Case Study Paper

The Spatial Strategies of Knowledge Corridors in Megacity Development:

Case Study of the Optical Valley Knowledge Corridor, China

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Abstract

As a comprehensive spatial concept, corridors especially mega-corridors and knowledge corridors have played irreplaceable roles in developing megacities. This paper uses the case of the Optical Valley Knowledge Corridor in China as an example to illustrate how to make spatial strategies of knowledge corridors in the dimensions of innovation networks, knowledge economies, environments and urban amenities, transportation systems and urban governance towards making a liveable, sustainable and efficient megacity in the backgrounds of knowledge-based urban development.

Keywords

Corridors, Knowledge-based urban development, Knowledge economies, Megacities

1. Introduction

Originated from the linear city model more than a century ago, the term "corridor" is not only an urban model fully tailored to the transport technology but also a comprehensive spatial concept in dimensions of infrastructures, economics, urbanizations and ecology. It is in the 1990s that the modern version of the corridor concept namely mega-corridor has been brought up in the Europe 1992 project, which aimed at the physical integration of European Territory. Especially with the addition of a prefix "mega", mega-corridors have been assumed to play key roles not only in physical but economic integrations together with the cross-border and transnational infrastructures. In a similar way, cities especially megacities are also growing out of their borders towards regional collaboration, which has given a new role for corridors in the aspects of achieving spatial, economic and social integrations to enhance regional competitiveness.

Especially in the times of global knowledge economies, there has been a prevalence of knowledge corridors considering their great contributions to knowledge-based developments for megacities. With the rise of innovation districts, science and technology clusters have been formed in the forms of corridors in the backgrounds of knowledge economies, which can be exemplified by Silicon Valley, Route 128, London M4 Corridor and

etc. With the announcement of *National Innovation-driven Development Strategy Outlines* in China(State Council of China,2016), great efforts especially in Chinese megacities have been dedicated to developing knowledge corridors aimed at enhancing regional competitiveness through linking themselves with their surrounding cities and towns by a bundle of infrastructures and mainly developing technology-led industries, like Shanghai G60 Corridor, Guangzhou-Shenzhen-Hong Kong-Macau Corridor, Hangzhou West Knowledge Corridor, Hefei Knowledge Corridor and etc.

To achieve regional competitiveness by knowledge-based development, the government of Hubei Province, as one of the major provinces locating in Central China near Yangtze River, has announced at the end of 2018 to develop a knowledge corridor based on one of the largest agglomerations of high technology, primary electronic companies in its territory, known as the Optical Valley which has aimed to be the Chinese version of Silicon Valley. As a provincial development strategy, the Optical Valley Knowledge Corridor (OVKC) is not only supposed to implement the Chinese innovation-driven development strategy, but also to develop a more liveable, sustainable and efficient megacity, which is Wuhan as the capital of Hubei Province, by enhancing the spatial, economic and social integration with its neighbouring cities. Greatly inspired by Silicon Valley, Route 128 and other corridors, the Optical Valley Knowledge Corridor is also an answer to the cluster phenomenon in innovation geography to develop a more competitive innovation economy through technology leapfrogging (Cornell University, INSEAD, WIPO, 2018).

However, despite the general claims of the importance of knowledge corridors, we still know very little about strategic goal-setting in this area. Although there have been a large number of practices concerning corridor development cross administrative borders, studies focused on planning practices of using corridor strategies at an urban scale can be considered relatively scarce. Thus, the aim of this paper is to investigate how to use corridor strategies towards more liveable, sustainable and efficient megacity in the context of China. The Chinese planning system can represent the characters of many top-down counterparts in most developing countries and some developed countries. With the goal to achieve spatial, economic and social integration, the spatial strategies of corridors concern a complex set of economic, social and even political factors, which may be not all applicable to different institutional systems but can be transferrable to other cities which intend to use spatial strategies of knowledge corridors.

The methodological approaches here do not only include the case study investigation of the OVKC as well as science and technology clusters, but also the literature review on corridors. In addition, a set of semi-structural interviews with local governments, representatives from 4 local universities and 17 local enterprises and an online survey concerning the needs of knowledge workers have been conducted. Starting with the literature review on the concept of corridors, the paper will attempt to provide an understanding of the knowledge corridor concept by an investigation of the innovation clusters especially a discussion of the Silicon Valley. Following the interpretations of knowledge corridors in five dimensions, the fourth section will attempt to establish the framework of making spatial strategies of knowledge

corridors. Using the OVKC as an example, strategies have been proposed in correspondence to the interpretations by making it as a loop for innovation systems, a boom for knowledge economies, an attraction for knowledge workers, a highway for innovation flows and a mutual-force for urban governance. Last but not least, the concluding part will discuss the challenge of implementation in policymaking, followed-up work to do and its implications for other cities.

