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How to Integrate Universities and Cities Through Local Spatial Developments:
Case Study of Wuhan, China

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ABSTRACT

As irreplaceable knowledge infrastructures, universities have been acknowledged to play the roles of fostering knowledge workers, supporting knowledge economies, and building knowledge cities. Through spatial developments, localized interactions can be built between cities and universities. There has been a global trend to design new knowledge precincts revolving around universities to make knowledge cities. This article focuses on how the local governments in Wuhan, known as the "Forest of Campus" in China, have proposed the vision of making a "Univercity," building knowledge cities by integrating universities and cities through local spatial developments. To interpret the concept of the knowledge precinct namely "Univercity," an analytical framework has been set up in the dimensions of fostering knowledge workers, supporting knowledge economies and building knowledge cities. Then, the spatial strategies of making a "Univercity" have been given accordingly, including enhancing the interaction between universities, knowledge businesses, and knowledge cities.

KEYWORDS

China, Knowledge City, Knowledge Economy, Knowledge Worker, Knowledge-Based Urban Development, University, Wuhan

INTRODUCTION

Along with the global prevalence of knowledge-based urban policies, universities, with their ability to provide a strong platform for knowledge marketing and transfer, have been regarded as one of the key knowledge infrastructures (Carrillo 2004; Martinez-Fernandez, 2008; Yigitcanlar et al., 2008b; Yigtcanlar & Sarimin, 2011). Recognized as an urban amenity, a promoter of population dynamics, a driver of economic development and an active actor for governance and social improvement, universities, with their "third mission" addressing questions arising from the spatial and socio-economic settings within which they function, can contribute to fostering knowledge workers, supporting knowledge economies and building knowledge cities (Esquinas & Pinto, 2013; Yigtcanlar & Sarimin, 2011). With not only mutual benefits but also negative externalities, the spatial relations

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between universities and cities can be very diverse and complex, depending on the university locations, the character of their expansion and the nature of their host cities (Benneworth & Madanipour, 2010).

However, city-university interaction, though involving more than spatial dimensions, can be strengthened through spatial developments in the modes like high-technology engagement, standalone campus, regional engagement, multiple interfaces, and collaborative growth management (Benneworth & Madanipour, 2010). In the past few years, there has been a global trend to design new knowledge precincts at local scales centered around universities in their visions, strategies and action plans for making knowledge cities. Although a huge amount of literature has been written about the spatial relations between universities and cities at national and regional scales, studies focused on planning practices for building knowledge cities at an urban scale can be considered relatively scarce (Esquinas & Pinto, 2013).

The aim of this paper is to investigate how to integrate universities and cities through local spatial developments in the contexts of China. The Chinese knowledge city experience, unlike those in many developed countries, can best represent the characters of top-down planning and policy making. Wuhan, a metropolis with a high concentration of universities, known as the "Forest of Campus" in Central China, has been chosen as the subject of this case study to understand and analyze its transformation into a knowledge city by integrating itself with universities through local spatial development strategies to. As the relationship between universities and their host cities has been shaped by a complex set of institutional factors, like the interaction between the management of the university and an array of external pressures and norms(Perry,2011), local spatial development strategies in Wuhan may not be all applicable to different ecosystems but it can be transferable and can provide references for other cities which aim to use universities as key leverage to support their knowledge-based developments in the formation of vision, strategies and action plans.

The methodological approaches, therefore, consist of: (a) a review of the literature on relevant topics including universities, knowledge-based developments, knowledge workers, knowledge economies and knowledge cities; (b) a case study investigation on the current relations between Wuhan and its universities in aspects of industries, talent output and placemaking by comparing with its counterparts domestically and abroad; (c) a set of interviews conducted with local governments, representatives from 21 local universities and 19 local enterprises; (d) a survey carried out and filled both offline and online regarding to the demands of knowledge workers.

Following this introduction, the second section of the paper provides a review of the literature related to the universities' engagement in the knowledge-based urban development as well as their spatial relations. The third section focuses on the Chinese context and discusses the spatial relations between universities and their host cities in China from historical perspectives. A case study of Wuhan, which has designed a new knowledge precinct resolving around universities, was introduced and examined. To interpret the new concept of the knowledge precinct namely "Univercity", an analytical framework has been set up in the dimensions of fostering knowledge workers, supporting knowledge economies and building knowledge cities. This is followed by spatial strategies to enhance the interaction between universities, knowledge businesses and knowledge cities in making a "Univercity". Finally, the concluding section also sets up a draft system of land use regulation to assist the implementation of the spatial strategies and proposes that the real challenge lies in policymaking at local levels.

LITERATURE REVIEW

To better understand how to integrate universities and cities through local spatial developments, this section intends to extend the review in two main directions. Firstly, literature concerning the historical engagements of universities with urban development will be reviewed. By analyzing the evolution of universities' roles, their contributions in fostering knowledge workers, supporting knowledge economies and building knowledge cities will be discussed. Secondly, the focus will be placed over

the spatial relations between universities and their host cities so as to provide evidence for the making of place-based initiatives.

Universities' Engagement in the Knowledge-Based Development

The twentieth century has witnessed the transformation of universities which has been greatly impacted by the rise of knowledge economy (Lundvall & Borras, 1997) and changing patterns of urban and regional governance (Madanipour et al., 2001), the concentration of knowledge production processes in cities (Beaverstock et al., 2000) as well as the pressure for regional engagement (Benneworth& Madanipour, 2010). Those structural changes can be regarded as elements of the four "revolutions" in university organizational approaches and institutional nature (Delanty, 2002, Benneworth& Madanipour, 2010). From the original cloistered communities of scholars to the Humboldtian university in nineteenth-century Germany and the "democratic mass university" (Daalder & Shils, 1982), universities have been characterized by a diversity of missions like the metropolitan university (Boyer, 1994), the entrepreneurial university(Clark, 1998), the virtual university (Watson, 2007), the ethical university (Garlick & Palmer, 2008) and the engaged university(Watson, 2007). There is a tendency that more recent literature has been focused on the evolving roles of universities in knowledge-based development (Edvardsson, Durst, 2017). Meanwhile, more new concepts, like the city-university complex (Le&Tu,2016), have appeared to describe a stronger university-city relationship which has been transformed from an operational one to a strategic one and from co-existence to collaboration (Curry, 2015).

