider STPs to be relevant tools for setting up innovation systems that will help set up new ecosystems that Basile (2011) categorises as inter-organisational. Different case studies defend the role of these ecosystems concerning STPs in the case of Europe (Nauwelaers, Kleinbrink and Stancova 2014), China (Sutherland 2007), Japan (Edgington 2008), or in the case of the Technopoles in Canada (Cooke 2001). The existence of disciplinary, institutional, organisational and cultural boundaries in the context of innovation has also been analysed, together with the relevance of breaking boundaries for better and improved ecosystems (Ziman 1991; Hill and Turpin 1993).

Leydesdorff and Etzkowitz (1996), Etzkowitz and Leydesdorff (1997), developed the model of the Triple Helix, to explain the system of relationships between the university, the business, and the government, which, at the same time, allowed a better understanding of the relationships that existed between the main components of science, technology, industry, and the business system. A key point of this model refers to the understanding of the relational dynamics established between the different components of the helix and the evolution between

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

organisations and institutions. Traditionally they worked separately, and later they advanced toward a system that overlaps each other. In the conception of this model, the authors gave a preponderant role to the universities as institutions of knowledge production. But Schumpeter's (1939) entrepreneurial model was also taken into account, which incorporates knowledge, education, the whole business system, and related public policies.

Another feature is that the three main components of this model are involved at different levels in the production, promotion, transfer, and dissemination of knowledge. This allows a better efficiency as a system but a greater complexity in the management of the interface. This requires understanding the processes of interrelation, the capabilities, and the contribution of each agent of the system in the configuration of a complex and dynamic ecosystem. The ecosystem works through agreements, network configuration, and experimenting with new hybrid organisations that emerge from evolving relationships among the members. The management involves the talent of the people who make it up, the material resources that can be captured, and the understanding of the dynamic relationship between the organisations that make up the Triple Helix (Piqué et al. 2005).

Some STPs have the ingredients to be considered entrepreneurial innovation ecosystems, a factor that brings us closer to understanding the Triple Helix Model in this context. And beyond that, some STPs can also be considered within the Quadruple Helix Model, or at least, they incorporate important stakeholders for the configuration of a Quadruple Helix (Nauwelaers, Kleibrink and Stancova 2014). The Quadruple Helix is an evolution of the previous model of the Triple Helix referenced above, which incorporates the social elements into the equation (Carayannis and Campbell 2012).

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

Entrepreneurial innovation ecosystems within and around STPs are generally the result of the creation of a tacit collaborative, tightly knit locally and loosely coupled globally environment in which diverse players of the Quadruple Helix work together in an open innovation paradigm (Chesbrough and Teece 1996; Etzkowitz and Leydesdorff 2000; Chesbrough 2003; Tataj 2015). In many cases, areas of innovation through their collaborative intentionality become physical and digital "spaces of place and flows" that are more integrated with their surrounding city or community and as a result more recognizable to the community-at-large (Castells 2009). Their capacity to bring together, connect and build social networks of diverse actors of innovation creates different types of relatedness between them (Farinha et al. 2019). This relatedness creates a social structure enabling a cultural transformation that underpins the economic revival of post-industrial regions (Farinha et al. 2019).

A few decades ago, Freeman (1987) and Lundvall (1992) pointed out that innovation must be located at the centre of the analysis together with several elements that have to be incorporated such as the Economy, technology, organisations, institutions, and social issues. The ecosystem of stakeholders can play a relevant role in the business environment of the region or territory where they operate. But the impact on the territory does not have to be solely economic results for companies and the economy as a whole, but also labour, social and cultural impact on the community. These aspects, additionally justify the participation of public institutions in the development of these instruments and the processes of interaction and networking between the different agents involved in innovation (Guadix et al. 2016).

Martínez-Cañas, Ruiz-Palomino and Sáez-Martínez (2011) use the relational perspective (Dyer and Singh 1998) and the theory of social capital (Westlund 2006), to analyse the interactions and networking processes that occur among all the agents (internal and external) participating in STPs. The authors found a powerful generation of social capital and value for firms, but

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

instead, this social capital did not necessarily help the creation and/or technological improvement of new products.

Communities and networks can also be seen in the analyses carried out on the different "modes" of knowledge production. Mode 1 of knowledge production is what is observed in the research activities of traditional universities. Mode 2 is when the knowledge generated in Mode 1 is applied and implemented (Gibbons et al 1994; Etzkowitz and Leydesdorff 2000). Mode 3 adds innovation networks, knowledge clusters, and STPs, as well as interactions among them (Carayannis and Campbell 2012).

In another analysis, STPs are recognised as key instruments in the networking system of innovation and with the capacity of increasing the innovation output (Basile 2011). From a different perspective, networks allow for knowledge sharing between companies and participating agents, but by contrast, opportunistic strategies are detected in other companies that do not necessarily create value for the community (Chan, Oerlemans and Pretorius 2009).

