Abstract: In recent years, numerous studies have shown that the Regional Innovation System (RIS) approach can make important contributions to the generation of innovation and economic development. Additionally, the key role of Higher Education Institutions (HEIs) in innovation systems has been increasingly acknowledged. Amidst the regulatory changes and ongoing economic progress of the region, the future of the Hong Kong-Shenzhen border region is bound for transformation, but there is a lack of research on its potential development. This study explores RIS theories and analyses the current development status and existing challenges around Hong Kong-Shenzhen cross-border collaboration. It analyses examples of innovation-oriented urban planning strategies and summarizes the key planning, urban design, and management principles that nurture innovation ecosystems comprising of multiple types of stakeholders. Applying these principles to the Lok Ma Chau section of the Hong Kong-Shenzhen border region, the study explores a mixed-use urban planning model that shapes innovative forms of live-work environments, which can attract talent and investment. It concludes that regional economic development can be supported through strategic infrastructure that supports businesses, as well as localised improvements in the quality of living.

Keywords: regional innovation system; cross-border cooperation; higher education institutions; Hong Kong; Shenzhen

1. Introduction

In recent years, numerous studies have shown that the regional level plays a significant role in the generation of new knowledge and economic development. The Regional Innovation System (RIS) approach has made an important contribution in this respect, highlighting the importance of spatial proximity and favourable institutional structures for innovation activities (Trippl, 2010).

Additionally, Higher Education Institutions (HEIs) are becoming increasingly important in innovation systems (Etzkowitz, 2008; Kruss et al., 2015). Universities play an important role in the creation, dissemination, and use of knowledge (Kruss et al., 2015) and knowledge-based economies (Mansfield, 1991), and contribute to educated workforces (Pillay, 2011). From the perspective of RIS, they are indispensable elements in a region, providing knowledge, resources, and human capital (Arbo and Benneworth,
2. Regional Innovation System Theories

Haken (1984) first proposed the theory of synergy in “The Science of Structure: Synergetics.” He believed that synergy is within an open system, each subsystem spontaneously forms an orderly structure in time, space, and function through synergy. Since then, the ‘collaborative theory’ has been applied to the field of innovation research, and the ‘collaborative innovation theory’ has emerged. Recently, the ‘triple helix theory’ has been introduced to further improve the theory of collaborative innovation, pointing out that “government-industry-university-research cooperation is the ‘third mission’ of universities and research institutions in addition to teaching and scientific research.” The ‘University-government-enterprise’ model can improve resource integration and collaboration between different types of stakeholders, and in successful cases of this model, the collaboration leads to the different entities independently implement innovations (Etzkowitz, 2003).

However, with the rapid development of society and the continuous optimisation of innovation models, the limitations of the traditional triple helix theory have gradually been exposed (Zhang & Huang, 2013). Civil society as a new innovation entity is included in the innovation system, and the triple helix model has developed into a quadruple helix model based on ‘government-enterprise-university-civil society.’ This new model pays more attention to the innovation environment and participation of the public and has a clearer division of functions for each innovation entity. The government acts as coordinator and is responsible for the operation and regulation of the system and the construction of the innovation environment; the enterprises are responsible for technology research, improvement and transformation of innovation, and universities and scientific research institutions are responsible for basic research and development and the cultivation of innovative talents (Wu & Shen, 2014); civil society is responsible for using products and giving timely feedback.

Early research on Regional Innovation Systems (RIS) mainly focused on national innovation systems. In 1987, Freeman defined the national innovation system for the first time. He proposed that the national innovation system is an organisational system composed of various enterprises, related industry institutions and various public sectors, and has certain innovative functions (Freeman, 1987). After the concept of the national innovation system was put forward, an upsurge of innovation system research was set off worldwide (Qi, 2021). Cooke (1998) of the University of Cardiff in the UK first expounded the concept of the RIS in the book “Regional Innovation System: The Role of Governance in a Globalized World.” He posed that a regional innovation system is a system of
geographically distributed, interconnected production enterprises, research institutions, and higher education institutions, and this system supports and generates innovation. Asheim and Isaksen (1997) argue that a regional innovation system is a regional cluster composed of supporting organisations around two types of actors and their interactions. The first category of main actors are industrial clusters and related supporting industries in the region; the second category contains institutional infrastructure including universities, research institutions, technical intermediaries, industry associations, and financial institutions (Asheim and Isaksen, 2002).