No matter how the roles of universities evolve and how the university-city relationship transforms, universities' engagement in the knowledge-based urban development directly relates to their so-called "third mission", emphasizing not only on their economic contributions but also the social, cultural, political and environmental benefits (Benneworth & Madanipour, 2010). At local scales, universities have been involving with urban affairs in four dimensions including physical infrastructure, human resources, economic development and civic engagement (Manuel,2014). Meanwhile, the focus of knowledge-based developments lies on catering for and attracting knowledge workers, high-technology industries and knowledge-based activities (Knight, 2008). In terms of universities' roles in the whole chain of knowledge production, the engagement can be characterized in three dimensions, i.e. fostering knowledge workers, supporting knowledge economies and building knowledge cities.

With the first mission of education, universities have been playing the roles as significant knowledge enterprises and suppliers of human and intellectual capital since their birth (Benneworth & Madanipour, 2010). The concentration of universities will directly lead to the agglomeration of young talents, who will attract innovation-led enterprises and become potential knowledge workers. With the setup of the linking between teaching and research in the nineteenth century, universities have been driven by funding pressures and competition threats to engage with knowledge-based business due to the spin-off effects (Benneworth & Madanipour, 2010). Therefore, universities have made more prominent contributions in the production, diffusion and deployment of knowledge which supports economic growth (Felsenstein, 1996; Geuna, 1998). Recently, there has been a shift of focus on their contributions from the economic to the social, cultural, political and environmental aspects. As irreplaceable amenities and attraction, universities can provide social and civic uses for their host cities, while their students and employees can also benefit from the cities (Benneworth, 2010). These mutual interactions will promote the quality of life, urban diversity, social equity and quality of place, namely the aspects for attracting and retaining knowledge workers in turn (Yigitcanlar et al., 2007) and also the link between tolerance, talent and technology for knowledge cities (Florida, 2003).

The Spatial Relations Between Universities and Cities in Knowledge-Based Developments

In response to the transformation of the natures and missions of universities as well as how they work as organizations and manages their resources, the spatial configuration of universities has been

changing as a result, which has a direct impact on their relationships with the host cities, either linking them to a wider context or isolating themselves from their surrounding environments (Benneworth & Madanipour, 2010). Literature has shown that creating appealing physical environments including affordable housings, diversified functions, efficient transportation as well as cultural and green amenities all contribute to a city-university capacity (Drucker & Goldstein, 2007; Fernandez-Maldonado & Romein, 2008; Florida, 2002; O'Mara, 1999; Van den Berg et al., 2005; Heijer & Magdaniel, 2018). Although spatial developments have been exemplified as important initiatives to achieve mutual goals and solve problems, not so many studies have been done about the spatial relations between universities and cities compared to the huge amount of literature on universities and knowledge-based developments.

University locations, which include three different types like greenfield campus lying outside the city, gated campus within the city and the campus integrated into the city, has proved to be key roles in the spatial relations between universities and cities (Heijer & Magdaniel, 2018). There has been a shift of university locations from peripheral to inner-city type, suggesting that campuses integrated with cities has become a major trend (Heijer & Magdaniel, 2018). Along with the shift, universities have also proved to be transformed from monofunctional business and research-oriented into multifunctional and open urban environments with more access to adjacent sceneries (Winden & Carvalho, 2016; Heijer & Magdaniel, 2018). A mix of education and research, residence, retail and leisure facilities, related businesses and infrastructure has been proposed as the required functions of universities, which can benefit the host cities in return (Heijer, 2011). With the two shifts from spatial separations to integration and from mono-function to multi-function, the city-university spatial relations can be enhanced to promote knowledge-based developments.

Besides university locations, the character of its spatial activities and the nature of its host city both play a part in their spatial relations as well (Benneworth & Madanipour, 2010). There are five modes of spatial interactions between universities and their host cities including high-technology engagement, standalone campus, regional engagement, multiple interfaces, and collaborative growth management (Benneworth & Madanipour, 2010). While the high-technology engagement and standalone campus modes have created "extended development periphery" and new campuses, the regional engagement, multiple interfaces and collaborative growth management modes have more focused on the integration of universities and cities despite their locations, which is in consistent with the above two shifts. Related to local contexts, the five spatial modes of city–university interactions can be quite diverse and complex, which may not only bring mutual benefits but also cause problems and tensions (Benneworth & Madanipour, 2010). Therefore, local spatial development strategies to integrate universities and cities should be made towards local goals and against local problems.

With the awareness of the physical settings as important resources to achieve mutual goals, cities with the assets of universities to be discovered, whether in developed countries or developing countries, have been endeavored to design knowledge precincts, make visions, strategies and action plans to promote knowledge-based developments, which become fixated upon attracting and developing knowledge-intensive services and technology-based industries, talented people and the amenities that facilitate attracting and retaining people and firms (Heijer & Magdaniel, 2018; Benneworth & Madanipour, 2010). Therefore, in the context of China, when discussing how to integrate universities with cities through local spatial developments, two important questions are: How to understand the university-city relationship in dimensions of fostering knowledge workers, supporting knowledge economies and building knowledge cities within the whole picture of local contexts? How to adapt to local needs and make spatial strategies to enhance the relationship based on the spatial modes mentioned above? Before answering the two questions, the next section will discuss the Chinese contexts first as a premise.