The evolution of the STP phenomenon

One of the key actors in the Triple Helix as well as in the Knowledge Triangle is STPs. When analysing STPs such as Ann Arbor Spark, it is important to know the evolution of the STP phenomenon. Three generations of STPs have been reported (Allen 2007). The first generation was based on the traditional model of science push, where investment in science preconceived expected results. The second generation focused on science, technology, and demand-pull. The demand factor predominated, and projects were developed based on these variables. The third generation sophisticated these previous models with the incorporation of interactive factors and better communication between the main agents involved at different levels: universities generating research and new knowledge, companies that demand existing knowledge but at the

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

same time generate their private knowledge within the company, and governments developing public policies that encourage interactions among the different actors involved. Local and regional agents, and the different processes of innovation from local to global, are expected to occur because of the development of the activities planned. Moreover, better management of interactions, processes, and their community environment is found. Another element that is detected is a more urban location of the third generation of Parks compared to previous generations that were more suburban (Annerstedt 2006).

Some aspects of the third generation have been controversial in terms of the ability to achieve results and meet goals as set out below. Therefore, the analysis of successful projects is necessary to advance the research, strategies, and management models that allow an advance of these instruments and the models that determine the new generations of STPs. The Ann Arbor SPARK case analysis seeks to contribute in this direction.

Within the International Association of Science Parks (IASP), there has been in recent years a discussion on models and case studies presented in the IASP annual conferences, which led to a rename of the IASP. And also, a redefinition of concepts with the added name of "Areas of Innovation" as an evolution of the name they already had previously (Davis 2013). Thus, the definition of Areas of innovation in the IASP became the following: "Areas of innovation are places designed and curated to attract entrepreneurial-minded people, skilled talent, knowledge-intensive businesses, and investments, by developing and combing a set of infrastructural, institutional, scientific, technological, educational and social assets, together with value services, thus enhancing sustainable economic development and prosperity with and for the community." (IASP 2021).

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

Community and cooperation aspects have been analysed within the STPs to find out the relevance of being a partner, promoter, or tenant of an STP. Richard Florida (2004) explains the importance of the community factor, both in economic, social, and cultural aspects, focusing on what he calls the creative class. Paul Romer's idea of the Hybrid Economy observes formulas of economic development in the relationship between science and the market, with a fundamental variable that is what type of community is involved in the development of the specific territory analysed (Romer 2000).

Institutions, together with personal and professional talent, collaborate and cooperate with both internal and external agents to build the community. People and their organisations and institutions such as universities, research, and technology centres, start-ups, small, medium, and large companies, workers, users, or customers, are interrelated agents, and are interdependent (Etzkowitz and Leydesdorff 2000; Bellavista 2002; Bellavista and Sanz 2009).

Aspects of collaboration and cooperation are also addressed by country as in the case of STPs in Spain (Díez-Vial and Montoro-Sánchez 2016), Japan (Fukugawa 2006), or China (Jongwanich, Kohpaiboon and Chih-Hai 2014). Being in an STP improves cooperation relations in innovation and the intangible benefits that come from the diversity of relationships that are established within STPs (Vásquez-Urriago et al. 2016). Also, the localisation of New Technology Based Firms (NTBFs) in STPs entails the capacity for cooperation and growth (Ferguson and Olofson 2004).

Other studies have analysed the relevance of the specific involvement of universities in STPs, which represents positive results in the number of patent applications, but instead negative results concerning the innovation sales of STP tenant companies. Moreover, in those analyses,

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

no obvious improvements are detected, in the cooperation relations of the companies located in the STP with the university (Albahari et al. 2017).

Link and Scott (2007), entered the controversy by stating that the models of university research parks in the US were not a relevant instrument of the US innovation system, but accepted that what was needed was further research on the subject and an in-depth analysis of the state of the art. On the other hand, despite these limitations, they detected a relevant role for STPs in the flow of knowledge between universities and industry and even predicted a more important task for STPs in the future with shorter technology life cycles and a more productive relationship between the actors involved.

Methodology: Towards a definition of an STP 2.0, Network Intelligence and the human social factors

The analysis of the evolution of the STPs shows the emergence of "STP 2.0" which we define as an STP that is a strong network node in the local innovation ecosystem for community cooperation, collaboration, and networking and connects local actors with the global value chains and flows of knowledge, talent, and capital. We analyse the emergence of the Ann Arbor Spark as an example of an STP 2.0. We highlight specifically one key success factor that is the leadership capacity to cooperate, collaborate and network both locally and globally at the level of the entire ecosystem of local actors representing the Triple Helix and Knowledge Triangle.