2. Literature Review

Not as a new and univocal one, the corridor concept can be traced back to the linear city models brought up by the Spanish urbanist Soria y Mata(1844-1920) as early as 1882, which has been called the first model fully tailed to the development of transport technology (H Priemus & Zonneveld, 2003). On this basis, the Ciudad Lineal model has been developed and exerted influences on the pattern of urban expansions along with infrastructures especially in regional plans, which was not in the form of unbroken lines but more likely "beads on a string". Although opposed by many urbanists due to the destruction of ecological environments, the linear or belt developments have taken place on a large scale with the technological progress of transportations. Especially in the 19th century, urban decentralization has been enabled by the widespread use of private cars, which can be exemplified by the Silicon Valley in California, Route 128 near Boston, the Silicon Glen in Scotland and the M4 Corridor in Britain. The Silicon Valley, originated from the Stanford Industrial Park, has undergone the expansion along the Route 101 and Route 280 towards San Francisco and Santa Carla. Meanwhile, Route 128, also benefited from the knowledge spillovers of MIT, has been known as the technology corridor due to the agglomeration of high technology firms. As the United Kingdom's equivalents to Silicon Valley and Route 128, Silicon Glen running through Edinburgh and Glasgow has been known as the "industrial belt" of Scotland, and the M4 Corridor has also witnessed the high technology growth along the M4 highway. The common features of all the cases mentioned before are not only that they are all originated from the spillover effects of universities but also famous for the agglomerations of technology enterprises along the main roads.

With the constructions of cross-border especially transnational infrastructures and the awareness of economic integration, corridors are leading urban expansion more at regional and interregional scales than at sub-regional and urban scales. As a modern version, the concept of mega corridors has been brought up in the "Project" Europe 1992, which aimed to promote the economic, social and physical integration by enhancing the level of connectives (Priemus & Zonneveld, 2003). Evolving as a multi-faceted concept, the mega corridor has been not only defined as a bundle of infrastructures with heavy flows of traffic linking transnational urban agglomerations, but also an attempt to reconcile regional economic growths and sustainable developments. Thus, the meaning of corridors has been extended to the dimensions of infrastructures, regional economy, urban development and governance(Zonneveld & Trip, 2003).On this basis, the spatial developments of corridors have been focused on establishing the connections between the transportation, economic development, environment and urbanization with the premises that which areas should be designated as corridors and which parts should be defined as development zones and open

spaces (Priemus & Zonneveld, 2003). As an instrument to achieve economic, social and urban integration, the corridor strategies imply overcoming not only physical borders but also social, cultural and institutional barriers which call for co-governance. Thus, strategic spatial planning, which is directed more towards integrated courses beyond traditional planning, concerns that the corridor concept has been elaborated as a physical and network of international infrastructure, and especially the nodal points of corridors have been balancing between the space of flows and the space of places (Albrechts & Coppens, 2003).

Although the concept of corridors has evolved from linear or belts forms to networks, one thing for sure is that the essential characteristic of corridors is the connectivity which enables the free and easy flow of people, goods and information (Chapman, Pratt, Larkham & Ian,2003). Especially in the backgrounds of knowledge economies which calls for efficient flows of financial and intellectual capitals, corridor developments have been considered as important instruments for megacities to achieve economic competitiveness by spreading economic activities from nodal points to the surrounding areas. Greatly inspired by the success of corridor developments especially the Silicon Valley, Route 128, the Silicon Fen and the M40 Corridor, developing countries in Asia Pacific Region have taken on initiatives of knowledge-based urban development especially science and technology clusters in the form of corridors. Amongst the most notable in the past few years are Tokyo-Yokohama-Tsukuba Corridor, Malaysian Multimedia Super Corridor, Shanghai G60 Knowledge Corridors, Guangzhou-Shenzhen-Hong Kong-Macau Corridors in China and etc. Although the concept of knowledge corridors has not been officially defined, the key elements of corridor projects in the backgrounds of knowledge-based urban development focuses on the assembly of knowledge infrastructure(e.g. universities, research and development institutes and etc), technological infrastructure(e.g. ICTs) ,connections to the global economy (e.g. international companies and finance institutions)and concentrations of well-educated and creative people(e.g. knowledge workers) (Winden & Berg, 2004; Carrillo, 2006; Corey & Wilson, 2006, Sarimin & Yigitcanlar,2011). The strategic developments of knowledge corridors in the economic, socio-cultural, enviro-urban and institutional dimensions have been exemplified by the case study of Malaysian Multimedia Super Corridor to be able to achieve economic prosperity, environmental sustainability, socio – spatial order and local institutional competence (Sarimin & Yigitcanlar,2011).