THE CHINESE CONTEXTS

Similar to the western countries, the spatial relations between universities and cities in China have evolved through the following four phases. The ninth century to the nineteenth century were the first phase characterized as cloistered communities of scholars in the influences of elitism education. The oldest universities in China originated from the academies especially for the gentries, scholars and government staffs in the feudal society. Influenced by the naturism of Taoism and Confucianism, universities in that time were mostly located in the forest and on the outskirts. Then to improve the efficiency of administration, universities with one or multiple courtyards with the functions of teaching, studying and living were mostly built within their host cities. Then it was the influence of western education which precipitated the transformation from cloistered communities of scholars to open campuses in the early nineteenth century. There was a revolutionary change in the traditional education driven by the Westernization Movement, that the academies were gradually transferred into schools influenced by the western thoughts. As a result, campuses became more open to cities, which can be regarded as the early forms of universities in China.

Then after the foundation of the People's Republic of China in 1949, the influences of western education mixed with the political changes initiated the third transformation. At that time, universities were mostly located on the outskirts which were usually planned as the educational land use in urban master plans. Within universities, there were multiple defined and interconnected functional areas like education areas, research areas, libraries and residential quarters, which composed the unique mode of self-contained gated communities. On the one hand, the state encouraged universities to share their gymnasiums and auditoriums with citizens. On the other hand, factories and warehouses were built in campuses to make use of every bit of space, which has decreased the efficiency of land use on the contrary. As a result, the mode shift from open campuses to gated communities has impeded the integration of universities and cities in China.

The most recent phase since the Reform and Open-up of China in 1978 has been characterized as function overflows out of campuses under the influences of higher education revolutionary movements in China. Not only the commercialization of research has been inspired but also adjunctive functions of universities has overflowed to cities, greatly influenced by the Chinese higher education revolutionary movements. Based on the gated community mode, adjunctive functions like catering and retails were gradually shifted outside of campuses, where also assembled technology clusters developing industries relating to the key disciplines of their adjacent universities due to spin-off effects, resembling the mode of high-technology engagement. After 1998, massification in higher education has directly led to the continuous expansion of universities. Local governments began to expand existing campuses and set up new sites in the outskirts, exemplifying the standalone campus mode.

With the gradual shift of global innovation resources to Asia in the knowledge economies, Shanghai, Beijing and other cities began to make knowledge investments by using universities as catalysts to upgrade and rebrand themselves. By designing knowledge-based districts revolving around universities, they have put forward urban strategies of developing global innovation centers, so to improve their competitiveness in the global innovation network. For example, some universities which were located in new towns with abundant land resources are engaging urban developments as university towns like the Guangzhou University Town or as featured industrial parks like the Hangzhou Eastlake Creative Valley, exemplifying the modes of regional engagements. Some universities which were located in the built-up areas have turned their surrounding areas into knowledge precincts, like the Zhongguan Village in Beijing and the central Intellectual Area around Shanghai Tongji University with multiple functions of business, retails, leisure and entertainments, which also exemplifies the modes of multiple interfaces and collaborative growth management.

The historical interaction between universities and cities in China shows that their spatial relations have evolved from total isolation to semi integration, concerning different modes like standalone campuses, high-technology engagement, regional engagement, and multiple interfaces. However,

the spatial configuration of self-contained gated communities has exerted profound influences which did not only become physical fences to keep universities isolated from cities but also led to negative externalities in the surrounding areas like traffic congestions, low-quality open space, insufficient amenities. Meanwhile, mental fences separating universities from cities have also been set up, leading to problems like low commercialization rates of research and limited civic engagement in urban governance. While suffering those problems, cities have also witnessed the overflow of graduates to other cities due to the decrease of overall attractiveness caused by the negative externalities, which can be exemplified by Wuhan.

Wuhan, a metropolis in Central China with 82 universities and more than 1 million graduates and undergraduates ranking ahead in the world, has been well known as an important national base for science and education. Mainly due to the gated community mode of universities located near mountains and lakes, Wuhan has been not only lacking the commercialization of research but also suffering urban diseases like traffic congestions, low-quality open space and insufficient amenities. As a result, the city has lost its attraction for young talents, witnessing the loss of a great number of graduates and undergraduates every year. Recently, Wuhan has also been inspired by Beijing and Shanghai to identify universities as one of the prominent actors in building knowledge cities. Therefore, in 2016, Wuhan has put forward "Ten Innovation Plans" to upgrade and rebrand itself as a prominent innovation city, one of which is to make a "Univercity". The next sessions will take a look at how Wuhan has visualized the new concept of "Univercity".