To define the next generation of an STP, or STP 2.0, we propose to utilise the model of an entrepreneurship-driven Knowledge Triangle (Tataj 2015). According to this model, innovation, and entrepreneurship, as a basis for innovativeness and competitiveness, are accelerated through the networking capacity of actors from the Knowledge Triangle which is formed by agents representing research, education, and innovation. These agents are brought

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

together into high-performance networked organisations (e.g., partnerships, consortia, communities) by entrepreneurial talent with a networking capacity to co-create and scale-up solutions across the silos of the Knowledge Triangle. A typical example of a Knowledge Traingle network is Knowledge and Innovation Communities co-created and co-funded by the European Union through the European Institute of Innovation and Technology.

A definition of an STP 2.0 as a node in a Knowledge Triangle should be conceptualised as one type of a value creation network — both at the level of an internal organisation (a network of co-located firms) and the regional or international level — as a node in an innovation ecosystem global architecture.

Conceptualised as a network in itself and as a network node, an STP 2.0 shares common features with other networked organisations when it comes, for example to the architecture and structure of human social networks, organisation of work (e.g., teaming capacity, collaboration across organisational boundaries), and dynamics of organisational change. If so, we can look at STP 2.0 as an organisation of interconnected networks of co-located firms, which have different importance and functionality and a temporary status in the STP. The STP 2.0 as a meta-node of this network adapts constantly to a volatile environment through its capacity to self-reconfigure its position and the network architecture around them. Scalability, one of the characteristics of networked organisations, entices that the STP 2.0 as a node in a regional ecosystem, can constantly expand by adding additional nodes (e.g., firms). The operational ability of such a dynamic organisation that is constantly expanding or shrinking is based on strengthening or foregoing the ties (both strong and weak ties) through communication (online and offline) with other organisations and individuals. Given that an STP 2.0 is connected with other STP 2.0 in a network, every single node can reproduce itself in different locations as it comes with the DNA encoded in every network node, enabling it to reproduce the program and programming

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

of the entire network unless connecting points are physically eliminated, breaking the network as a unit.

Utilising the network science to develop a definition of STP 2.0 means taking into consideration the human, social and cultural factors related to both management and leadership of an STP 2.0. as an innovation network (internal processes and organisational culture), and as a node of an innovation network (external processes especially driving collaboration with other actors of Knowledge Triangle networks). Therefore, the management capacity and leadership style are vital for the design and execution of public and private policies focused on investment in STP 2.0 as an instrument for innovativeness, competitiveness, and transformation — especially when we focus on post-industrial regions and the much desired digital and green transformation to the carbon-neutral economy which is at the top of policymakers and business leaders.

In the post-Covid workplace, the emergence of entrepreneurial innovation ecosystems is conditioned to an ever-larger extent than before the fundamental digitalization of the workplace, by the networking capacity among actors from the four silos of the Knowledge Triangle. The networking capacity has a special dimension, which is the networking of entrepreneurial firms as they are often a missing link in several post-industrial regions and objects of diverse policy interventions and public investment.

To utilise the implosion of global value chains caused by the pandemics, an STP 2.0 can be a policy instrument to accelerate innovation and lead to greater competitiveness as well as a vital tool for embracing a shift from old to new economy models especially based on circularity, near-shoring, hard tech for manufacturing regions shifting towards a “build forward better” philosophy (European Commission 2022). An STP 2.0 should therefore exceed the paradigm of a real estate investment and become a vital node in the regional innovation ecosystem

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

fostering a mission for a more sustainable and inclusive society and economy. In this context, a key element of a successful STP 2.0 is the human factor.

The human factor in the context of an STP 2.0 means a set of specific skills (foremost digital skills) which underpin the utilisation of networks for innovation and an entrepreneurial growth mindset. This networking capacity has been defined by Tataj as a specific type of human and collective intelligence; the network intelligence and codified through the Network IQ competency model which defines 7 core digital skills for a baseline network literacy, that is an ability to procure benefits networks offer and be of value to other network members; 5 types of profiles clustered around objectives for engaging in networking activities, and a Purpose — Network — Fit framework as a process to assist in building a human social ecosystem along a shared mission for individuals and groups to accelerate innovation and entrepreneurship.

Network intelligence allows us to get a deeper understanding and empirically develop value creation networks. Such a value can be defined, for example, as the relative value of its members as nodes of the original network by developing their capacity to become linking agents to other networks or by creating multiple, overlapping, and multi-layered connection points with other relevant networks and including members of the original, through projects leading to adding value and their status as connectors. The pioneering empirical work with value creation networks in Spain, the UK, and The Netherlands sheds some light on further research on what kind of skills are needed to unleash collective intelligence and drive transformation by accelerating high-impact innovation and entrepreneurship projects within value creation networks.