Although there have been examples of corridors towards knowledge-based urban development, the concept of knowledge corridors hasn't been officially proposed yet based on the literature reviews. Thus, before discussing the spatial strategies of knowledge corridors, there are two key questions to be resolved. Firstly, how to understand the concept of knowledge corridors in the new economies driven by science and technological clusters, which do not rely on traditional factors like before. Secondly, how to make spatial strategies of knowledge corridors towards a more liveable, sustainable and efficient megacity based on the local conditions? The next sections will attempt to answer the questions.

3. The Understanding of Knowledge Corridors

On the one hand, what knowledge corridors are different from other corridors is that the former one has an agglomeration of knowledge infrastructures especially and the ability to attract knowledge flow especially intellectual and capital resources constantly. On the other

hand, what corridors can contribute to the knowledge-based developments is that they can use the strength of connectivity to draw more flows into the nodal points and spread them into the surrounding areas so as to increase the regional competence at a larger scale, which will affect the space of places in return. This section will attempt to elaborate on the interpretations of knowledge corridors.

As a complex process, innovation often requires knowledge flow between different kinds of knowledge organizations which establish contact networks and alliance networks by frequent and repeated interactions (Huggins &Thompson, 2015). During the process, local innovation network could be established, which initially catalyzes the intellectual change and knowledge transfer across administrative borders, namely the regional innovation networks which will improve the efficiency and influences of local networks in return. (Pyka & Scharnhorst, 2009). This could be exemplified by the new-emerging trend of science and technology clusters since 2017, which grow beyond urban or regional borders by major transportation systems to achieve collaborations (Cornell University, INSEAD & WIPO, 2018). In the top-ranking list of the science and technology clusters, knowledge corridors have proved to improve their competitiveness of local and regional innovation networks by achieving efficient connections at different scales. Thus, knowledge corridors can be interpreted as a new form of urban and regional spatial structure, which could establish free flows of innovation resources by a bundle of infrastructures linking urban agglomerations, so as to develop local and regional innovation networks. The following five aspects are the major features of knowledge corridors that could be exemplified by case studies.

First of all, there should be a high concentration of different kinds of innovation resources related to the whole process of knowledge production, diffusion and transfer, which act as the foundation of producing innovation flows. In particular, knowledge production sectors include universities as well as their affiliated labs, knowledge transfer sectors like research institutions and related servicing facilities including investment captures and incubators should be all included as the three basic kinds of innovation resources, which keep interacting with each other to form innovation networks of knowledge corridors. Taking the Silicon Valley as an example, Stanford University, Stanford Research Park and Institutional Venture Partner can represent the three typical kinds of innovation resources, which have been interacted with each other frequently and repeatedly and formed the foundations of innovation networks. What's worthy to mention is that key technological infrastructures like national labs, as essential parts of the innovation resources, are playing crucial roles in forming regional innovation networks.

Secondly, the commercial spin-off effects of knowledge production sectors are the roots of innovation networks as well as their dynamics, considering their roles of enhancing expected economic returns of knowledge. For instance, the success of the Silicon Valley does not only repy on the spillover of Stanford University, which has given birth to local leading enterprises but has also benefited from firm neighbourhoods, where leading enterprises play the role of dandelion so as to nurture new start-ups. As essential parts of local innovation networks, firm neighbourhoods and their structures can be depicted as matrix machines, which indicates that distances matters a lot to the way leading enterprises interacting with new start-ups (Pyka & Scharnhorst,2009). This can be exemplified by the case of Hangzhou West Knowledge Corridor, which has witnessed the assembling lots of new start-ups within a 5 kilometre-radius circle centred at the local leading enterprise namely Alibaba.

Thirdly, keeping an attraction for knowledge workers can be considered as catalysts to boom innovation networks, as human capitals have proved to be key flows to improve regional competence. The various demands of knowledge workers should be satisfied by providing not only pleasant environments but also well-established urban amenities. Taking the Silicon Valley again as an example again, its pleasant climate, seashore and mountain landscapes have been known as one of the key factors to keep withdrawing human flows from other places of the world. Besides, there are not only basic urban amenities like schools, gyms, cultural centres and hospitals, but also a high density of the third places besides home and work like coffee shops for knowledge workers to interact with each other face to face, which has also proved to be essential urban amenities especially to creative industries. Thus, it has been proposed in the plan of the Hangzhou West Knowledge Corridor that the density of coffee shops should be improved to 2 per kilometres square, according to the counterparts of the Silicon Valley.