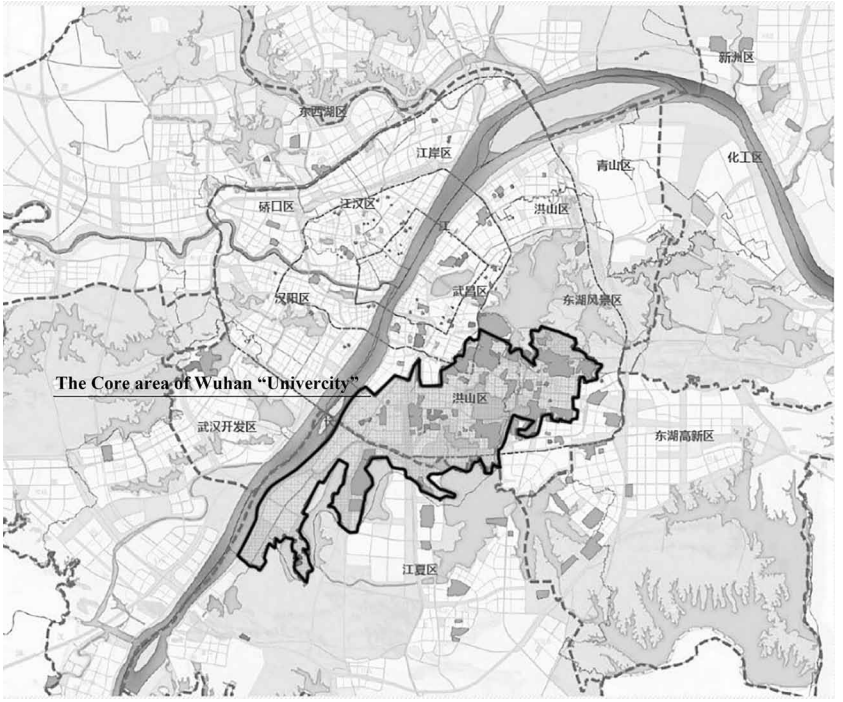
THE VISIONS OF MAKING A "UNIVERCITY" IN WUHAN

The new concept of "Univercity" has been proposed to make universities integrate with cities as a whole maximizing mutual benefits through local spatial developments, not only to fulfill the visions of becoming a knowledge city but also to recognize and address the negative externalities caused by universities. Within the initiatives of local governments, a knowledge precinct has been identified and designed as the core area of Wuhan "Univercity" in terms of the density of key universities, national labs, and undergraduates[1] (see Figure 1). Based on the literature reviews on the roles of universities in building knowledge cities and analysis on how universities have been interacting with cities in China, the concept of "Univercity" can be illustrated in the dimensions of fostering knowledge workers, supporting knowledge industries and building knowledge cities. Taking references from the *Guidelines of Developing Innovative Cities* (Ministry of Science and Technology of the People's Republic of China, 2016), an index system of the concept "Univercity" has been established in three dimensions and nine categories (see Table 1). For every category, two to five indexes were chosen to characterize the features, goals, and processes of making a "Univercity". By the method of comparative studies and interviews with local governments, university and company representatives, a quantitative analysis has been made for every index in three types concerning they are related to the features, goals or processes of making a "Univercity", which has been shown in Table 1.

The Dimension of Fostering Knowledge Workers

Knowledge workers, who can be defined as people with a graduate or higher level of education, have been known as the most important actors in knowledge-based developments (Brinkley, 2008; Jacobs, 1969; Yigitcanlar, T., & Sarimin, M, 2011). As the original source of knowledge, universities can contribute to the supply and exchange of knowledge workers (Caloghirou et al., 2001; Yigitcanlar, T., & Sarimin, M, 2011). Therefore, the first dimension in interpreting of the concept "Univercity" is to increase the output of knowledge workers especially leading talents based on key discipline building. As assisting the contacts between universities and research institutes has been regarded as important strategies to establish interactions between potential knowledge workers, promoting the interdisciplinary corporations and international exchanges will also generate flows of human resources (Blien and Maier, 2008; Yigitcanlar, T., & Sarimin, M, 2011). This will not only produce more local

Figure 1. Range of the core area of Wuhan "Univercity"



knowledge workers in the local economy and also increase more chances to attract more potential knowledge workers from other cities. Therefore, the indexes in the dimension of fostering knowledge workers should include input on education expenses, key disciplinary and interdisciplinary platforms as well as personnel recruitment. For example, key indexes like the number of world-famous leading universities, world-famous leading disciplines, and national key technological facilities were chosen in the sub-categories of key disciplinary and interdisciplinary platforms. While these indexes are all related to the process of fostering knowledge workers, the categories of input on education expenses and building key disciplinary &interdisciplinary platforms are more related to the process and the graduate immigrates are more targeting towards the goals.

Taking the core area of Wuhan "Univercity" as an example, the goal of two world-famous leading universities with twenty-first key disciplines has been proposed based on the resources of current universities and disciplines. According to the *Mid-and-Long-Term Plan of National Key Technological Facilities (2012-2030)* (General Office of the State Council of the People's Republic of China, 2013), there will be about fifty national key technological facilities in China. Based on this, Wuhan "Univercity" has been proposed to establish at least two national key technology facilities based on the current resources compared with other cities.

The Dimension of Supporting Knowledge Economies

As the providers of job opportunities to knowledge workers, knowledge clusters, defined as a geographically proximate group of interconnected knowledge enterprises, suppliers, service providers and associated institutions, are the foundations of knowledge-based developments by transforming research inputs into economic outputs, supporting regional innovation systems and stimulating economic growth (Enright and Roberts, 2001; Metcalfe and Ramolgan, 2005; Yigitcanlar, T., & Sarimin, M, 2011). The key to achieve boosts in knowledge economy is the accumulation and flow of information and knowledge in one geographical area with a high concentration of knowledge

Table 1. Key indexes of the "Univercity"

Dimensions	Categories	Indexes	Types		
			Feature-Related	Goal-Related	Process-Related
Fostering Knowledge workers	Input on Education Expenses	Percentage of Technology Input to Public Finance (%)	√		√
		Percentage of R&D Expenditure to GDP (%)	√		√
		Percentage of Basic Research to R&D Expenditure (%)	√		√
		Number of Labs with Nobel Prizes	√	√	√
	Building key disciplinary &interdisciplinary platforms	Number of World-famous Leading Universities	√	√	
		Number of World-famous Leading Disciplines	√	√	
		Number of National Key Technological Facilities	√	√	
		Number of Research Platforms between Universities	√	√	√
	Graduate Immigrates	Percentage of Graduates to Local Employments (%)	√	√	
		Percentage of High-level Talents to Local Employment (%)	√	√	
Supporting Knowledge Industries	Industrial R&D expenditure	Percentage of Enterprise Input to University Research Expenses (%)	√		√
		Number of Key Disciplines Transformed to Industries	√	√	
	Innovation Infrastructures	Number of Innovation Infrastructures	√		√
		Contribution Rate of Technology Progresses to Economy Boost (%)	√	√	√
	High-tech enterprises	Number Percentage of High-tech Enterprises to Enterprises (%)	√	√	
		Revenue Percentage of High-tech Enterprises to Enterprises (%)	√	√	
Building Knowledge Cities	Urban Quality	Number of City Parks	√	√	√
		Number of International Schools	√		√
		Number of Apartments for Graduates Per Year	√		√
		Coverage of Metro Station with a Radius of 500m to Universities (%)	√	√	
	Campus Openness	Sharing Rate of Art, Culture and Sports Amenities (%)	√	√	√
		Number of Campus Park Projects Funded by Governments	√		√
		Network Density(km/km^2)	√	√	
	Urban Regeneration	Percentage of Lands used for Innovation (%)	√	√	√
		Rewards for New-built Research Facilities			√
		Rewards for New-built Apartments for Graduates			√