The research on Network IQ individual skills conducted among a limited sample of STP managers from the IASP in 2020, shows that the self-perceived effectiveness of utilisation of

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

networks towards 17 diverse objectives significantly exceeds the standard level at the ecosystem composed of a set of different networks (e.g. university, business-academia partnerships, government, and business) — all of which share a similar mission to activate and build the ecosystem for innovation (IASP 2020). Further analysis of this data could demonstrate in which of the 5 Network IQ profiles (Trader, Connector, Buddy, Builder, and Innovator) lie strengths of the STP community and what is the relation between their networking effeteness and the level of 7 Network IQ skills.

Leadership is a key component for the performance of networked organisations and teams working in fully digital or hybrid mode, especially in the knowledge sector (Katz et al. 2004). The interactions and dynamics that are created in groups and networks of different types also get good results thanks to proper leadership (Kouzes and Posner 1995). Moreover, it is important to analyse the influence of not only leaders but also followers on interpersonal and group dynamics, and thus better understand the role of leaders and their outcomes (Dinh et al. 2014).

What happened in Ann Arbor: "sparking" the birth of an STP 2.0

This part of the article will look at the Ann Arbor SPARK as an example of an STP 2.0. We argue that there are two success factors related to the networking capacity across the silos of the Triple Helix and Knowledge Triangle networks and an entrepreneurial growth mindset underpinning the effectiveness of utilisation of networks.

The SPARK case study illustrates a development of a transformative, new generation STP which throughout 2011-2020, triggered a transformation of an ecosystem by enabling the development of an entrepreneurial community in the post-industrial manufacturing region of

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

Michigan in the United States, at the heart of the highly industrialised region, commonly referred to as the "Rust Belt".

The SPARK STP community has become the seedbed for 352 in-company projects resulting in $1.6 B in new capital investment and 9000 new jobs and yielding 732 start-ups employing 2600 FTEs (Ann Arbor SPARK 2021). This new generation science park is a community platform designed to accelerate the transformation of a post-industrial region into an entrepreneurial innovation ecosystem and connect the global flows of knowledge, talent, and investment in the transformation of the manufacturing sector's global value chains into Industry 4.0.

On the one hand, in the case of SPARK, there was an intentionality to network diverse actors of innovation both locally and globally from the very origins. On the other hand, leaders within each of the silos of the value creation networks shared a mission not only to drive innovation and entrepreneurship but also to drive change from the old to the new economic paradigm. In this context, SPARK was set up as a "space of places and a space flows', intentionally networking and consciously influencing the ecosystem beyond its boundaries. The key element of this intentionality was personal leadership from members of the value creation networks which over time has evolved into continuing institutional leadership to build and manage networks fit for a purpose, to systematically invest in networking to keep social connectivity and expand local networks, to orchestrate projects based on communication and collaboration protocols and finally to influence the Knowledge Triangle and have agents from research, education, and innovation co-create entrepreneurial projects faster.

The SPARK case is important as there are hundreds of cities and metropolitan areas, both in the developed as well as in the emerging economies, that could benefit from creating similar next-generation STPs. Research on Ann Arbor SPARK can inspire transformation and provide

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

concrete recommendations both for leaders and policymakers on smart investment into the R&I ecosystem. In the case of Ann Arbor SPARK, both the university, local business leaders, and government set up a funding model and a governance system so that Ann Arbor SPARK has not become yet another real estate investment project but a vibrant change agent driving the shift from the old automobile Michigan industry into the new Industry 4.0 based on digital technologies such as AI, blockchain, smart city sensor systems.

The contribution of innovation ecosystems is both economic and societal and creates a virtuous cycle that advances the well-being of a surrounding community. Existing businesses benefit from the presence of the customer base that the technology workforce represents and through the increased vibrancy that a daily workforce represents that is a magnet for other customers. At a macro-level for the local government entity, revenues are increased both from the rising value of the occupied buildings and the economic activity of the workforce, creating a virtuous cycle of reinvestment in services and capital projects that, in turn, encourage more locations by early-stage innovative companies who are drawn to the environment.

For the business, the clustering of talent is important. A variety of studies in the USA indicate that more than 65% of young people pursuing careers in innovative and creative fields choose where to live first before who to work for. And their choice globally has become more urban, with a desire to live in vibrant areas — an essential consideration for deciding in which surrounding community to place a new innovation ecosystem (Florida 2004).

Before 2005, the Ann Arbor region (population 330,000) could best be characterised as one of unmet potential as a place of innovation. Unmet both in terms of economic and societal impact, despite the rich assets that should have made it a hotbed of innovation and innovative companies. Year after year, the University of Michigan deployed the largest research budget of

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

any public university in the US with annual expenditures now exceeding $1.5 billion, yet it lagged in technology transfer, licensing, and company formation (University of Michigan 2020). The university had a renowned international reputation and attracted students, faculty, and researchers from all over the world. The region was also blessed, with many high-net-worth individuals and families from Southeast Michigan's legacy as the United States' first "Silicon Valley". Ann Arbor was and is one of the most attractive communities to live in not only in Michigan but in the US with a highly educated populous, high quality of life, and in comparison, to US norms a relatively low cost of living and cost of doing business.