Fourthly, infrastructures which are the backbones of knowledge corridors should be well-equipped, so as to improve the efficiency of innovation flows. On the one hand, transportation hubs like airports, train stations and harbours as nodal points should be well-connected to the regional transit systems, which can not only facilitate the absorption of intellectual and capital flows but also help developing regional innovation networks based on the local networks. On the other hand, the inner transit system including highways, subways as well as bike lanes should be well established to improve the efficiency of inner flows between nodal points. This can also be exemplified by the Silicon Valley which has not only benefited from the Route 101 and 280, but also from the San Francisco International Airport and San Jose International Airport. Thus, it has been proposed in the plan of Shanghai G60 Knowledge Corridor that the network density of highways should be improved 15 percent based on the existing transit system.

Last but not least, smart urban governance to keep urban planning, development and management flexible and adapt to the uncertainty of innovation is the key to keep constant flows in the places of space. The case of the Silicon Valley has not only exemplified the success of market-driven forces but also the smartness of urban governance. Not only the top-bottom approach by governments to regulate the spaces which play necessary roles in the process of innovation but are less-favoured by market, but also the bottom-top approach to improving the initiatives of markets should both be used in the governance of knowledge corridors. Besides, as the boundary of knowledge corridors usually crosses the borders of cities, provinces or even nations, the governing process usually requires the collaborations of vertical governments as well as the participation of universities, enterprises, citizens and etc. As a dynamic participatory process, the co-governance of knowledge corridors will not only need a long-term vision and short-term actions, but also require continuous evaluation and revision according to their own developmental stages and also adapting to new requirements (Sarimin & Yigitcanlar ,2015)

Based on the interpretations of knowledge corridors in five dimensions, the next session will attempt to discuss corridor strategies especially for megacities by the case studies of the OVKC in China, so as to shed some lights on other cities

4. The Knowledge Corridor Spatial Strategies in Megacity Developments: Case of the Optical Valley Knowledge Corridor in China

As the largest knowledge-based urban development initiative in Hubei Province, China, the OVKC covers an area of 1515 kilometres square in Wuhan as well as its neighbouring city namely Ezhou. By benchmarking the progress amongst the prosperous knowledge corridors, it is intended that the OVKC function as a high-tech catalyst to help Wuhan and Ezhou to attract knowledge workers and techno-enterprises and become global international centres, so as to help with the transformation of urban development. The completion of the OVKC is estimated at an approximate 30-year timeframe and the development staged into three phases to allocate the initiatives. The first phase of the OVKC aims at creating a regional innovation hub in the Yangtze River Economic Belt in three years. The main goal of the second phase would be making the OVKC as an essential part of the Chinese innovation communities until 2035. Last but not least, the final goal would be aiming at a world-class innovation cluster, so as to help transform China into a "knowledge nation" till 2050. Towards the goals, adapting to the prevailing social-economic, technological and environmental circumstances in Wuhan, with the principles of producing diversity, prosperity, equity, efficiency and sustainability, a framework of spatial strategies of knowledge corridors based on the five dimensions of interpretations have been established in the aspects of making the OVKC a loop of innovation networks, a boom for knowledge economics, an attraction for knowledge workers, a freeway for innovation flows and a mutual-force for urban governance.

4.1.   Making knowledge Corridors a Loop of Innovation Networks

As a type of linear form, knowledge corridors are actually science and technology clusters with a variety of knowledge sectors interacting with each other. The major differences between knowledge corridors and other types of science and technology clusters lie that the former ones with the character of connectivity are easier to develop a loop of innovation networks both locally and globally. Cases like the Silicon Valley show that the development of innovation networks usually go through stages from the agglomeration of knowledge sectors, the formation of local networks, the development of local networks and establishment of regional networks. Although the OVKC has abundant innovation resources including 60 universities, 19 national labs, 121 research institutes and etc, there are still missing ingredients including inter alia, key technology infrastructures, new types of research institutions, venture capitalists to fund the start-ups compared to other knowledge corridors home and aboard. Due to the lack of certain types of innovation resources, the local innovation networks has not been well-established only with local universities, research institutes interacting frequently with enterprises in Wuhan and out of Hubei Province. Let alone the regional innovation network, which has been dominated by three technology clusters centred around megacities like Beijing, Shanghai and Shenzhen. Therefore, the OVKC is at the stage between the formation of local networks and the development of local networks.