actors to engage in R&D activities, including universities, incubators for high-tech enterprises from small scales to large scales (Yigitcanlar, T., & Sarimin, M, 2011). Since universities have been urged to contribute economic boost in the 1980s, bi-directional and reciprocal knowledge flows between universities and industries are encouraged to be created by spillover effects (Cockburn & Henderson, 1996; Meyer-Krahmer & Schmoch, 1998). Therefore, to provide evidence of spillover effects from universities, the input including industrial R&D expenditure, innovation infrastructures, innovative output and high-tech enterprises can be used to elaborate the dimension of supporting knowledge economies (Uyarra, 2010). As an important catalyst to accelerate the flows, the performance of innovation infrastructures can be evaluated not only by their quantity but also their contribution rate of technology progresses to the economic boost.

As the area possibly contributing the most to knowledge-based developments in Wuhan, the core area of Wuhan "Univercity" has been proposed to meet the demands of leading universities and institutes by focusing on establishing innovation infrastructures. According to the *Thirteenth Five Years' Plan of National Technology Innovation* (General Office of the State Council of the People's Republic of China, 2013*)*, the contribution rate of technology progresses to the economy boost has reached an average level of 55.3% in 2015 and been proposed to achieve the goal of 60% in 2020. Learning from experiences of other cities, the goal of the core area of Wuhan "Univercity" has been set as 70%.

The Dimension of Building Knowledge Cities

As the flow of knowledge workers has been a decisive factor for the economic competitiveness, the key of building a knowledge city lies with attracting and retaining skilled personnel not only from local universities but also other ones. As a traditional social amenity and attraction for people which is often unique and difficult to obtain from other organizations (Esquinas & Pinto, 2014), universities have been linked with local communities since the late 1990s, which goes much further than with industries. Like the university-industry links, the interactions between universities and cities are also bi-directional and reciprocal. On one hand, universities can engage more with urban developments by sharing their resources like parks, roads, arts, sports and cultural amenities with local communicates. On the other hand, local governments can take initiatives in improving built environments surrounding campuses by building city parks, international schools, apartments for graduates and metro stations with walking distances to universities so as to increase city attraction and retain local potential knowledge workers. Besides, considering the significant roles of universities in urban regeneration, it is necessary to use the indexes like the percentage of lands used for innovation (%) to evaluate if the urban regeneration activities around universities are related to knowledge-based development. From a policymaking point of view, rewards for new-built research facilities and apartments for graduates are also indexed to encourage the implementation of urban regeneration activities.

As the model of the Wuhan "Univercity", the core area has been proposed to focus on the improvement of urban qualities so as to increase attraction for knowledge workers. Based on the references of Beijing, Shanghai and Guangzhou in which there are about 2.3 to 3.3 international schools per billion people, it has been estimated that there should be at least 3 international schools in the core area based on the total number of people. Besides, as the current road network density is less than 2.5 km/km^2 due to the gated community mode of universities, the goal of planned road network density has been set as 5.5km/km^2 after the opening-up of campuses based on national standards and the current situations.

THE STRATEGIES OF MAKING A "UNIVERCITY" IN WUHAN THROUGH LOCAL SPATIAL DEVELOPMENTS

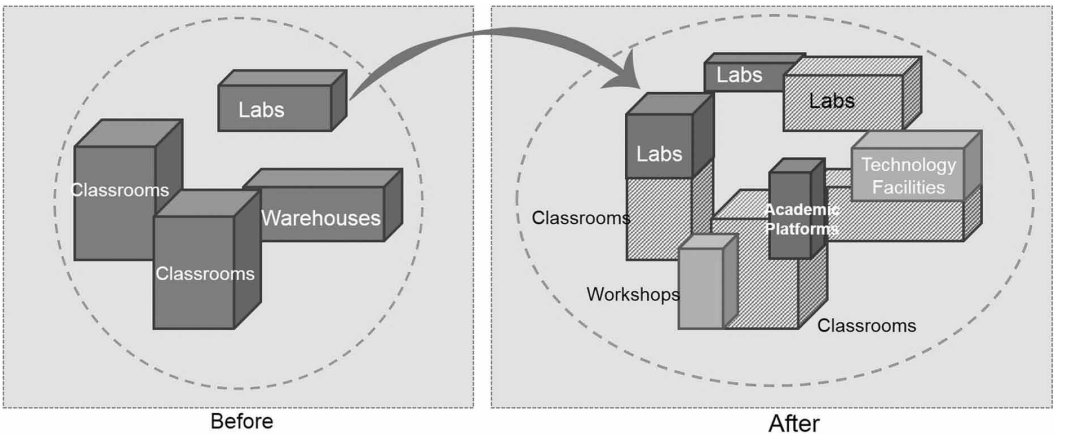
Based on the interpretation in the former session, the new concept "Univercity" is not only about designing a precinct to make universities engaged more with urban developments, but also a more

engaged mode to integrate universities and cities in mutual ways. In other words, the collaboration is like a chemical reaction instead of a physical combination by using universities as catalysts to promote knowledge-based developments. As city-university collaboration can be achieved through spatial development which differs with university locations, city contexts, etc., this session sets up an analytical framework in three dimensions by linking the physical elements identified in the processes of making a "Univercity" exemplified by Wuhan. As a new knowledge quarter, the physical elements of "Univercity" consist of universities, incubators for high-tech enterprises from small scales to large scales, parks, transportation facilities as well as cultural, arts and sports amenities. Thus, to achieve the collaboration goals, interactions should be enhanced between universities, local businesses, and cities in the spatial developments of "Univercity" in dimensions of co-fostering knowledge workers, co-supporting knowledge economies and co-building knowledge cities.

