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The Future of Science Parks and Areas of Innovation: Science and Technology Parks Shaping the Future

Malcolm Parry☆

Surrey Research Park, University of Surrey, UK

Abstract

The successful development of science parks is dependent on the relevance and delivery of a range of value propositions they offer to their stakeholders. Experience has shown that the benefits of these value propositions are 'place based' and 'time dependent', influenced by the prevailing technology, social and business environments in which they operate, and the relationship that is developed between entrepreneurs, corporates, academia and government in creating these projects, and their performance is dependent on economic, physical and networking assets they create and deploy.

This paper looks at some of the history that has influenced the development of parks, lessons learnt from their planning, development and operation. It reviews these details in the context of delivering value propositions in the context of temporal, spatial, technology and entrepreneurial profile of the new idea of 'innovation districts', influencing 'city planning' and supporting 'smart specialisation strategies'.

Keywords

Science and Technology Parks; Innovation Districts; Economic Assets; Physical Assets; Network Assets; Entrepreneurs; Innovation; Science and Innovation Audits

1. STAKEHOLDERS, SCIENCE PARKS AND THE MOVING TARGET OF THE INNOVATION ECOSYSTEM

As an entry point in any discussion about how science and technology parks (STPs) can influence the shaping of the future, it is important to recognise that the development of these projects has been neither static nor uniform and each of the major stakeholders has its own history that predates their involvement in these projects.

☆Correspondence to : Dr. Malcolm Parry
CEO, Surrey Research Park, University of Surrey, Guildford, UK, GU2 7YG
E-mail : m.parry@surrey.ac.uk

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In the case of universities, their historical function has been concerned primarily with discovery and teaching. However, in the UK since 1997, and in many other countries, government policies and funding programmes have been introduced in order to increase the contribution by universities to the development of their communities.

Business and industry has always needed to innovate to gain and keep a competitive advantage. Often, in the context of industrialisation, these innovations have reduced the need for human energy by imposing automation. The modern era of automation, which was ushered in with the advent of the era of computing, has enabled opportunity-entrepreneurs (Reynold et al., 2001) to compete with capital intensive industries and continue the cycle of innovation and disruption first elaborated as a theory in 1942 (Schumpeter, 1976) when the role of entrepreneurs in this process was also recognised as crucial to successful innovation at a scale necessary to drive disruption.

Entrepreneurs and small and medium sized enterprises (SMEs) have been one of the most important building blocks behind the development of science and technology parks. They are now being seen as critical to catalysing innovation in new economic development strategies such as regional development smart specialisation (Foray et al., 2012) initiatives, planning cities[1], and creating innovation districts (Katz and Wagner, 2014) as these areas and assets within them search for technology triggers that will create new waves and sustain productivity. Many of the programmes pioneered by the science park movement, which were implemented to support businesses, find these "triggers" are being adopted in these initiatives and many governments are adapting policies, regulations and investments that are prioritising the role of entrepreneurs in innovation in order to keep up with change.

Overlaying the start of the modern science park movement on the characterisation of the innovation-disruption cycle (Hargroves and Smith, 2005) since industrialisation began, places the emergence of Silicon Valley as the first recognisable science park at the start of the electronics wave in the 1950s. The wider development of science parks across Europe began in the 1980s with the launch of the digital age wave.

Although the first modern computers had their origins in the late 1930s with the use of electrical magnetic relays followed by valve technology, the real revolution for opportunity-entrepreneurs[2] started with the introduction of microelectronics and the launch of the era of the personal computer in 1974, by Apple products in 1977, and the IBM PC in 1981.

The experience of being involved in the planning and development of the Surrey Research Park since 1981 makes it possible for me to state that the current wave of advances in digital technologies has had a significant influence on the development of the Surrey Research Park and most likely many other science and technology parks[3].

The business landscape has continued to change with the deployment of the Internet, networks, and mobile communications in the mid-1990s and the creation of companies such as Google in 1998, the move online of Amazon in 1995 and the launch of eBay in the same year. The growth of these new companies has influenced many traditional large firms, as they have had to refocus their core business.

The increasing trend of technology being embedded in products and services has helped to raise the social status of opportunity entrepreneurs that start technology companies. Securing funding for these companies was also given added momentum in the UK because of the easing of credit that followed the liberalisation of banking laws in 1986 (Robertson, 2016). In addition, in the UK and in many other countries, governments have also taken on the added responsibility of helping fund the early stages of innovation while private investors have also helped opportunity-entrepreneurs drive their technology up the value chain by offering access to crowd funding programmes, establishing angel clubs and developing venture capital funds.

In the period between 1989 and 2010, which coincides with the period when science parks started to develop in numbers, there have been a number of changes in population dynamics that have impacted world labour markets. More than 1.7 billion new workers joined the international labour market as they shifted from 'farm – to – factory' and 245 million graduates have entered the workforce since in 2010. However, there is a predicted potential shortage of 38 to 40 million college-educated workers in 2020 (Dobbs et al., 2012). These statistics pose a significant challenge for government as well as presenting opportunities for science and technology parks and areas of innovation.

Against the impact of these changes, the financial performance of large corporations has had to rely increasingly on high levels of innovation. In trying to achieve this, many companies have moved from a vertical integrated structure to a more horizontal operating structure. Since the early 2000s this has led to the adoption of open innovation as part of corporate R&D strategy.

However, with the emergence of companies as such as Apple some are moving back to a vertical distribution and production model but retain strong connections with opportunity-entrepreneur led tech communities and international hotspots for research, particularly where these companies have built unique specialisms that are perceived to be cross cutting technologies that will influence future market trends.

[1] http://citie.org

[2] This description makes a distinction between Opportunity Entrepreneurs (those who start a business because they spot an opportunity in the market, which they want to pursue) and Necessity Entrepreneurs (those who start a business, as they do not have another means of generating income).

[3] The master planning and early development of the Surrey Research Park in the 1980s was directly influenced by access to Oracle SqlCalc on an Apple Euro 2.

WTR 2018;7:44-58 https://doi.org/10.7165/wtr18a0430.18

Based on an analysis of data collected from a sample of 488 companies from the Surrey Park, and the observations from nearly all traditional science parks, it is clear that the greatest number of tenant companies on UK science parks are opportunity entrepreneur led start-ups (Parry, 2014). This makes them a major component of the success of a park.