Based on the current stage of the OVKC, strategies towards making a loop of innovation networks have been made including bringing more varieties to the types of innovation resources, developing both local and regional innovation networks, so as to improve the

regional roles in the national and international innovation geographies. Firstly, various knowledge sectors have been proposed to be introduced including new types of research institutions and all related servicing sectors like venture capitals and incubators specifically. What's more important is that key technological infrastructures should be encouraged to locate within the OVKC, which would prefer scenery sites. Secondly, networking development is required not only between local universities and industries within Wuhan, but also between all kinds of knowledge sectors in and out of Wuhan as well as Ezhou. Knowledge neighbourhoods have been proposed to be established centring at local universities and research institutes surrounded by venture captures, incubators and new start-ups within 5 kilometres, so as to enhance the transfer of knowledge (Figure 1). On this basis, local innovation networks can be built with four distinctive functional zone designated as key areas to produce, transfer and commercialize knowledge specifically and multiple knowledge neighbourhoods as nodal points to improve the capacity of local networks. Thirdly, the regional networks can be developed with the two airports acting as the innovation hubs to input and output knowledge talents and products. Based on its own strengths, the OVKC will be able to form a regional innovation community with Shanghai and its surrounding cities along the Yangtze River.
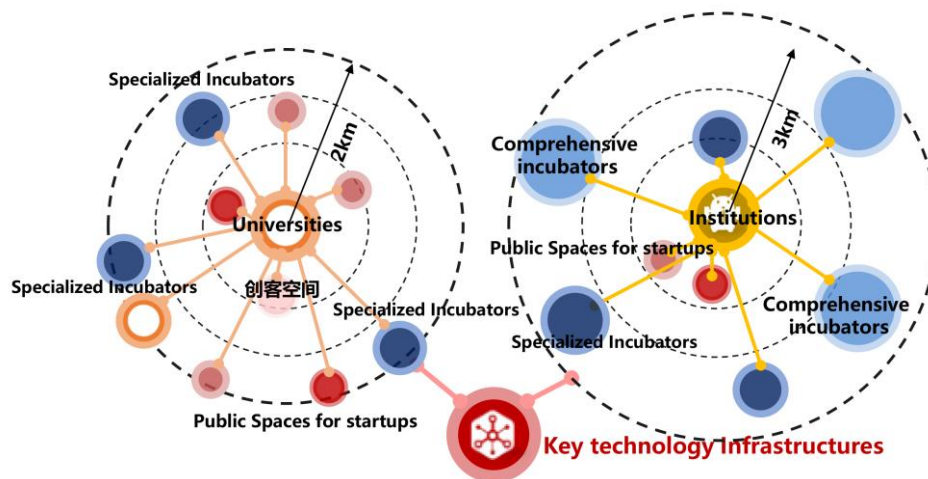

Figure 1 Local Knowledge Neighbourhoods

4.2. Making Knowledge Corridors a Boom for Knowledge Economies

Related to the innovation network is the geographical concentration of technology enterprises, which form industrial clusters and derive the booming of knowledge economies. Thus, the key to making knowledge corridors as a boom for knowledge economies is to incorporate the industrial chain with innovation networks by bridging the gaps between the producing and commercializing knowledge so as to keep nurturing local leading enterprises which could also give birth to new start-ups in the firm neighbourhoods. However, although the OVKC has been well-known for its competitiveness in optoelectronics industries, bio industries and intelligent manufacturing industries, the main reason lies that local leading firms are mostly the branches of national enterprises with their research functions locating in the first-tier cities like Beijing, Shanghai and Shenzhen. This has resulted in the failures of building local firm neighbourhoods, which can be exemplified by the fact that the current

amount of unicorn enterprises ranks behind compared to other knowledge corridors in China. Besides, there is an intriguing fact that high-tech firms have taken account for two-thirds of the total amounts but one-third of all the production value of Hubei Province respectively. Investigations indicate that current high-tech firms are experiencing the threshold of growth due to lack of technical service facilities like pubic semi-works, public data-sharing centres.