However, these potential assets were underperforming at the beginning of the 21st century. Entrepreneurship and the creation of new companies, and the commercialization of an incredible number of new ideas of product and processes coming out of the University of Michigan was lagging when compared to other areas of the US. Those that did emerge migrated to the communities like Boston or the San Francisco Bay Area where there was a nurturing environment of capital, talent, and serial entrepreneurship was in abundance. So much like a "potential' viticultural area with good soil, climate and geography are lying dormant and overgrown with weeds, Ann Arbor needed several "vintners" to recognize its potential and to intentionally intervene by introducing appropriate varietals with modern growing techniques with well capitalised support systems to bring the product to market and to maximise its potential.

The efforts to change this were centred around the University of Michigan, starting from 2002. In addition to a student body of 50,000 undergraduates and 20,000 graduate students and post-doctoral researchers, the University has over 500,000 alumni living and working all over the world. However, of note was the university's low ranking in technology transfer across all metrics in patents, licensing, and commercialising promising research.

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

To assess what was not working and to build a strategy to move the University into full engagement with the local, regional, state, and national economies, the university convened a national advisory panel, which consists of experts in technology transfer from universities around the US, venture capitalists and executives, many of which are alumni of the University of Michigan. The key conclusion of the national advisory panel was that Ann Arbor lacked an effective private-public-academic platform outside the physical and intellectual capital of the university to create a nurturing environment to receive potential companies that could be spawned once the Technology Transfer Office improved its processes to commercialise new technologies and create start-ups and early-stage companies. It was felt that if such a collaborative platform could be created, then an entrepreneurial ecosystem would evolve to bring talent, ideas, and capital together and dramatically change the surrounding region into a known locale for entrepreneurship, early-stage company creation, and innovation – becoming an area of innovation.

It is important to note at this point of this narrative, that the conclusion of the national advisory panel was not to create a science and technology park affiliated with the university. It was to build an ecosystem within and around the City of Ann Arbor where the company formation and growth would happen organically within the community taking advantage of the quality of "place" that Ann Arbor already possessed. It is also important to note that the effort was not to limit what clusters would evolve, but to create a nurturing environment for all types of technologies and innovation and let those clusters evolve naturally. In other words, the "terroir" of Ann Arbor was ripe for development into an area of innovation but there needed to be a "SPARK".

The University committed funding and talent to this new platform and made changes in its internal programming to support start-up formation and entrepreneurship campus-wide.

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

However, it was clear to the President and the University's Board of Regents that for it to be a successful platform, other members of the Triple Helix needed to come to the table as equal partners. University of Michigan took up the baton of leadership and convened private sector and governmental leaders. A new non-profit organisation was created, funded, and led by a board made up of the key stakeholders in the region from the private sector, public sector, and the two universities and one community college in the region. These stakeholders came to the table as equal partners with a charge to create a technology-based entrepreneurial ecosystem in the Ann Arbor region. SPARK came into being in 2006 and has been integral in creating an area of innovation.

The board of directors of SPARK adopted a strategic plan consisting of three pillars of acceleration, talent, and growth on the foundation of two supporting pillars of leadership and planning. These initiatives are delivered through the individual actions of different elements of the Triple Helix that are coordinated and advanced through the collaborative efforts of the SPARK professional staff teams in the areas of business development, business acceleration and marketing and communications as directed by the SPARK board of directors working through its executive committee and its finance, business development, entrepreneurial services, foreign direct investment, talent, and public sector committees.

Ann Arbor Spark Values

> To provide **high value and innovative services** to our stakeholders and customers helping meet their challenges in an increasingly dynamic and volatile global economy.
>
> To pursue the principles of **open-source economic development** by engaging in regional and state-wide collaboration with public, private, and non-profit partners to advance the Ann Arbor region, Southeast Michigan, the State of Michigan, and the nation.

The nascent area of innovation took advantage of a major policy initiative of the State of Michigan to improve its overall economic development posture through a concept called "smart

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

zones". The State would allocate a portion of the revenues generated from taxing real estate value growth because of business activity in a defined district to support the growth and acceleration of technology start-ups and commit to doing so for a fifteen-year contract period without subject to annual appropriation. The initial funding raised through this scheme in 2002 was $60000. Over the ensuing 15 years, this allocation has risen to 3.5 million dollars supporting technology companies (Yeo and Yeo 2017). The State of Michigan passed legislation before the expiration of the first fifteen to reauthorize this program in Ann Arbor for an additional 15 years.

A virtuous cycle was created: as growing tech companies filled up vacant space, market rates increased, further increasing the tax base. Google occupied a multi-story former old bank building within the Innovation District. Even though it did not fully occupy the building, its presence attracted other tenants. Vacancy rates dropped to less than 2%. In 2005, the vacancy rates were greater than 20% (Concentrate 2020). Capital costs are borne by the companies themselves in negotiation with individual landlords and developers. For example, Google was responsible for its capital costs.