3. Precedents and Case Study Analysis

The study presented in this paper started with research into the current composition of innovation systems in Hong Kong and Shenzhen. It then conducted an analysis of two precedent case studies that included innovation-oriented urban planning strategies that achieved economic and cultural collaboration. Based on these precedents, planning principles, and design guidelines for innovation ecosystems were formulated. The second part of the study consisted of site research for the Hong Kong and Shenzhen border region, collecting relevant information on the urban processes and structures in this region, including land use planning, transportation networks, infrastructure, and surrounding environment, as well as social and economic activities on both sides of the Shenzhen River.

The final stage of the study explores a strategic development scenario for a case study site at Lok Ma Chau, defining an urban planning mechanism that could support the cooperation between the two adjacent innovation systems.

3.1. Existing Innovation Systems in Hong Kong and Shenzhen

Based on further literature research, the current strengths, and opportunities for strategic improvement within the existing innovation systems in Hong Kong & Shenzhen can be formulated.

Hong Kong: An international financial metropolis

The Hong Kong government’s initiative to promote innovation is mainly to provide an intermediate platform to connect different stakeholders and provide financial policy support to improve government efficiency. To further promote the development of innovative technologies, Hong Kong established the Innovation and Technology Commission (ITC) in 2000 and the Hong Kong Science and Technology Park (HKSTP) in 2001. In 2015, the Innovation and Technology Bureau (ITB) was set up to strengthen the connection between various stakeholders and generate greater synergy (ITB, 2017). In parallel with the establishment of innovation-related departments, the Hong Kong Government is committed to strengthening investment in the innovation and technology sector (Chan, 2017, 2018). As of March 31, 2021, the government’s financial support for innovation and technology had reached 10,071.5 million HKD (ITF, 2021). The government has also formulated a technical talent introduction plan, which aims to support qualified companies to invite overseas and mainland scientific and technological talents to come to Hong Kong for research and development work through fast-track processing arrangements (ITC, 2020).

Hong Kong has advanced higher education, but its R&D industry and innovation are relatively weak. According to government statistics (Tables 1), about 93% of Hong Kong’s GDP comes from the tertiary industry (HKSAR Census and Statistics Department, 2016), which reflects the single and strong dependence of Hong Kong’s economic structure. It is this unbalanced economic development that has weakened Hong Kong’s performance in innovative technologies. Compared to Shenzhen, Hong Kong’s expenditure on innovative industries and its proportion are also lagging behind (Wang, 2018). In 2019, Hong Kong’s R&D expenditure (US $3387 million) was only about 20% of that of Shenzhen (US $20543 million). In addition, Hong Kong’s expenditure on innovative industries as a percentage of GDP (0.92%) is approximately 22% of Shenzhen (4.2%) (Shenzhen Bureau of Statistics, 2019; HKSAR Census and Statistics Department, 2019). On the contrary, the higher education sector in Hong Kong has excellent universities and plays an important role in innovative research and development activities. Of the eight government-funded universities in Hong Kong, five of them are ranked in the top 100 in the 2021 QS World University Rankings. This shows that the research capabilities of universities of Hong Kong are globally competitive (QS, 2021).
Table 1. Hong Kong’s industrial structure

<table>
<thead>
<tr>
<th>Industrial structure</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary industry</td>
<td>6.9%</td>
<td>6.6%</td>
</tr>
<tr>
<td>Tertiary industry</td>
<td>93.1%</td>
<td>93.4%</td>
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</tbody>
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Table 2. Shenzhen’s industrial structure