Optimizing Inner Spaces of Campuses to Enhance Interactions Between Universities and Universities and Co-Foster Knowledge Workers

As the cradle to foster knowledge workers, universities, as well as research institutes, are in the upper stream of innovation chains, which provide the spaces for key disciplinary &interdisciplinary platforms. Therefore, to promote research activities within universities and international academic exchanges between universities, adequate spaces should be provided by optimizing inner spaces of campuses to co-foster more knowledge workers. Interviews with teachers and students from local universities show that inner spaces within campuses have been not fully used and could be improved greatly to provide more spaces for teaching and research activities. Thus, the spatial development strategies in this dimension go beyond the standalone campus mode but more focus on the inner space use within campuses no matter located in the built-up areas or on the outskirt. References can be taken in China like Beijing University which has just completed the transformation of campus buildings from residences into offices. So with the socialization reform of logistics services in universities, residential areas for teachers and staff, dormitories, cafeterias as well as other spaces to provide logistic services can gradually evacuate their original functions out of campuses, so as to provide spaces for national key technology facilities and research cooperation platforms between universities. Besides, more research functions could be also put into current classrooms, schoolhouses and warehouses along with their renovations (see Figure 2). To encourage the reuse of existing buildings within campuses to provide more spaces for teaching and research activities, policies are suggested to make that the intensities and densities can be improved when the lands originally used for college education are transformed to hold key technological infrastructures.

Figure 2. Analysis of reusing the existing buildings within campuses



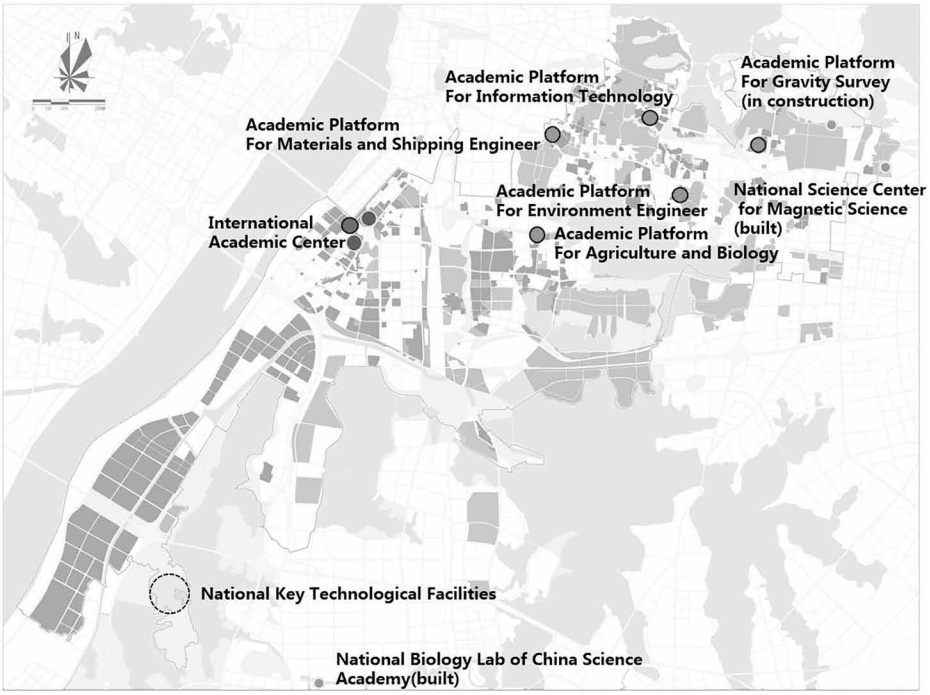
Towards the problems of lacking key disciplinary & interdisciplinary platforms between universities in the core area of Wuhan "Univercity", it has been proposed to evacuate the existing logistic service facilities within campuses and remake them as national key technological facilities and research cooperation platforms between universities. Besides, encouragements in policymaking have also been proposed to make, like the FAR reward ranging from 1.1 to 1.2 for the reuse of existing buildings to provide more spaces for academic activities, so as to improve the land use efficiencies of inner spaces within campuses. Thus, by implementing the spatial strategies to enhance interactions between universities, there will be one national science center, one international academic center and five academic platforms within campuses in the core area of Wuhan "Univercity" by reusing the existing buildings (see Figure 3).

Providing Various Innovation Spaces to Enhance the Interactions Between Universities and Local Businesses and Co-Support Knowledge Economies

As the major innovation spaces in local knowledge economies, incubators play the determinant role in transforming educational resources into urban innovation competitiveness. Not only university-industry links should be built, but also interactions should be made between the key disciplines of universities and dominant industries of local businesses. In this process, all kinds of incubators for high-tech enterprises from small scales to large scales, like nursery incubators for new-born startups, incubators for growing startups and accelerators for grown-up startups, are all needed to set up local innovation systems. As the knowledge spillover studies suggest that geographical proximity would amplify the economic impacts of academic research, it is the basic rule that incubators should be located near universities. Spatial strategies to enhance the interaction between universities and local businesses would differ with the location of universities and the spatial layouts of local businesses.