Through a collective and sustained effort, the Ann Arbor region is now recognised as one of the most important technology-based economies in the United States and globally (Ann Arbor SPARK 2020). The proof is quantifiable metrics. From 2011 to 2020, SPARK has enabled the development of the entrepreneurship community with the following results: 352 company growth projects, resulting in $1.6 billion in new capital investment and 9000 new jobs; 732 start-ups employing 2600 Full-time Employees (FTEs), assisted through intensive accelerator services; $56.6 million in investment from the federal and state government in the community; 7.2 million social media interactions with 500000 engagements and 783000 video views in

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

2020 alone; and $982000 in private equity investment in SPARK's family of start-ups and early-stage companies (Ann Arbor SPARK 2021).

SPARK's permanent convening platform is not limited to bimonthly meetings of its board directors and regular committee meetings have led to significant regional initiatives, some staying within SPARK's remit and others that have been spun out. For example, in 2015, Ann Arbor SPARK launched Tech Trek to connect the community with the burgeoning tech scene in their hometown, allow companies to showcase their innovations, and enable job seekers to explore potential employers. Tech Trek is a free community event and essentially an open house for community members to visit the offices of downtown tech companies. The event has nearly tripled in scope since its inception, with attendance increasing nearly 75% year over year (Ann Arbor SPARK 2021).

Building on the success of previous years, SPARK added a new element in 2017, Tech Talk, a TED-style event featuring some of Ann Arbor's most interesting and impactful companies. Speakers shared key insights on evolving innovations, research, and technology, and took questions from the audience. The addition of Tech Talk was such a massive success that it spurred the evolution of a multi-day tech "festival" planned for June 2018, branded as "A2Tech360". A much smaller version of Austin, Texas's South-by-Southwest, A2Tech360 2021 will be a 10-day affair, including events such as the New Mobility Summit (an event capitalising on the proliferation of mobile technology in the region), the FastTrack Awards (honouring fast-growing companies in the region), Tech Talk, an open-air free concert between Tech Talk and Tech Trek, and the flagship event on Friday afternoon: Tech Trek. The evolution of Tech Trek into A2Tech360 is a testament to the vibrancy of Ann Arbor's Area of Innovation, the critical mass of companies and activities, and the initiative of Ann Arbor SPARK to connect the wider community to the technology community.

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

In part due to the success of Tech Trek and its evolution into a multi-day event, as well as the recognition of Ann Arbor as an Area of Innovation and tech hub, Ann Arbor SPARK worked to implement a prototype of a living laboratory for mobility technology in downtown Ann Arbor. SPARK worked closely with eight stakeholders including Amazon Web Services, Deloitte Consulting, Ford Smart Mobility, the City of Ann Arbor, and the University of Michigan. This type of city-level "operating system" will enable "plug and play" hardware such as vehicles and street-level infrastructure as well as data management, payment, and other software systems to allow for maximum efficiency. The project endeavours to use design thinking to offer mobility-as-a-service to residents, visitors, and workers in Ann Arbor. In this way, Ann Arbor will play to existing strengths as an Area of Innovation, support cluster development in a burgeoning industry, and cement its global position as a leader in mobility technology.

The benefit to government-level stakeholders of this project will be analysis and insights on operations, service, and future investments, with a low-touch engagement (expertise and data). Mobility pilots are being pursued, consistent with institutional goals for testing transformational approaches to serve Ann Arbor area residents, visitors, employees, employers, etc. The living laboratory would not be possible without the existence of Ann Arbor SPARK, and the intentional creation of a Quadruple Helix structure that cultivates relationships between local government, the private sector, the University of Michigan, and the neighbouring city of Detroit. This demonstrates that beyond the physical assets of Ann Arbor, the community of actors is crucial to building and maintaining a living and breathing area of innovation.

The story of the American Centre for Mobility (ACM) begins with Willow Run and is pivotal in American history. Willow Run history is about a place and people that helped win a world

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

war set the stage for equality and social change, and dramatically accelerated the development of Southeast Michigan.

In 1941, both the US government and established aircraft manufacturers believed it impossible to build aircraft on an assembly line, and initially hoped The Ford Motor Company would help the war effort by creating a plan to handcraft one airplane per day. That plan became Willow Run, which included a major airport, a 5 million square feet manufacturing plant, and a village for the workers, all rising from scratch on former farm fields in less than a year. Aircraft production began in 1941, and at its peak during the war years, over 40,000 workers at Willow Run produced B-24 Liberator bombers at the astounding rate of one airplane every hour. After the war, Ford sold the plant to the Kaiser-Frazer Corporation, which used it to produce automobiles. During the Korean war, Kaiser-Frazer produced C-119 and C-123 planes, before ceasing operations in 1953 and selling to General Motors. For several decades, Willow Run stayed GM's transmission plant. In 1982, the 50 millionth transmission rolled down the assembly line. In 2010, the production stopped, and the property was abandoned by GM as a part of its restructuring through bankruptcy.