In addition, evidence from the sample of tenants on the Surrey Research Park has shown that the acquisition of some of these by large corporations has resulted in over £600million (Reynolds et al., 2001)[4] of inward investment to the park.

The perspective of the opportunity-entrepreneurs, open innovation, has created an exit route for technology companies, which in turn has been one of several important drivers pushing the development of innovation cultivation programmes.

These cultivation programmes include such operations as Surrey's general technology business incubator which has been branded under the name 'SETsquared' to enable it be franchised across the region and 5 other university parks, and its specialist games incubator branded as Rocketdesk. In the wider market large companies such as Google, Telefonica, Johnson & Johnson and John Lewis have all created bespoke incubators, accelerators, and start-up studios to connect to the opportunity-entrepreneur led business community.

2. THE SCIENCE PARK MODEL

The benefits of clustering that produced industrial districts, and then science parks, are intensifying because of the trend, in all economies, towards greater dependence on knowledge, information and high skills levels.

In recognition of meeting this trend forward thinking governments, universities and businesses are experimenting with new models of collaboration and interaction that will help sustainable development of the social, technology and business environment.

To understand the value of science parks as a model it is important to understand:

- The underlying value propositions (Parry, 1992) that fuelled their initial development and created the culture of risk sharing among their stakeholders.
- The various combinations of the value propositions they offer to: government; universities and other hosts; corporates; and business comprising opportunity-entrepreneur led start-ups, micro companies and SMEs[5].
- How the risks associated with innovation are shared through the influence of the value propositions on the delivery of the physical, economic and networking assets that sit at the heart of the operation of science and technology parks and more latterly on areas of innovation.

[4] Sample of the acquisition of companies on the Surrey Research Park by large corporations

Company on Park	Companies that made acquisitions
Bullfrog and Criterion Software -computer games companies	EA Europe (formerly Electronic Arts)
Top Tier Software - SAAS	SAP
Lionhead studios (computer games development company)	Microsoft
Surrey Satellite Technology Ltd (SSTL) – small satellite manufacture	AirBus
Detica – systems engineering, CRM development and high level technology consulting, cybersecurity	BAE Systems
Power Planning – power grid R&D	Riccardo
Stingray Geophysical Ltd – laser technology for subsea geophysics	TGS
Brookstreet computers - SAAS	Sanderson
TTP Com – software for mobile telecoms	Motorola

[5]

Company category	Staff headcount	Turnover	or	Balance sheet total
Medium-sized	< 250	≤ € 50 m		≤ € 43 m
Small	< 50	≤ € 10 m		≤ € 10 m
Micro	< 10	≤ € 2 m		≤ € 2 m

It is important to recognise that the combination of these value propositions and balance of the contribution made by the stakeholders also lies at the heart of influencing how parks are financed, their governance structure, rate of growth, path of development, and performance in driving innovation, although considering all these facets is well beyond the scope of this paper.

Network assets

Early work on the performance of companies on science parks (UKSPA, 2003) and subsequent research on sub regional economies (SEEDA, 2001; Huggins and Izushi, 2007) noted the importance of the presence, and full operational capacity of, the networks that link knowledge capital and innovation capacity. More recent research has gone further than simply identifying the need for functioning links and has shown the impact of these links suffers from 'distance decay' (Malechi, 2010) ; and is sharply influenced by the presence of entrepreneurs (Malechi, 2010).

There is also strong evidence emerging that (Lobo and Strumsky, 2008) some cities are proving to be very effective at cultivating and driving innovation and that this has a positive influence on levels of productivity. Research has shown that social networks play an important role in the diffusion of knowledge particularly between individuals working on similar technologies. The evidence also suggests that the diffusion of knowledge tends to be more 'local than global' on average, and co-location is one of the most important factors for tacit knowledge transfer, and requires high levels of face-to-face contact until knowledge becomes codified. This suggests that distance undermines transfer and capture of knowledge spillover, which supports the importance of networking assets in building regional competence (Strumsky and Thill, 2013).

It is also clear that despite some knowledge being easily transmitted, tacit knowledge embedded in people is much 'stickier' and if there is sufficient competence associated with this tacit knowledge this helps build local competence and a competitive advantage for the locality. Universities' contribution to this 'sticky knowledge' lie behind increasing pressures on them to contribute to their regional economies (ESMU, 2010). This is consistent with the view taken by the British government when it noted that although the cost of transmitting knowledge across the world has fallen, this cost still rises with distance (HM Treasury and the Office of the Deputy Prime Minister, 2006).

What has emerged from these observations about the 'value proposition driven, place based assets' innovation models are:

- A proliferation of descriptions of these locations.
- More refined classification of their characteristics.
- Suggested strategies, using this characterisation, for capturing innovation.

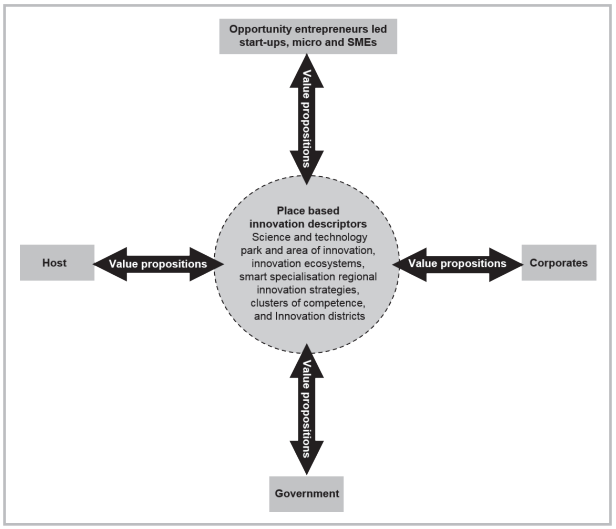

Fig. 1. Characterisation of the descriptions of areas, which merge the interests of the four stakeholders in locations that are effective in cultivating innovation through their respective appreciation of value propositions offered by these locations

Source: Wal and Corbishley (2014)

Recent work (Katz and Wagner, 2014) on refining the descriptions of areas that are effective at supporting innovation involved the deconstruction of the characteristics of existing 'value proposition driven, place based assets'. This identified and categorised three subdivisions of assets that underpin the productivity of these locations in terms of their innovation capacity and set out in table 1.