<table>
<thead>
<tr>
<th>Industrial structure</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary industry</td>
<td>39.6%</td>
<td>39.0%</td>
</tr>
<tr>
<td>Tertiary industry</td>
<td>60.3%</td>
<td>60.9%</td>
</tr>
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</table>

Shenzhen: An innovation city

Compared to Hong Kong, Shenzhen’s higher education industry is less developed, which restricts the development of its innovation system. In order to solve this problem, the Shenzhen Municipal Government has implemented strategies of cooperation with regional and international universities, increasing investment in higher education industries and formulating incentive policies to attract talent (Kang & Jiang, 2020). In 2000, the Shenzhen Municipal Government issued the first policy – “Regulations on Encouraging Overseas Chinese to Start Businesses in Shenzhen” to encourage overseas Chinese to participate in the development of Shenzhen (Shenzhen Municipal Government, 2007). In 2010, the Shenzhen Municipal Government launched its own overseas high-end talent recruitment program, called the “Peacock Plan.” The purpose of the program is to recruit outstanding innovative talents and advanced research teams from abroad to Shenzhen, with the expectation of developing the local economy and industry through innovative technologies (Shenzhen Municipal Government, 2011). In 2020, the programme had introduced a total of 162 peacock teams and innovative scientific research teams (Shenzhen Municipal Government, 2020). Established in 1999, the Shenzhen Virtual University Park is an Industry-University-Research innovation park in accordance with the “one park and multiple schools” model. To attract more universities to join the SZVUP, the Shenzhen government provides preferential policies for joining universities. So far, a total of 60 renowned universities, including 44 universities in Mainland China, six universities in Hong Kong, and seven international universities, have joined the initiative (SZVUP, 2012).

3.2. Precedents

By analysing two international precedents of innovation ecosystems, it is possible to extract insights on the measures, management mechanisms, and experiences that could apply to future Hong Kong and Shenzhen innovation and integration projects. The case studies were chosen because of their multi-faceted nature, combining a range of stakeholders, policies, and supporting infrastructures which have resulted in a proven track record of successful incremental growth and productivity gains. While these precedents do not involve cross-border collaboration, they offer valuable insights applicable to a future Hong Kong-Shenzhen border region managed within a context of increased governmental alignment.

High Tech Campus Eindhoven (HTCE), the Netherlands

The Eindhoven High Tech Campus was once the location of the R&D headquarters of the Philips Group in the Netherlands. Within only five years, the initially closed R&D centre had transformed into an open science and technology campus, thanks to the forward-thinking policies and collaboration between government, university and local companies. In 2015, the area was named ‘the smartest campus in the world’ by Forbes Magazine. The experiences around the planning, design, and management of the Eindhoven High-tech Park offer valuable lessons for innovation campus development projects in Hong Kong and Shenzhen border region:

i) Giving leading companies a powerful driving role: This project was anchored around leading institutions such as Philips and the Eindhoven University of Technology (TU/E), a top research university in Europe. The leading role of these institutions attracted a range of other technical
institutions, small and medium-sized enterprises, and created a collaborative ecosystem of research and innovation entities and supporting infrastructure.

ii)  *Creating an open environment and promote resource sharing:* The most successful part of its planning was to implement urban design and architecture strategies that create an open environment that promotes resource sharing. Besides this open campus environment, the district promotes resource sharing through knowledge sharing events, shared facilities and organisations that actively pursue collaborative research activities.

iii) *Increased services:* the campus was supported by dedicated government services to streamline and optimise the processes of company registration, recruitment, and settling in of talented people, and to protect research outcomes, and help bringing innovations onto the market. A wide range of functional and social support functions is located in the area, including banks, print ships, restaurants, meeting rooms, health and fitness centres, etc.