As mentioned above that technology park is a typical mode to co-support knowledge economies, but the case of the central Intellectual Area around Tongji University in Shanghai has also suggested

Figure 3. Function analysis of the research facilities in the core area of Wuhan "Univercity"



that multiple interfaces between universities especially located within cities and local businesses should also be created to activate knowledge transfers. Spatial development strategies should also correspond to the type of incubators with different requirements. Considering that incubators providing spaces for different enterprises favor different locations, nursery incubators especially for new-born startups, which are sensitive to land rents but also should have easy access by public transport for newly-graduated, are suggested to be located surrounding old residential areas, commercial facilities and offices, to which it will take less than 30 minutes by public transports from universities (see Figure 4). As growing startups prefer favorable industrial environments more than affordable land rents, incubators for them would be better to be located on the lands planned as industries and businesses, especially in well-developed industrial parks. Once startups have developed to a larger scale, they will not only look for well-developed industrial parks but also with the possibilities for expansions. Therefore, incubators for them namely accelerators would be suggested to be located in industrial parks with abundant lands (see Figure 5). In the aspects of policymaking, especially the scales and locations of incubators should be controlled in regulatory plans as the index of lands used for innovation so as to ensure that there are adequate physical spaces to nurture spin-off enterprises. Specialized strategies are suggested to propose for the innovation spaces near universities with key disciplines of human and social science like building infrastructures specialized in production and consumption of creative industries surrounding the current historical districts. In this way, creative industrial clusters neighboring universities will be formed not only to provide spaces for the transfer of human and social science knowledge to creative industries but also to enhance the cultural identities of cities (see Figure 6).

Figure 4. Location analysis of the nursery incubators for new-born start-ups

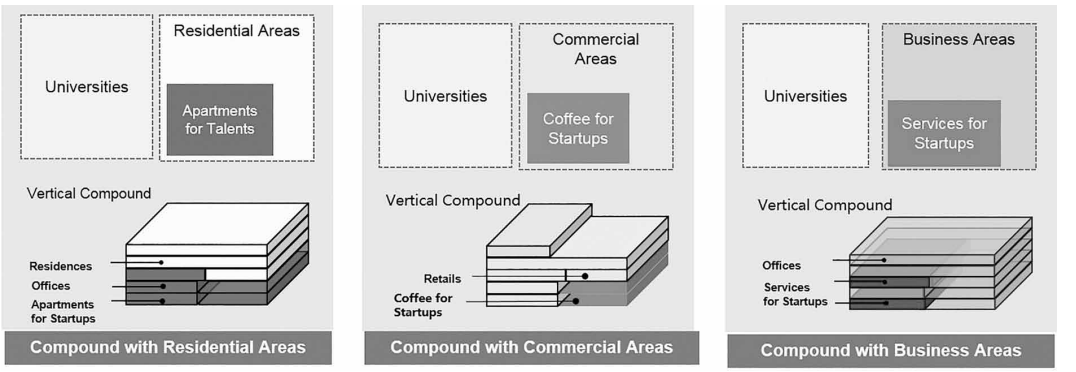


Figure 5. Location analysis of the incubators and accelerators

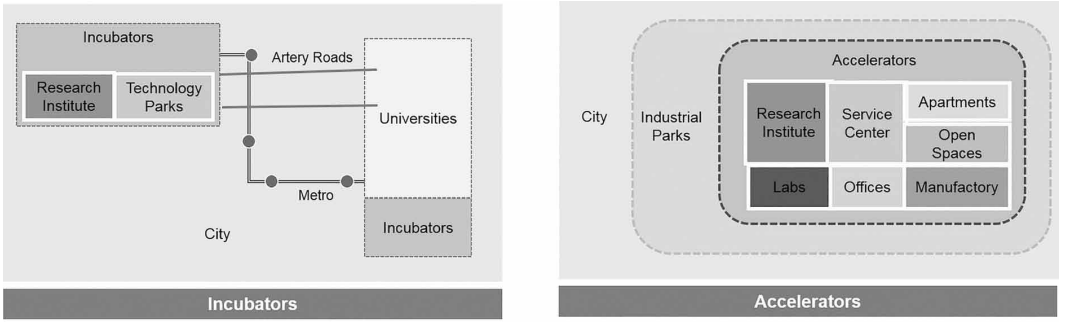
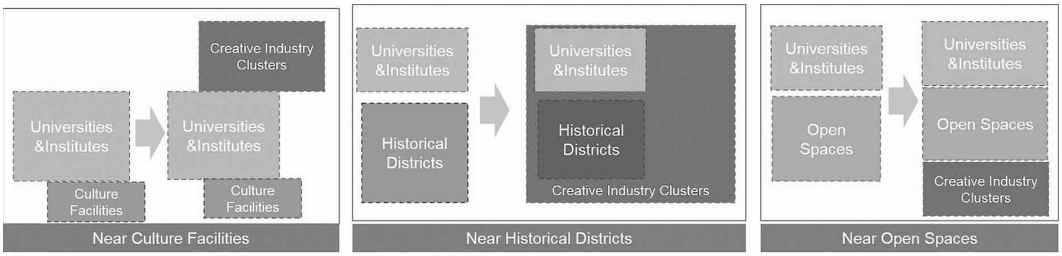
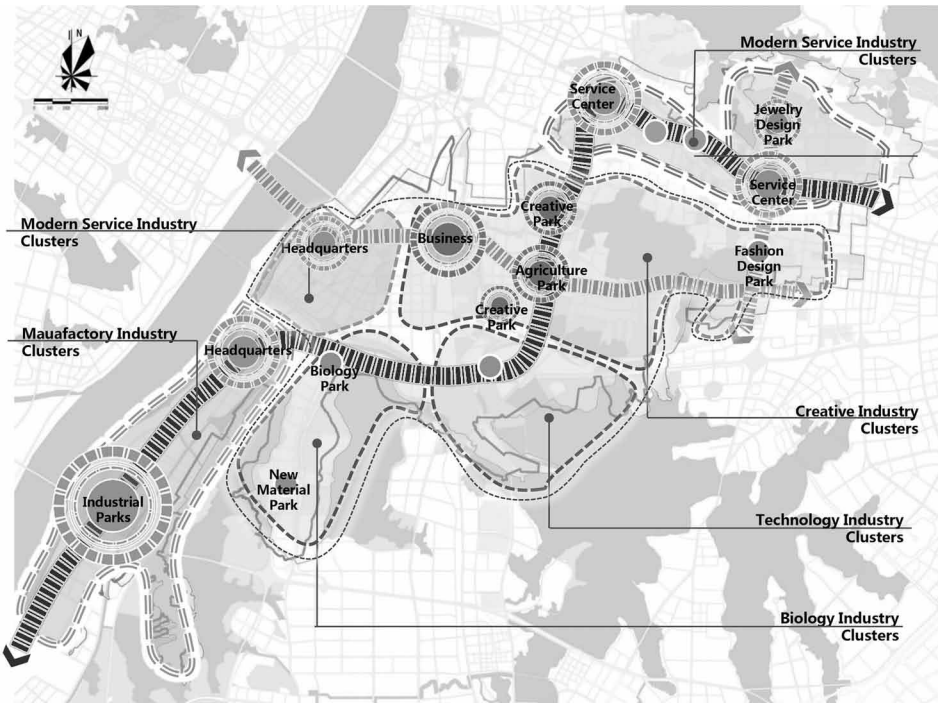