The paths for development of science and technology parks

The powerful attraction of these value propositions in various combinations as drivers for creating science and technology parks and areas of innovation is revealed by the number of parks that have been created and their importance in trying to drive innovation.

Common models for the development of parks include those that are instigated respectively by an existing cluster, academic, corporate, or government initiative. In each in-

WTR 2018;7:44-58 https://doi.org/10.7165/wtr18a0430.18

Table 1. After Brookings[6] Institutes classification of characteristics of existing active innovation districts

Asset class	Provision	Purpose/ description/ elements
Economic assets (EA)- This describes the firms, institutions and organisations that drive, cultivate or support an innovation-rich environment.	Innovation drivers	Research and medical institutions, large firms, SMEs, start-ups, and entrepreneurs focused on developing cutting-edge technologies, products, and services for the market
	Innovation cultivators	Companies, organisations, or groups that support the growth of individuals, firms, and their ideas and include incubators, accelerators, proof-of-concept centres, tech transfer offices, shared working spaces (with programs to support idea and firm development), secondary and further education facilities, skills training firms particularly where these are aligned with a local specialisation
	Neighbourhood amenities	Contemporary facilities such as coffee shops and other retail and leisure facilities.
Physical assets (PA) Public and privately-owned spaces—buildings, open spaces, streets and other infrastructure—designed and organised to stimulate new and higher levels of connectivity, collaboration, and innovation.	Public realm – digitally and physically connected	Provision of space to support specialist sectors
	Living labs for testing ideas/public test beds	Enable testing of new technologies and prototypes
	Cultural spaces – theatres, libraries, conference centres	Recreation and family cohesion
	Offices accommodation	Accommodate pivoting and growth and growth of companies
	Adaptable equipped laboratories to support specific science sectors	Enable companies to have access to high value equipment to develop ideas.
Network assets relationships between actors—such as between individuals, firms, and institutions—that have the potential to generate, sharpen, and/or accelerate the advancement of ideas.	Housing – appropriate tenure and tariff	Proximity to enable family life to function
	Open spaces, connecting routes cycles ways and paths that links district to locale	Recreation and community cohesion
	Strong ties	Collaboration and networking within specific sectors - engagement through branch membership of professional institutions
	Weak ties	Links across sectors in dedicated network events / or interest groups e.g., 'game jams' and 'mixers', workshops on business process and business ideation.

[6] Katz, B., and Wagner, J. (2014) "The Rise of Innovation Districts: a new Geography of innovation in America", Metropolitan Policy Program at Brookings (May 2014), Brookings Institution. Available at: https://www.brookings.edu/essay/rise-of-innovation-districts

stance the value propositions of the lead organisation is a major influence, which in turn influences the governance, funding and planning.

Details of these combinations of developments are noted in figures 2 to 4.

This analysis shows that ecosystems created by science and technology parks can originate from a number of combinations of stakeholders; however, the common themes in all of these models are:

- They are all 'value proposition' - 'place based' concentrations of economic and physical assets.
- This process needs to be animated with networks to create an interdependence that helps academics and entrepreneurs reach their respective potential that derives from the natural cultural differences between these stakeholders. Experience suggests the culture of knowledge discovery is to ask questions that push the boundary of knowledge and the body of knowledge defined as science while the culture of what drives successful entrepreneurs is their capacity to scrutinise technologies and ask the critical questions about whether it has a market, what regulatory changes if any are needed to deploy the technology and what problems are required to solve to take a technology to market and make it pay. The critical difference between these cultures is that academics like to find more questions to answers because they are pushing the boundary of knowledge, which contrasts with entrepreneurs who only answer questions, which keep them from the money.

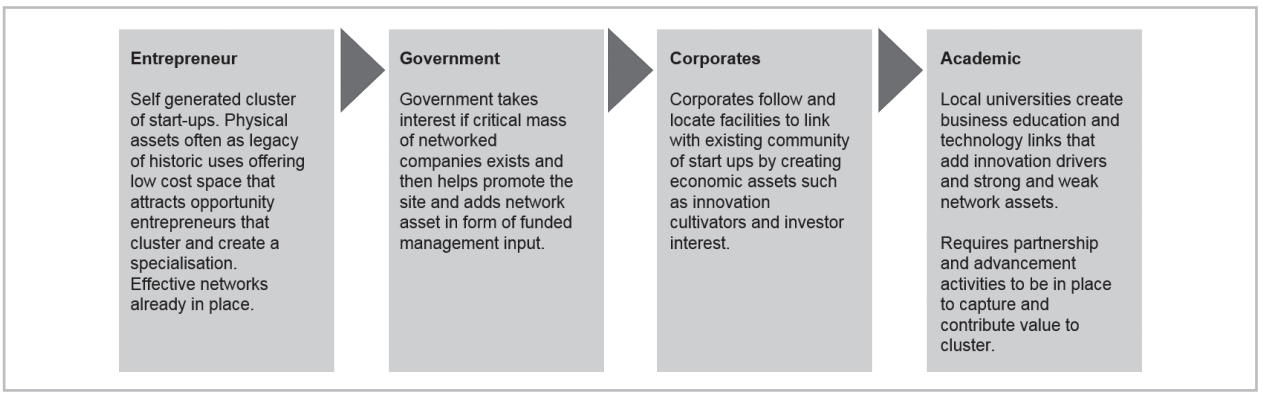

Fig. 2. Start up entrepreneur led cluster – examples of these clusters include Tech City London, Silicon Allee Berlin, and Silicon Valley San Francisco California