*Aalto University Regional Innovation Ecosystem*

Aalto University is located in Espoo, an area in the metropolitan area of Helsinki that is famous for high-tech manufacturing. The university has created an innovation and entrepreneurial (E&I) ecosystem based on its inherent regional innovation advantages. The development model focuses on student entrepreneurship and supporting start-ups. As a result, Aalto University is now the birthplace of several highly productive innovation and entrepreneurial companies in Finland. Some of the mechanisms for success are the energetic student-led entrepreneurial movement, supported by the university’s senior leadership team (Graham, 2014). Learning from Aalto University’s successful experience in building a Finnish innovation and entrepreneurship ecosystem, and evaluating the existing conditions in Hong Kong and Shenzhen, the following recommendations can be distilled:

i)  *Breed a positive innovation environment:* local governments can promote the introduction of high-quality services, resources and human capital into the regional innovation system through targeted initiatives and policies. Enterprises are invited to work together to connect supply chains, exchange experts, and expertise, and together create a multi-level network of innovative companies.

ii)  *Encourage public participation:* Aalto University’s innovation and entrepreneurship ecosystem encourages the integration of regional public cultures, media, and people. On one hand, this creates and open and supportive atmosphere for education, innovation, and entrepreneurship to promote the long-term sustainable development of the innovation industries. On the other hand, the increased public discourse and information dissemination helps the government to plan innovation and entrepreneurship strategies through timely information feedback, so as to achieve collaboration between universities, governments, innovative enterprises, the public and other stakeholders.

iii)  *Establish a deregulated and decentralized governance model:* The model promoted by the Finnish government provides an enabling environment for Aalto University and the enterprises within the area. Aalto University enjoys a high degree of decision-making power and autonomy, and this bottom-up model is conducive to cooperation and consultation between university and companies, and to the connectivity of the innovation and entrepreneurial ecosystem to the outside world.

3.3. Research into the Hong Kong and Shenzhen border region

The Hong Kong and Shenzhen Cross-border Area (Frontier Closed Area) was established by HK-British government in June 1951. It was set up to prevent illegal migration and other illegal activities from mainland China and elsewhere. Because of the strict control and lack of human activities, the cross-border area became a natural habitat
for flora and fauna. In 2008, the Hong Kong government reduced the Cross-border Area to 400 hectares, freeing up a large vacant area with a high potential for development.

**Urban form and land use**

In relation to urban form and land use, analysis shows that the Luohu and Futian Districts in Shenzhen are already highly developed, densely populated, and urbanised areas. In contrast, the border areas of Hong Kong are dominated by natural landscapes such as farmland and villages, and some relatively isolated new towns. In terms of land use, the Futian Financial Centre and the Luohu Commercial Centre in the border area of Shenzhen are mainly commercial and residential. In contrast, Hong Kong’s border areas are mainly residential land and rural land (Figure 1). Generally, the urban fabric and land use in the border areas of Shenzhen and Hong Kong are quite different, and the boundaries are obvious.

**Transport networks**

Shenzhen has formed a comprehensive road network extending in all directions, and the roads are further extended to the Shenzhen-Hong Kong border region. However, due to the restrictions on movement across the Hong Kong border, the road network does not have a good connectivity across the border region. Shenzhen’s subway network covers the city’s main urbanised area and also several of its recently emerged satellite nodes. Hong Kong’s northern New Territories are relatively sparsely served by MTR lines, with the East Rail Line and West Rail Line mainly serving many of Hong Kong’s new towns. Currently, Shenzhen and Hong Kong have two interoperable cross-border railways. The first is the East Rail Line, which connects Hong Kong and mainland border crossing at Lowu/Luohu and Lok Ma Chau/Futian Checkpoint, and the second is the Hong Kong-Shenzhen-Guangzhou High Speed Rail, which connects Shenzhen Futian Station and Hong Kong West Kowloon Station (Figure 2).