In 2013, SPARK released a white paper titled "Ahead by a Century: *The Future of Automotive Technology"* outlining how the Willow Run site could be utilised as a connected and automated vehicle testing centre. The site included over $100 million in abandoned usable infrastructure ideal for simulating real traffic scenarios, vehicle testing, vacant roads, cross lighting, an abandoned railway, and other unique structures including two triple overpass sections and a bridge over a natural waterway. SPARK staff then began a series of meetings with key officials at the federal, state, and local levels, briefing them on the importance of the project to the region and the state. Multiple surveys and research reports were undertaken by partner organisations to outline the feasibility of the project.

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

In 2015, work began to organise a non-profit entity that would operate the American Centre for Mobility (ACM), as well as begin the due diligence process for the development of the site. A working group was designated to continue work on the study, including the Centre for Automotive Research, the Detroit Regional Chamber, Business Leaders for Michigan (BLM), the Michigan Economic Development Corporation (MEDC), the Michigan Department of Transportation (MDOT), Walbridge (a construction and engineering firm), and the University of Michigan. Ann Arbor SPARK and Walbridge were awarded a grant from the federal US Economic Development Administration to conduct a feasibility study for the former manufacturing site to serve as a national centre for connected and automated vehicle research, testing, product development, validation, and certification facility. 2016 saw the official launch of ACM, the formation of the board, further investment for the final acquisition of the site, and the ground-breaking ceremony for the start of construction.

In 2017, total funding from the Michigan Strategic Fund to the project reached $32 million — illustrating the level of commitment from the State of Michigan to bring the facility to the next stage of development. In addition, construction on Phase 1 of the project — the high-speed loop — began and was complete by the end of the year. Throughout third and fourth quarter of 2017, Toyota, Ford, Hyundai, and Visteon all announced their intent to support as Founder-level sponsors with a $5 million contribution each. In December 2017, construction on Phase 1 of the project was completed, and American Centre for Mobility opened its proving grounds for testing, with Visteon Corporation and Toyota Research Institute on-site to begin testing operations.

The ACM's facilities are unparalleled within the US. Its infrastructure mimics a wide range of environments that automated and connected vehicles will encounter. Unique to ACM is that it will have areas that serve today's needs (urban, sub-urban and high-speed environment) but

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

also areas that serve future needs (rural, off-road), all in one place. Michigan's wide range of weather conditions allows testing of all these environments in varied weather conditions, a representative of the entire American continent.

Ann Arbor SPARK was a key player in identifying the opportunity, the nascent industry cluster, the commercial prospects, and the community building potential of ACM, and acted with intent. SPARK continues to be heavily involved in all aspects of the project, viewing it as a community asset that necessitates a community approach. Leadership in this sense does not follow a top-down structure but originates from the "glue" between different partners in the development process. The American Centre for Mobility is already a crucial economic driver for the area of innovation, operating at near capacity with major mobility companies and start-ups working on products and services that will change how people and goods move in the remainder of this century and beyond.

Key findings

Our analysis of the Ann Arbor SPARK case study shows that the theoretical models of Triple Helix, Knowledge Triangle, and Network Intelligence provide useful frameworks to understand key success drivers which enabled SPARK to deliver outstanding results as an STP 2.0 (measured in terms of the number of start-ups, funds raised, jobs created, and transformational purpose-driven initiatives). We present our key findings below.

Firstly, the origin of SPARK points to the importance of a university in the local ecosystem as an entrepreneurial agent, catalyst, leader, and investor. The foundational role of an entrepreneurial university is multiplied in the case of SPARK with the strategic networking capacity of the University of Michigan able to build research-education-innovation coalitions which resulted in the establishment of SPARK as the lead community platform and instrument

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

for regional government development policy, city-level experimentation, as well as forward-thinking initiatives of large industry.

Secondly, the case of SPARK shows the right Purpose-Network Fit was core to the platform's success. The clear purpose statement: "to provide high value and innovative services to its stakeholders and customers" and "to pursue the principle of open-source economic development", was aligned with the engagement strategy with the right people. The intentionality of SPARK leadership to build a platform for regional development with stakeholders was institutionalised, with the right governance model and the board representing industry, academia, and government.

Thirdly, the success of Ann Arbor SPARK was based on its capacity to build not only the platform but a high-performance innovation community. This community has become a vital node in the local, regional and global innovation network architecture. For example, SPARK has become a popular networking space as well as a community manager; it gained high global visibility and brand recognition by investing in social media presence (e.g., over 9.000 followers on LinkedIn); and it has gained a high reputation in the global STP community with its President and CEO elected as the Chair of the Board of the IASP, which has over 270 members from around the world.