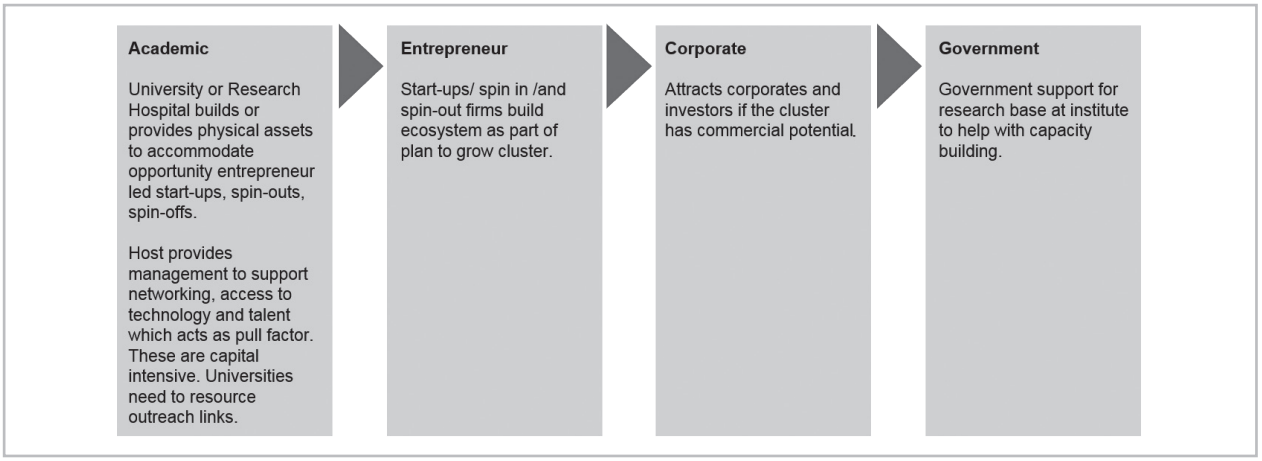

Fig. 3. Academic led cluster – examples include Surrey Research Park Guildford UK; Heriot-Watt University Research Park Edinburgh UK; Cambridge Science Park Cambridge UK; Karolinska Institute Stockholm Sweden; Oxford Science Park UK

WTR 2018;7:44-58 https://doi.org/10.7165/wtr18a0430.18

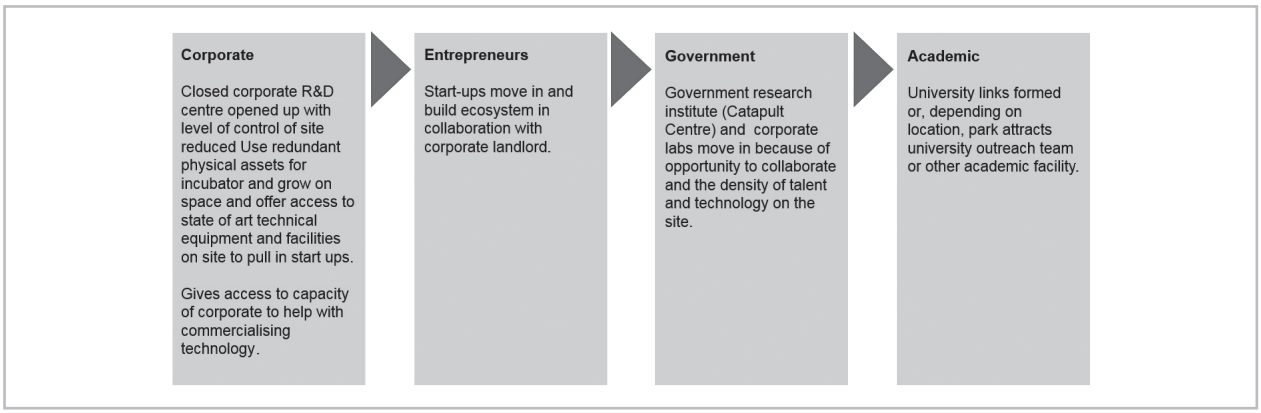

Fig. 4. Corporate led park – examples include Eindhoven Science Park, Colworth Science Park, MIRA Science Park was originally Motor Industry Research Association centre Cirencester, UK