Therefore, to boom the knowledge economies of the OVKC, the first thing to do is to build local neighbourhoods of firms and enhance networking possibilities between existing local leading enterprises and start-ups by locating technological service facilities including public semi-works, data-sharing centres and research labs in between, which not only can decrease the cost of growth for start-ups but also can realize the "dandelion" roles of local leading enterprises through face-to-face communications(figure 2). Besides, it is also proposed to introduce new leading enterprises which could locate their research and development sectors locally. To increase the attraction for them, designated zones with specific favourable policies on tax, constructions and etc, have been proposed, which requires deeper discussions furthermore. In this way, the current industrial chains of the OVKC could be incorporated with the innovation networks, which will not only focus on increasing the competence of the existing dominating industries, but also stress the roles of the technological service industries and attempt to expand the boundaries of existing industries towards the future. Especially, stressing the roles of the technological service industries like finances would benefit the building of local innovation networks by enhancing the access of knowledge sectors to venture capitals.
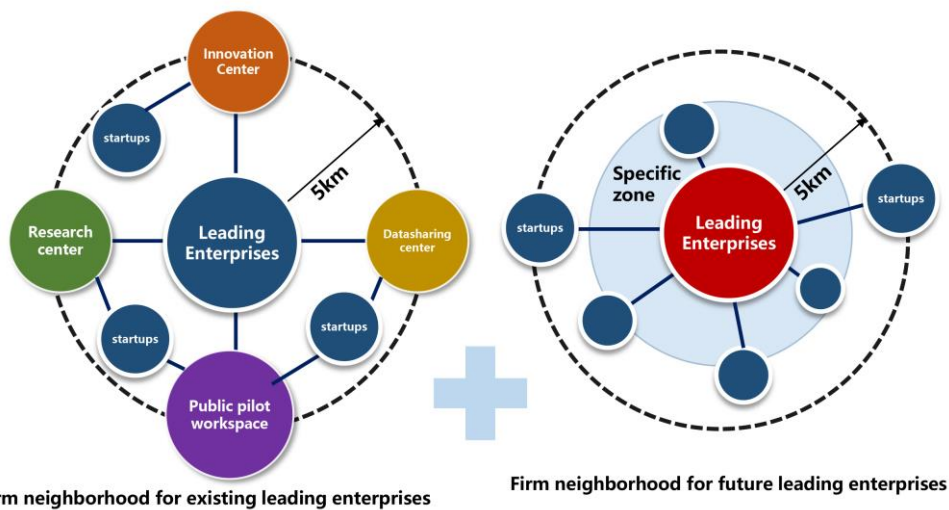

Figure 2 Local Neighbourhoods of Firms

4.3.   Making Knowledge Corridors an Attraction for Knowledge Workers

Knowledge workers, with a higher level of education, have been known as one of the most important driving forces behind knowledge-based developments. Together with knowledge, they are sourcing from universities but are free to move anywhere favourable to their living expectations. Pleasant environments and well-established urban amenities have proved to be the major attractions for them. As for the case of Wuhan, it has been known for its

nickname as "the Forest of Campus" but suffering from the loss of undergraduates for a long time due to the lack of attraction for knowledge workers. Although the OVKC is surrounded with mountains, lakes and rivers, there is neither many high-quality city parks with easy access nor greenways linking the surrounding sceneries. Investigations indicate that public space is the most important aspect that the OVKC should be improved at, and the existing urban amenities fail to meet the requirements of knowledge workers. Not only there is a lack of basic urban amenities especially elementary schools and hospitals, but also the third places like coffee shops for knowledge workers to mingle are short-supplied compared to other knowledge corridors. Considering that the number of knowledge workers in the OVKC is increasing at a higher rate than that of local residents, it is necessary to supply with customized urban amenities to meet the requirements of knowledge workers.

Thus, to make the OVKC an attraction for knowledge workers, it is suggested to establish a complex of "green", "red" and "yellow" infrastructures towards the current problems. Firstly, "green" infrastructures including high-quality urban parks with multi-functions like culture and sports and easy-access pocket parks with communication spaces have been proposed to locate within the corridor, linked by greenways (Figure 3). Secondly, "red" infrastructures which mean basic urban amenities for local residents should not only be supplemented according to the whole evaluation of the current facilities but also be required to be built with high standards. Thirdly, "yellow" infrastructures specifically targeting towards local knowledge workers are suggested to locate around workplaces within 15-minutes walking distances. According to the investigation with knowledge workers, the functions of "yellow" infrastructures are supposed to include not only retails, apartments, sports and so on for basic livings, but also encouraged to provide coffee shops, art galleries, book stores and libraries for knowledge workers to minge between and after work. This complex of "green", "red" and "yellow" infrastructures will furnish the innovation networks by keeping attracting knowledge workers.
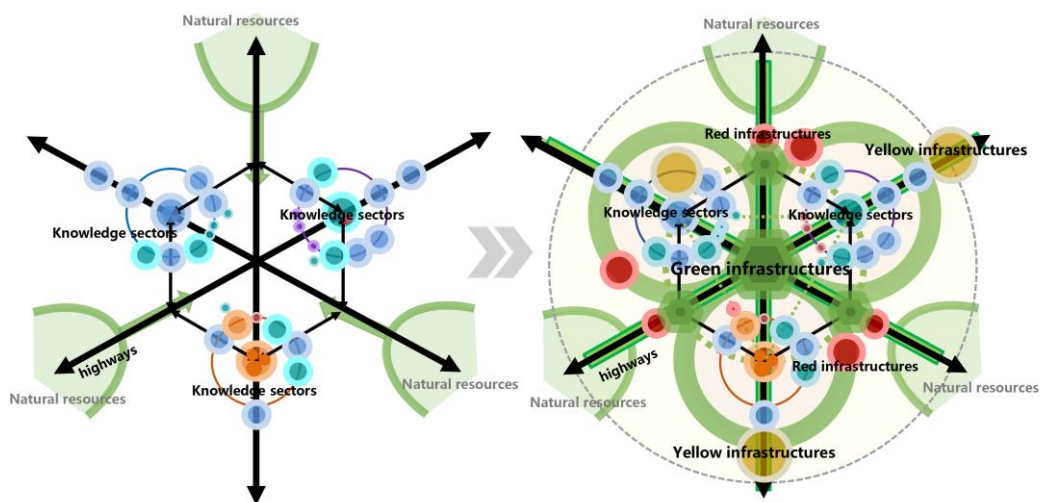