Fourthly, the SPARK networking power as an important network node was translated beyond networking or e-networking activities into a capacity to optimise its network and build cooperation, collaborations, and orchestrate diverse projects. These projects provide evidence to support our thesis that SPARK is a good example of an STP 2.0 as they connect local actors (e.g. start-ups) with the global value chains (e.g. through investment by global corporations and access to lead markets), local and global flows of knowledge (e.g. research on cutting edge

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

technology and living lab approach), and local and global flows of talent (e.g. the immigrant and migrant talent in the SPARK start-up community).

Lastly, SPARK was able to power its network as an influencer in the direction of development towards sustainability and Industry 4.0. While data on the Network IQ skills of the SPARK community is not available, the evidence of high Network Intelligence in the SPARK leadership team and its ecosystem is visible through their capacity to attract investment for initiatives focused on the future of mobility and transformation of old industry towards sustainability.

Conclusions

Our findings show that Ann Arbor SPARK leadership was able to intentionally build diverse social networks and interconnect them into an organisational structure, which was the core infrastructure and enabled the networking culture within this STP 2.0 as a community platform to systematically invest in several strategic networking activities. These activities stimulate collaborations between diverse public and private actors, enable the execution of open innovation strategies, strengthen the human social technology ecosystem of local technology start-ups, and overcome the silos mentality of the networking industry and academia.

There are several strategic implications concerning the successful establishment of STP 2.0 which can be drawn upon the SPARK case study and its role in building entrepreneurship culture and networking its surrounding community into diverse value creation networks:

- For the newly established areas of innovation, it is essential to simultaneously address the tasks of infrastructure creation and community building, attracting all the key stakeholders in the ecosystem. Balancing the interests of the academic, private sector, and government interests through an independent organisation is critical and is an important insight from Ann Arbor SPARK's, almost two decades of experience as the

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

curator of the regional area of innovation. If any of the three elements of the Triple Helix exert dominance, the platform will be less effective because it will be deemed as the "university's initiative" not the private sector or local government and vice versa, reducing and perhaps ending the participation of the non-dominant member(s) of the Triple Helix.

- Areas of innovation arise and thrive through the intentional collaborative action of key Triple Helix and Knowledge Triangle stakeholders, and such mechanisms as e.g., establishing joint working groups or steering committees are necessary to enable result-oriented dialogue. Many regions can successfully pull together for one-off projects or respond to a major private sector opportunity or funding made available by state or national government entities but can find themselves in the cycle of having to recreate the wheel (the working relationships) for each new opportunity. Sustained and structured leadership and engagement are critical to the long-term success and sustainability of the organisation acting as the curating and coordinating entity for the area of innovation. This provides a ready platform to respond to one-off opportunities when they are fit for an agreed-to strategic plan without having to reinvent the wheel. Such a permanent platform also creates the collective voice and will to advocate national and sub-national administrative and legislative entities that a regional innovation economy needs from that level in terms of policies, programs, and funding to be successful.

- A "permanent" platform connotes an ongoing stable source of funding to build the high-level professional staff necessary to be a successful area of innovation. Too often, such initiatives start with good intentions and commitments and those initial leaders move to new positions. The commitment to fund must be institutional, not personal, sufficient

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

for the task and the long term. If it is all possible, tying it to the economic success of the area of innovation is preferable and not dependent on the annual "political" appropriation within government, academic institutions, private companies, and foundations.

- Formalised networking by "independent" players in an area of innovation maximises the potential of a region's economic and physical assets and creates results that the mere presence of the physical assets can create on their own. It is therefore vital to ensure a baseline level of Network IQ skills and effectiveness of utilising networks for innovation and entrepreneurial growth.

- Recognizing and building on the concept of an STP 2.0 as a vital instrument leading to activation of a local innovation ecosystem and the accelerated transition of post-industrial manufacturing regions into the new, green and digital economy models.

- The evolution from the first, second, and third generations of STPs to the complementary concept of Innovation Areas, together with the new generations of STPs, may require additional conceptualization and analysis of experiences such as Ann Arbor SPARK with the variables and literature provided in this article — especially when it comes to understanding the network-based paradigms of future of work in the post-pandemic era.

Our analysis has attempted to contribute to research devoted to STPs and Areas of Innovation, altogether with the analysis of the entrepreneurial innovation ecosystems, community-based innovation networks, the Triple and Quadruple Helix Models, Knowledge Triangle, skills, and strategies to use a permanent platform, and the locus in a nurturing environment with strong leadership, that favours business growth, regional development, and economic and social

Volume 7, Number 2, 100-132, July-December 2022 doi.org/10.1344/jesb2022.2.j108

impact. All these elements may be useful for other cases that may be analysed and developed in the future regarding the new generations of STPs.

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