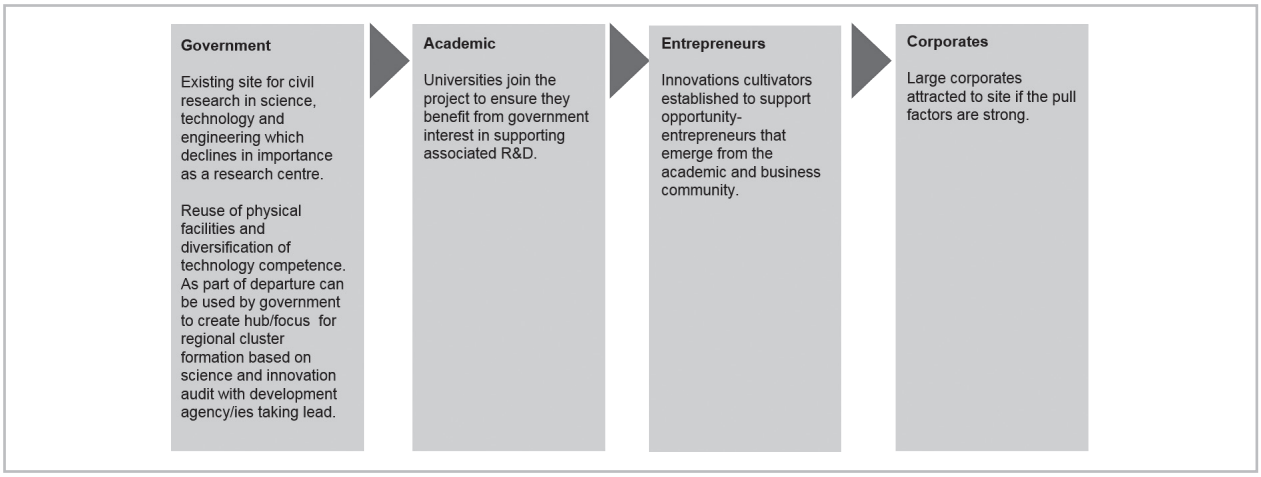

Fig. 5. Government led parks: examples include Harwell Oxfordshire UK

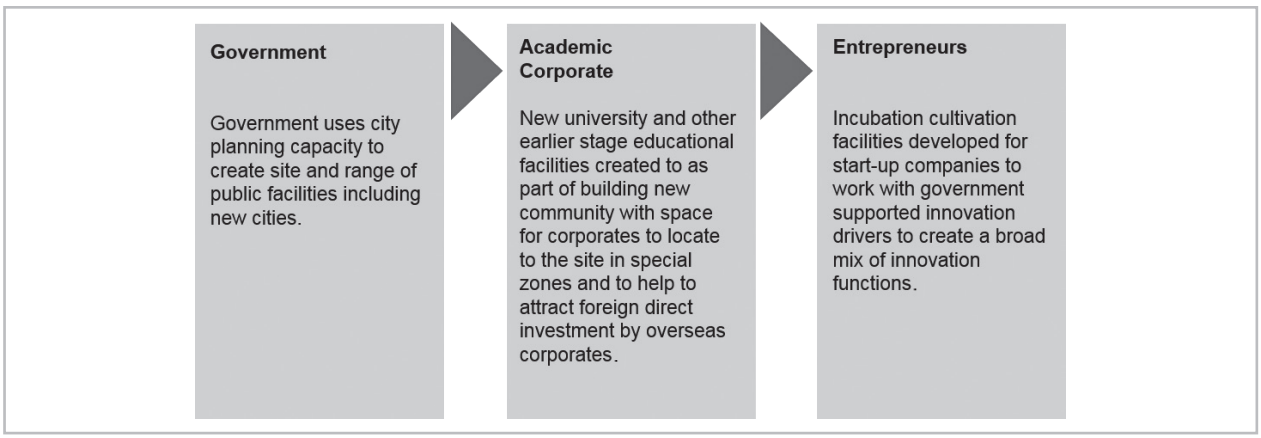

Fig. 6. Government led new town/city: examples include Cyberjaya Sepang Malaysia, Innopolis Taejon South Korea, Zhongguancun Science Park Beijing China; 22@Barcelona district Barcelona Spain

Table 2. Combines the value propositions[7] for each of stakeholders and the individual asset class and function, set out in table 1 and is elaborated in figures 2-5, which deliver the proposition to the individual stakeholders

Stakeholder group	Value propositions made to host organisation	Asset class	Asset function
Universities or groups of universities in a city that support a city zone[8]/ research hospitals/ government research laboratories/ corporate[9] R&D centres. These are now being defined as anchor institutions that form the basis of creating the technology and talent pool that is critical to the evolution of science.	Income generation from property if they are owners of any of the physical assets – raise revenue to support scholarship (teaching and research).	EA	Innovation driver
	Creating a physical asset that has a capital value that forms part of an endowment for the host and supports funding of scholarship.	PA	Innovation driver
	Create connections with tenant companies to extend research activities and secure research income.	NA	Strong tie
	Attracting and retaining staff and students because of the opportunity of engaging with or forming companies.	EA	Innovation cultivator
	Raising their image and reputation as a centre of innovation, which enhances the host's profile in 'place-making' for innovation.	EA	Innovation cultivator
	Collaborating in corporate and entrepreneur led innovation strategies.	EA	Innovation cultivator
	The presence of a park can support a change of culture within a host that helps clarify the impact of research.	NA	Innovation driver
	Supporting spin out companies from the host.	EA	Innovation driver
Stakeholder group	**Value propositions made to opportunity-entrepreneurs**	**Asset class**	**Asset function**
Opportunity entrepreneur led micro companies and SMEs. These tenants are the most numerous stakeholder group.	Access to flexibly managed and serviced space that shares the risk of building a company and enable its physical growth, with a 'landlord' – this empowers opportunity-entrepreneurs.	EA	Innovation cultivator
	Developing and testing against markets and investor interest new product and service.	EA	Innovation cultivator
	Giving a positive image and heightening reputation because of the quality of the address.	EA	Innovation cultivator
	Ability to gain access to a talent pool of undergraduates, graduates and staff.	EA	Innovation cultivator
	Access to high cost specialist equipment.	NA	Innovation cultivator
	Joining a community of companies that provides scale, which helps to attract talent and finance.	EA/NA	Innovation driver/ Strong tie
	Access to coaching, mentoring and self-help groups to assist with company development.	EA	Innovation cultivator
	Opportunity for investor groups / clubs to associate themselves with the location that helps to build a relationship with the host of the park and with the community of companies.	EA	Innovation cultivator
Stakeholder group	**Value propositions made to Corporates**	**Asset class**	**Asset function**
Corporates – either as larger facilities that serve a country or region or a smaller specialist division of corporates.	Location of corporate facilities close to a pool of technology and talent, which gives access to tacit knowledge from early R&D activities.	EA	Innovation driver
	Opportunity to locate small specialist parts of large companies close to specialist teams in the host organisation.	EA/NA	Innovation driver/ Weak tie
	Opportunity to support in one location companies that are developing in a cluster associated with a technology sector.	EA/NA	Innovation driver/ Strong tie
Stakeholder group	**Value propositions made to governments**	**Asset class**	**Asset function**
Government Local, regional or national government which in different measure play a role as supporters of science and technology parks and area of innovation as well as an investment partner. In the case of local government, their contribution is usually related to land use planning related matters. At a regional level, the contribution tends to be focussed on regional innovation strategies. At a national level, the contribution concerns policies that influence investment in research, development and innovation.	Create a physical location that has the potential to support the formation of a cluster that can develop a region or a city district – by creating these from new or leveraging an existing technology and skills/talent base.	PA/EA	Create public realm permission for private realm. Providing Innovation drivers and supporting innovation cultivators
	Population retention in an area, which has experienced a loss of talent in a 'brain drain' effect.	EA	Innovation cultivators
	They can be developed as special economic zones e.g., 'freezone' 'enterprise zone' to attract foreign direct investment by anchor organisations.	PA/EA	Public realm.Innovation drivers.
	Support a location that has already established an active cluster of competence to accelerate its impact on a region.	PA/EA	Public realm.Innovation drivers. Innovation cultivators.
	Increasing the return on investment in government R&D by creating a structure for helping to commercialise technology.	EA	Innovation driver
	Supporting the development of new technology companies that can create a new generation of businesses that strengthen the national tax base and create employment.	EA	Innovation driver
	Dealing with market failure in the provision of space and support for local technology businesses or promoting a site for development	PA/EA	Public realm Innovation drivers Innovation cultivators
	Creating a focal point associated with the host organisation to support the formation of a smart specialisation in a region.	EA	Innovation drivers Innovation cultivators
	Employment density helps ease the sharing of resources, goods and labour.	EA/NA	Innovation drivers Innovation cultivators Strong and weak ties

[7] Parry, M. (1992) "Science Parks: the driving forces behind the concept and their physical planning", Paper presented at the International Symposium on the Development Strategies for Science Town, Organised by KOSEF Daejeon November 19th -20th 1992.