Figure 3 The Complex of "Green"," Red" and "Yellow" Infrastructures

4.4.　Making Knowledge Corridors a Freeway for Innovation Flows

Based on a bundle of infrastructures, knowledge corridors should become a freeway for innovation flows owing to the connectivity. With nodal points equipped with a transportation hubs playing the roles of attracting flows, the infrastructures of corridors could provide a freeway for innovation flows, so as to improve both the local and regional innovation network as a result. Aimed to be the national and international innovation centre, the OVKC still has a long way to go due to its current weak connection locally and regionally. Although with 3 high-speed train stations and 10 intercity train stations, the OVKC has taken the position of transportation hub in Central China, which will be threatened due to the construction of new super highspeed railways in nearby cities. Although there is the Tianhe Airport which is supposed to become the biggest passenger airport in Central China and will be the Shunfeng Airport which aimed at ranking the third among freight airports in Asia, this area is weakly connected to both the airports. Due to the rivers as natural barriers, the transportation system of highways, subways and greenways are all underdeveloped, leading to the traffic jams in rush hours let alone easy access to nodal points.

Therefore, to realize the goals of the national and international innovation centre, the first thing to do would be improving the strategic position in national and international transportation systems by speeding up the construction of the Shunfen Airport and locating super highspeed railway stations within the boundary of the OVKC. Besides, the network density of highway systems is proposed to be improved so as to improve the connection between nodal points especially airports, train stations and other hubs. More efficient public transport systems are also proposed to be built by extending the subway line to link with most nodal points and establishing greenways to connect subway stations with workplaces and housing areas. In particular, a specialized public transport system including subways and bus lines is suggested to establish door to door between universities, research institutions and major knowledge sectors, towards the problems of low efficiency of current public transport. A smart transit system is also suggested to build upon the existing roads, towards the problems of traffic jams in rush hours. In this way, the goal has been set that it will take not more than 60 minutes to reach nodal points especially the airports, train stations and other transportation hubs from anywhere within the boundary of the OVKC.

4.5.   Making Knowledge Corridors a Mutual Force for Urban Governance

The tricky parts of governing knowledge corridors lie not only with the uncertainty of innovation but also the cross-bordering issue of linear developments, which is like a dynamic, participatory and strategic process and it requires a careful and delicate orchestration (Sarimin & Yigitcanlar, 2015). As the boundary of the OVKC crosses the borders of two cities, a mutual-force between central governments vertically as well as the two municipalities and the public horizontally has been missing due to the institutional issues. Although the public policies concerning to the innovation activities in the OVKC have been issued at a number of more than 100, only less than 10 percent of the policies are related to the governance of spaces for innovation activities. This has led to the difficulties in the whole process of knowledge-based urban development, due to the lack of flexibilities to adapt to the uncertainty of innovation. For example, the current land use regulation has set up a rigid upper limit for the mixed-use functions while investigations indicate that the requirements of the existing enterprises to improve the proportions of mixed uses are difficult to meet with. This has also increased the institutional cost for enterprises to be engaged more in innovation activities.

To form a mutual-force for urban governance, it is suggested that a "one-stop-agency" for the operational management of the OVKC should be established at first to enhance the organizational capacity, which involves not only the provincial government of Hubei, the municipal governments of Wuhan and Ezhou, but also local universities, enterprises and the public. Besides, the flexibilities of current land use regulations have been proposed to be enhanced by increasing the upper limit of mixed-use functions and adding a new type of land use to the existing system, which could be undefined of land use and applying for specific policies to locate key technological infrastructures, leading enterprises and etc. Beyond this what needed most is not only the adjustment of current public policies but also a continuous policy monitoring system to recognize the current development stage as well as the problems and ensure that the objectives can be achieved. In correspondence to the understanding of knowledge corridors, the system of 36 indexes which can be measured every year and compared with other cities have been established in 5 dimensions corresponding to the interpretations of knowledge corridors (table 1).