![Figure 1. Imbalance of urban form at the Hong Kong & Shenzhen Border](image)
4. Strategic Development Opportunities

Based on the above analysis of the border region between Shenzhen and Hong Kong, the Lok Ma Chau Loop and Shenzhen Huanggang Port areas were selected as the site to test strategies to implement a cross-border innovation district at the urban planning and urban design levels (Figure 3). The Lok Ma Chau Loop is close to the Huanggang and Futian ports, which are the two main ports connecting Hong Kong and Shenzhen. The site is close to the Futian Central District, which is the commercial, financial and cultural centre of Shenzhen. It was created by the rerouting of Shenzhen river, and is already planned to be developed into a collaborative technology and innovation area. The area has a strategic location along the newly planned ‘development corridors’ in between Hong Kong and Shenzhen, connecting to a major transit hub in the integrated infrastructure networks of the future Greater Bay Area. The implementation of the Lok Ma Chau technology area has suffered delays due to regulatory differences and other organisational difficulties, which are projected to be increasingly manageable as further connective infrastructures and economic and institutional collaborations are being developed.
4.1. Planning principles

Based on the insights from the literature and case studies around Regional Innovation Systems, strategies for the translation of border region collaboration principles can be translated into planning principles. The principles are aimed at expanding and strengthening the Hong Kong-Shenzhen innovation ecosystems, facilitating high-level cooperation strengthening the region’s international competitive position. Following the examples of the High-Tech Campus Eindhoven and Aalto University’s innovation ecosystem, and adapted towards the regional characteristics and local conditions, this study proposes a specific implementation path for a new Shenzhen-Hong Kong cross-border innovation ecosystem.

Form a Shenzhen-Hong Kong co-city coordination and management mechanism

The first measure would be to facilitate facilitating high-level cooperation, identifying strategic partner collaborations and formulate policies, infrastructure, and support programmes from the government-level point of view. It would be recommended to set up a Hong Kong and Shenzhen science and technology cooperation department to coordinate and handle the multi-faceted approach to promote innovation and collaboration between the different territories and stakeholders.

Expand the role and services of local government

The second measure should involve the creation of additional policies, programmes and incentives to optimise access to the area for new enterprises, scientific research institutions, and regional and international talent. As it is important to support a dynamic sector, government services should be accessible or implemented with high speeds and efficiency. Policies should be put in place to encourage enterprises, scientific research institutions, and universities to open up to the outside world, to build an “open innovation and collaboration platform,” and create a mature innovation ecosystem that creates a supportive, creative, and progressive atmosphere.

Stimulate industrial clusters to improve the efficiency of the regional innovation system

As innovation is not isolated, but tends to occur in clusters (Qi, 2021), it would be recommended to establish the first clusters of leading companies into the innovation area and promote their leading role to attract small and medium-sized enterprises to join the growing cluster. Government support and special arrangements could be made with these “anchor-institutions,” to kick-start the gradual emergence of an ecological development model of “large enterprises + small and medium enterprises + scientific research institutions + universities” (Qi, 2021).

4.2. Urban Environment Qualities for a Contemporary Innovation District

In the final stage of this study, the economic and governmental policy ambitions formulated around the goals of creating an innovation ecosystem were translated in spatial urban planning and urban design goals. This translation from planning to urban neighbourhood qualities helps to explore the spatial mechanisms such as function mixture, density, infrastructure, and public services planning to help the innovation area become successful as an urban environment that is attractive and supportive for companies and institutions, as well as for the people that work for these.