[8] Examples include zones of cities such as Bareclona@22 in Spain and Porto Digital Recife in Brazil.

[9] Examples include Motor Industries Research Laboratory in Cirencester in the UK and Eindhoven Science Park, Netherlands.

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What is interesting to see from this analysis of the growth paths of science and technology paths is the versatility and plasticity of the models of development and what investment and structures need to be put in place to enable a productive link to be formed between discovery and exploitation.

This plasticity has been recognised in three current initiatives that are attempting to create environments that have the capacity to capture the potential of the next wave of technology development.

3. FUTURE OPPORTUNITIES

Concepts that are developed relate to one of three ways that physical and economic assets are distributed. In the case of these being distributed across regions this is usually a result of an accident of history; however, it critical to capture these assets and assemble them into 'value proposition, place based assets'. The current view of how to do this requires a regional /central government model in the form of regional innovation strategies based on the concept of smart specialisation[10].

The importance to cities of meeting the challenges of urbanisation has resulted in an initiative defined by the CITIE[11] organisation. The third initiative has emerged from observations about the value of combining talent and technology in spatially compact areas defined as innovation districts (Katz and Wagner, 2014).

At the heart of the success of any model for developing any of these three extrapolations of the science and technology park model is the ability of the project to deliver its value propositions to all the stakeholders. Delivery of these requires not only creating the physical and economic assets but also building connections and interactions through effective network assets.

In the case of smart specialisation regional innovation strategies, creating links needs investment in organisational structures, those in cities rely on town planning skills that drive investment and in the case of innovation districts the major driver is proximity.

Smart specialisation (RIS3)

The publication of 'Knowledge for Growth' in 2009 by the European Commission (Research Commissioner Janez Potočnik's Expert Group, 2009) shifted thinking towards an approach to investment in knowledge and innovation that would complement a country's other productive assets, particularly those of entrepreneur led businesses, to create future domestic capability and interregional comparative advantage, now termed smart specialisation.

The necessary work to prepare the evidence on which to base a RIS3 strategy is complex because it needs to gather data that review the full range of assets that sit at the heart of cultivating and driving innovation.

In the UK Science and Innovation Audits (SIA) were launched by BEIS to help to identify and validate where existing and growing research excellence is coupled with emerging innovation strength (Technopolis, 2016). The purpose of these has not been to create an exhaustive compilation of all science and innovation activity in a region; rather they are intended to test the hypotheses that set out by regions as their regional strengths (R. Gill, Personal Communication, 2017). The SIA for the South East of the UK has been overseen by a Steering Group and Advisory Committee and involved:

- An analysis of core data from national databases supplemented by bespoke data.
- An open call for evidence with universities, businesses and other partners being encouraged to submit data.
- A series of stakeholder workshops.
- A literature review.

The output is a report that sets out a series of options for creating network assets, strengthening economic assets and the need for any associated physical assets necessary to cultivate and drive innovation.

The process behind this is set out in Figure 7 (Foray et al., 2012).

In addition to individual regional responses to smart specialisation the leaders in the science park movement have responded to smart specialisation by suggesting parks evolve from providing what has been portrayed as a bridge for technology transfer to what has been described as actively engaging in creating a cluster of competence. This change at Surrey, and in places like the Manchester Science Park and many others within the UK, has helped to parks to add value to the principles behind smart specialisation.

[10] Smart Specialisation Platforms – Science Parks (http://s3platform.jrc.ec.europa.eu/science-parks)