Table 2 The Indexes of the Monitoring System

Category	Sub-category	Index
Innovation Resources	Innovation Input	Number of key technology infrastructures
		Number of Incubators
		Number of Public Spaces for Startups
		The percentage of research and development expenses in GDP（%)
	Innovation Output	Valid patents per 10000 people per year
		Number of PCT patents per year
		Number of invented international standards
Industries	Industrial Structure	Percentage of the added value of strategic industries in GDP(%)
		Percentage of the added value of new economies in GDP(%)
		Percentage of high-tech service industries incomes(%)
	Innovative Enterprises	The Increasing rate of gazelle enterprises(%)
		Number of unicorn enterprises
		The Increasing number of high-tech enterprises per year
		Number of enterprises with venture capitals
Physical Environments	Public Spaces	Areas of parks per person(square meters)
		Coverage of urban parks with an area of more than 5000 square meters to residential districts within 500 meters(%)
		Number of urban parks with an area of more than 10 hectares per 10000 people
		Coverage of greenways to residential districts within 5-minute walking distances
	Urban amenities	Number of international schools per 10000 people
		Number of hospital beds per 10000 people
		Number of larger urban amenities(including exhibitions, libraries, art galleries, theaters and etc.) per 10000 people
		Coverage of urban amenities to residential districts(%)
		Areas of the third places(like coffee houses) per person (square meters)
Transport	Accessibility	Coverage of airports within 60-minute travel(%)
		Coverage of train stations within 45-minute travel(%)
		The Density of high-way network(meters per square meters)
	Connectivity	The Density of branch network(meters per square meters)
		Milestones of subways(kilometers)
		Percentage of travel by public transport(%)
		Milestones of public transport per 100000 people(kilometers)

Governance	**Spaces**	Percentage of increased spaces for innovation activities in office buildings per year(%)
		Percentage of increased apartments for knowledge workers in housings(%)
	Policies	Percentage of policies for innovators (%)
		Percentage of policies for capitals
		Percentage of policies for related issues (%)
		Percentage of policies for coordination(%)

To implement the strategies at local scales, short-term, mid-term and long-term targets for the index system have been made respectively and an action plan for the next year has also been established especially. As a complex of long-term vision, plans and short-term actions together with effective policies, knowledge corridor strategies would require a long span of time to achieve progress. Within the first phase of development, the projects listed in the action plan for the OVKC are about to launch or still in progress though. However, what's obvious right now is that both local governments of Wuhan and Ezhou are preparing to collaborate with each other with the establishment of the strategic plan, which indicates a good start for the implementation of the strategic plans. With the strategies been proposed elevated to national agenda while keeping sinking locally and regionally, this would also improve the competitiveness, sustainability and liveability of the megacity of Wuhan and its metropolitan area.

5. Conclusions

How to understand the concept of knowledge corridors in the new economies driven by science and technological clusters, which do not rely on traditional factors like before? How to make knowledge corridor strategies towards a more liveable, sustainable and efficient megacity based on the local conditions? The two questions above have been answered by the literature review and case studies in this paper. Although the corridor concept, with a long history, has evolved from linear or belt patterns to networks, one thing which has never changed is its character of connectivity. Greatly inspired by the success of the Silicon Valley, M80 and other technology clusters in corridor patterns, there has been a trend of using the spatial instruments of knowledge corridor with its connectivity to improve the regional roles of megacities in developing countries especially like China. Based on the original concepts and case studies, knowledge corridors, as the combination of knowledge-based urban development and corridor development, could be interpreted as corridors with various knowledge resources to establish local and regional innovation networks, clustered leading enterprises which could nurture start-ups to boom knowledge economies, pleasant environments and urban amenities to attract knowledge workers, well-connected transit systems to improve the efficiency of innovation flows and co-governing mechanism to adapt to the uncertainty of innovation. Based on the five dimensions of the understanding, the case study of the OVKC has been used to elaborate the knowledge corridor strategies, which are proposed to be made as a loop for innovation networks, a boom for knowledge economies, an attraction for knowledge workers, a freeway for innovation flows and a mutual force for co-governance, towards a more liveable, sustainable and efficient megacity. As a complex of visions, plans and actions together with effective policies, knowledge corridor strategies should not be phased according to its own circumstances but also require continuous monitoring.

As there will a span of time to access the achievements or failure of the strategic plans of the OVKC, what the case study would like to contribute is the framework in making knowledge corridor strategies rather than the wholesale packages. Like an orchestra, the implementation of knowledge corridor strategies does not only require a conductor to vision, lead, monitor and make adjustments constantly but also a group of music players to collaborate. Although the music books like the framework of the strategies may not change in different theatres, the performances will be not the same with different audiences like the country-specific social, cultural, economic and technological circumstances, which are the key factors to determine the final effects.

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