An Urban Infrastructural Framework

One of the first and most important urban planning related design challenges is to design a comprehensive spatial framework that can serve as an open platform and support network for the institutions and people moving into the innovation area. Instead of planning a car dominated urban district where road infrastructure takes priority, a wider system of traffic, business and social infrastructures should be designed that enables flexibility, collaboration, and liveability. In the case study application (Figures 4 and 5), the theoretical model of the ‘mat-building’ was referenced to envision a combined urban system of slow traffic roads, public transport, public spaces, and blue/green landscape features. The grid system was adopted to ensure a market-driven flexible provision land-leasing, also promoting function mixing within each plot and vertically within buildings. Integration with existing rail stations is key to ensure seamless connectivity with the urban context.
**Human-centric Urban Design**

As the key success factor for innovation districts is the attraction of talented people and their families, the emphasis of the urban design strategy is liveability. The area will not only spaces for work, but also for living and recreation, and offering high quality and varied urban spaces. Walkability is ensured by reducing and hiding car roads and car parks, creating small urban plots intersected by alleyways and courtyards, and generous greening, seating, street-facing retail, coffee shops, and restaurants. Existing assets such as waterfront areas can be turned into large parks to offset high-density urban neighbourhoods with high-quality natural environments and recreation. Investment in design, construction, and maintenance will ensure the attraction and interaction of high-value companies and institutions, and can support international and local talents to stay and grow, together with the development of the district over time.

Figure 4. Strategy framework
5. Conclusions

This study has explored the theoretical principles and precedents of Regional Innovation Systems, outlining how planning strategies, urban design measures, and supporting policies can nurture multi-stakeholder ecosystems that achieve innovation through collaboration. As Shenzhen and Hong Kong may see increased regulatory alignment and governmental cooperation in the future, the promotion of their technology and innovation sectors will be a strategically important collaborative opportunity. With the economic development of the Greater Bay Area, the expansion and evolution of knowledge and research-based enterprises requires support from Higher Educational Institutions and government initiatives. The border region, currently regarded as a ‘back garden’ by both Shenzhen and Hong Kong, is a place with high development potential. Attracting key new industries, research institutions, and talented people to this area could enhance the competitiveness of Hong Kong, Shenzhen, and the Greater Bay Area on the world stage.

From analysing international precedents of Regional Innovation Systems, it has become clear that successful examples of these systems involve leading institutions and companies, which are able to drive policy and development decisions in close collaboration with local government bodies. Planning, urban design and architectural strategies for innovation areas should not only focus on quantitative goals and branding, but incorporate progressive attitudes towards creating human-centric, open urban environments that promote interaction between different stakeholders through shared spaces and facilities. A comprehensive and service-oriented government-led urban infrastructure system could form a ‘framework’ for adaptive stakeholder-led development over time, incorporating transport and business infrastructure, as well as social and recreational facilities.

When these principles distilled from international case studies are applied to the Shenzhen Hong Kong border region, several challenges and opportunities emerge. The cross-border nature of this area poses difficulties due to the regulatory differences, requiring high-level coordination or the creation of a new governing body dedicated to the new collaborative innovation and technology districts. This co-city management mechanism can establish a pro-active, expanded government role to boost the growth of new R&D innovation industries, and improve the flow of key resources such as personnel, capital, and technology between Hong Kong and Shenzhen. The geographic location of the border region offers key opportunities to develop a sustainable urban district that benefits from its valuable natural environment, to establish a highly liveable working and living environment.
environment in contrast with the highly densified urban areas in Shenzhen and Hong Kong.

The literature on Regional Innovation Systems highlights the crucial importance of policies and initiatives to stimulate a local culture of open collaboration, public engagement, and promotion of technology and innovation within the wider society, establishing close feedback loops between enterprises and the evolving needs and aspirations of the community. When we translate these goals into an urban planning approach for the case study site at Lok Ma Chau, a comprehensive district with high-quality public spaces, facilities, and services is envisioned, and highly connected to the surrounding urban nodes within the polycentric urban region. At the same time, urban planning and design strategies should be calibrated toward establishing a vibrant and mixed-use urban district that can facilitate dynamic growth and change over time, prioritising the needs of the talented individuals who drive the future success of specialised enterprises, research institutions, and start-up companies with a wide range of requirements. A new district for boundary-breaking research and business initiatives warrants an equally innovative approach to urban planning, design, and management, maximising the potential of the cross-border area to become an important alternative place for living and working in-between Hong Kong and Shenzhen.

References