[11] http://citie.org/

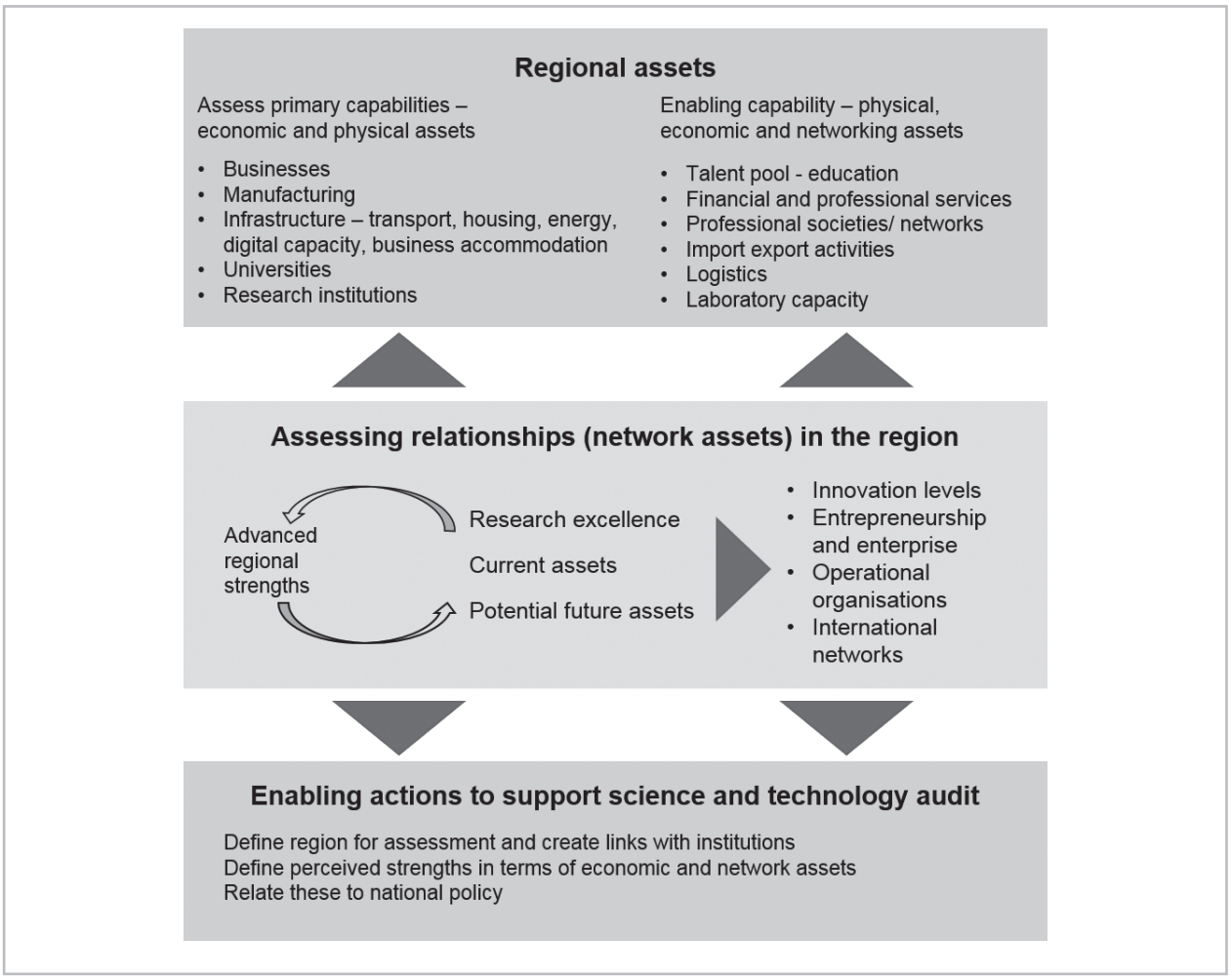

Fig. 7. After RIS3 Guide to Research and Innovation Strategies for Smart Specialisation (RIS3)

Source: Foray et al. (2012)

This transition from a linear approach to one combining the economic, physical and network assets in an interactive approach (Nauwelaers et al., 2014). This transition is important because it increases the influence of a science and technology park in both areas that have established smart specialisation strategies and those still planning their ideas. Examples of these include:

- Creating multilateral exchanges to support tenants such as creating an active angel club – this helps to build more effective network assets by the management team that can help to use the economic assets more effectively.
- Linking with government innovation agency officers to help start-ups to secure translation funding - these kinds of relationship help to supplement the economic assets that a park can draw on when supporting tenants.
- Engaging with university business schools that run enterprise related courses on campus for students, postgraduates and businesses – this helps to build economic and network assets.
- Employing Entrepreneurs in Residence to help with coaching and mentor groups to fill a managerial gap in start-up and growing companies (Parry, 2016) - these individuals have strong network connections.
- Developing a Knowledge – to – Market Accelerator, which would be based on a business and university backed body, which could identify, and potentially co-finance, joint projects to increase commercialisation of the technologies that sit at the heart of a regions technology

WTR 2018;7:44-58 https://doi.org/10.7165/wtr18a0430.18

strength with the view to building collaboration and between institutions and the wider business community to seed and develop innovations.

- Linking Innovation Hotspots to support a strategic and planned approach to the provision of innovation centres and support for new and early stage businesses across a region. An example is being piloted by the Surrey Research Park based SETsquared partnership and Innovate UK, and funded by the Department for Business, Environment and Industrial Strategy (BEIS). This offers university researchers with commercially promising ideas, up to £50k to 'get out of the lab' and validate their ideas in the marketplace.

4. CITY INITIATIVES FOR TECHNOLOGY, INNOVATION AND ENTREPRENEURSHIP: (CITIE) INITIATIVE

The changing population dynamics and the impact of the knowledge economy prompted the formation of the UK's CITIE[12] organisation. Its aim is to develop city initiatives that focus on technology, innovation and entrepreneurship by supporting city leaders in developing policies to catalyse innovation and entrepreneurship. This focus shares common ground with the work of science and technology parks.

To support this CITIE has created an analytical framework based on empirical data collected from 40 cities from which it has developed nine policy roles. These frameworks require resourcing at a level, which means civic authorities are the only realistic organisations that can develop this kind of programme.

There is an important role for science and technology parks to encourage and support the implementation of such a programme by offering to develop and manage associated assets. The development of these projects is based on a diagnostic tool that allows a city government to interrogate its infrastructure, leadership and openness in order to explore policy dimensions, policy roles, operational practices and resources that help to encourage opportunity entrepreneurship.

Details of these elements are noted in Table 4. This shows the build-up of the framework consists of three policy dimensions (overarching questions about how a city supports innovation and entrepreneurship), nine policy roles (that city governments can play to support innovation and entrepreneurship) and a range of policy levers to cultivate and drive innovation and entrepreneurship[13].

Using this framework as a diagnostic tool, cities can collect the data with which leadership can use help to create environments that will assist with creating effective areas of innovation.

5. INNOVATION DISTRICTS

The concept of innovation districts as a new urban model is being promoted in the US. The definition being adopted for these districts is a geographic area where leading-edge anchor institutions and companies cluster and connect with start-up, business incubators, and accelerators, they are physically compact, transit accessible, and technically-wired to offer mixed-use housing, office and retail.

The theory that underpins this concept is that through a process of active design and management of the three sets of assets elaborated in Table 1 in a specific location there is a synergistic effect that creates a 'hotspot' of innovation which has been termed an innovation district.

This is characterised in Figure 8 after Brooking (Katz and Wagner, 2014).

To establish this kind of city based innovation district requires local government, real estate development, science and technology parks and their incubators, accelerators and other economic cultivators, anchor tenants, research institutes, advanced medical facilities and social networking programmes to develop over time in order to attract and develop business and investors.

This model is being considered at Imperial West in London, by Imperial College (Wal and Corbishley, 2014) using its leadership to work with its own academic structure to develop strategies for supporting start-ups, attracting corporate discovery laboratories and attracting government initiatives that cultivate and drive innovation.

[12] http://citie.org/

[13] http://citie.org/framework/

Table 4. Framework for CITIE analysis programme

Policy dimension	Policy roles	Roles city governments can play to support innovation – policy levers
Infrastructure How a city optimises its infrastructure for high growth businesses. "High performance cities invest in transport, digital infrastructure and support access for talent and capital".	Host: how does a city use its space to create opportunities for high-growth companies?	Support access to co-working. Support incubator and accelerator schemes. Enable access to affordable flexible office space. Nurture innovation districts. Play role of matchmaker in innovation district.
	Investor: how does a city invest in the skills and businesses required for innovation?	Promote provision of education to support technical skills. Access for young people to business and tech sector. Help businesses understand types of financing options. Provision of funding.
	Connector: how does a city facilitate physical and business connections?	Support access to high-speed internet. Provide free public Wi-Fi. Ensure quality-cycling infrastructure. Ensure frictionless integrated public transport.
Policy dimension	**Policy roles**	**Roles city governments can play to support innovation – policy levers**
Openness How open is a city to new ideas and businesses? "High performing city governments support new businesses controlling regulations, procurement and advocacy".	Regulator: how does a city regulate business models in the way that allows for disruptive entry?	Enforce existing regulations proportionately. Review and update regulations to take account of new business models. Engage full spectrum of stakeholders to develop balanced regulation.
	Advocate: how does a city promote itself as an innovative hub and its new business community to the outside world?	Ensure a new business focus within trade and investment function. Provide set up support for new businesses. Promote city as hub of business creation. Sponsor events relevant to high growth sector. Help early-stage ventures access global networks.
	Customer: is procurement accessible to small businesses and does the city actively seek out innovation?	Ensure visibility of procurement opportunities through a single portal. Ensure pre-qualification requirements are achievable by new businesses. Define targets for spend on new businesses. User problem-based procurement methods. Use open innovation methods to engage the ecosystem.
Policy dimension	**Policy roles**	**Roles city governments can play to support innovation – policy levers**
Leadership How does a city build innovation into its own leadership? "High performing city governments use data to plan to support innovation and innovative companies."	Strategist: has the city a clear direction to build the internal capability required to support innovation?	Publish vision of how it supports innovation and entrepreneurship. Have public set of key indicators to measure city's vision. Have innovation function in city hall. Have senior leadership for innovation and entrepreneurship.
	Digital governance: how does the city use digital channels to foster high quality, low-friction engagement with citizens?	Enable digital by default city services. Enable citizens to report problems to cities on the go. Enable citizens to engage in policy decision making.
	Datavores: how does the city use data to optimise services and provide the raw material to innovate?	Use data analytics to optimise city services. Publish open data. Publish live data with appropriate APIs.

Source: Gibson et al. (2015)

WTR 2018;7:44-58 https://doi.org/10.7165/wtr18a0430.18

The challenges for Imperial in driving this initiative are perceived to be:

- Safeguarding its long-term funding for fundamental and applied science to ensure it retains its excellent position in area of expertise on which the venture position is to be built.
- If it is to gain traction and visibility, it is advised that this needs to be around a limited number of areas of excellence.
- Commercialisation expertise and translation capabilities need to be fit for purpose and to ensure this is the case current education programmes need to equip students with entrepreneurial and industrial skills and the selection of the academics that will be effective in a cluster ecosystem.
- Imperial will need to engage in international collaborations between universities to access a global pool of talent.

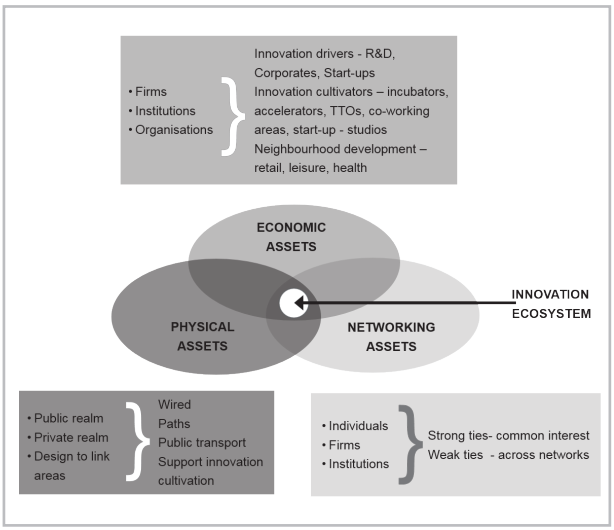

Fig. 8. Characterisation of an Innovation District

Source: Katz and Wagner (2014)

6. OPPORTUNITIES FOR THE FUTURE AND CONCLUSIONS

Science and technology parks have developed a culture of risk through their early development of working with the emerging groups of young opportunity entrepreneurs that took advantage of the emerging computer age. The value propositions that were the foundation to the planning, funding and governance of a park remain valid, and to satisfy the delivery of these a number of physical, economic, and networking assets have been defined which have become commonplace. In addition, the original model of parks is sufficiently plastic and transferable to provide a framework to support regional, city and district developments that are planned for maximising innovation.

Looking forward, the opportunities for science and technology parks include:

- Using their value propositions, they offer to influence land use planning in order to encourage a range of hosts to adopt a significant range of innovation cultivation programmes, which can then help address future waves of technological development.
- This includes taking an active role in smart specialisation strategies, city developments or innovation districts.
- Where the opportunities to engage in large land use planning projects are limited other smaller innovation cultivation programmes can be offered in order to create risk-taking cultures that can then offer opportunities for opportunity entrepreneurs.
- Managers of parks are well placed to monitor emerging trends in technologies that have the potential to drive innovation and to use their value propositions with government to take an active role in supporting entrepreneurial discovery that can build a new cluster.
- Managers of parks need to work in a political dimension as well as with the investor and business community to ensure they have a voice and influence at decision-making level. The message they have in their favour is their capacity to create a risk culture that can serve regions as well as focussing on city districts has survived the test of time. The value propositions they espouse and the models of development are versatile and this is fit for purpose as the next cycle of disruption emerges because the ingredients of knowledge, technology, talent, entrepreneurship, corporate interest, and government commitment are likely to remain at the core of the process.

However, there remains one challenge for science and technology parks, which is the move for some sites to use the brand but not offer the services to tenant companies. Clearly, this needs to be resisted.

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