Figure 6. Location analysis of creative industry clusters surrounding universities



Due to lacking research commercialization, there are not enough incubators to nurture spin-off enterprises let alone to retain and attract knowledge workers in the core area of Wuhan "Univercity". Therefore, it has been proposed to establish more innovators along with the urban regeneration projects with their specializations corresponding to the key disciplines of universities and dominant industries of local businesses. On the one hand, nursery incubators for new-born startups have been suggested to be located in old communities and factories neighboring universities along with their regeneration processes. On the other hand, incubators for growing startups have been proposed to be located in well-developed industrial parks with easy access to public transport. Also, accelerators for grown-up startups have been suggested to be located in industrial parks with abundant lands for expansions. With the set-up of local innovation systems, local industry clusters corresponding to the disciplines of universities and dominant industries of the local businesses as well as six innovation service centers will be located surrounding the existing universities (see Figure 7).

Figure 7. Layout of the industry clusters in the core area of Wuhan "Univercity"

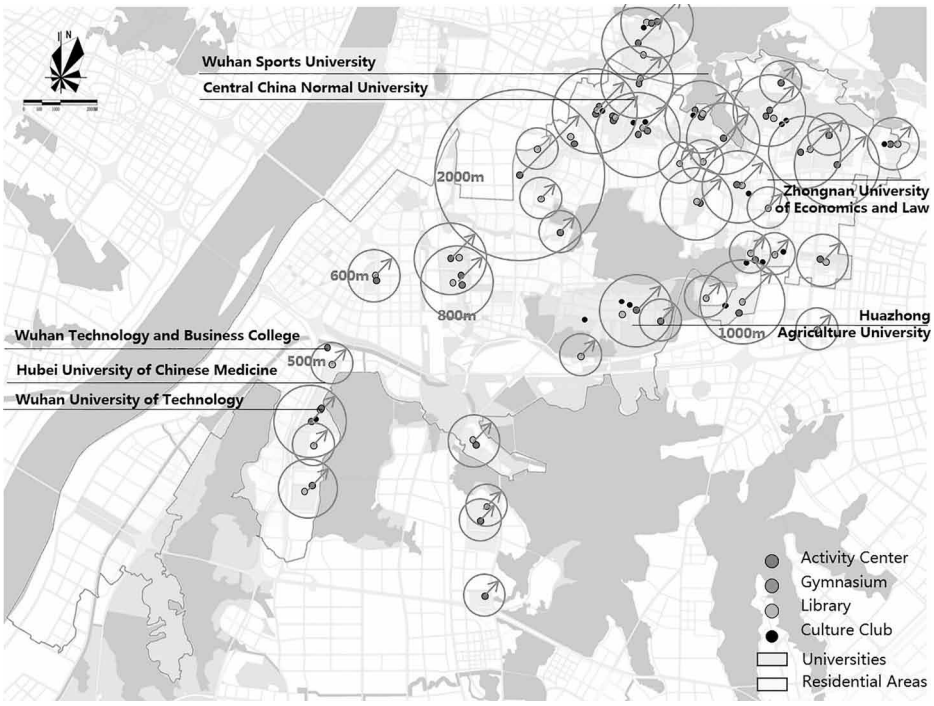


Co-Sharing Public Infrastructures to Enhance the Interaction Between Universities and Cities and Co-Build Knowledge Cities

Making universities engaged with knowledge-based urban developments by co-sharing public infrastructures including open spaces, roads, arts, cultural and sports amenities will not only improve the quality of urban environments and the attractions for knowledge workers but also cure urban diseases to some extent due to the conflicts between universities and cities. For example, Harvard University has placed its resources including campus arts, sports, lectures, classes, and religious services at the service of the local community (Benneworth & Madanipour, 2010). In this way, the city can benefit from the university's economic and cultural activities while students and employees of the university can have access to better infrastructures due to saving the cost. To achieve this collaborative growth, the premise is that efforts should be made on both sides of universities and cities, which is co-building knowledge cities.

For universities, art, cultural and sports amenities like activity centers, libraries and gyms are encouraged to be open to the public. All kinds of cultural activities are proposed to be organized on the weekends or holidays to improve the efficiency of campus facilities. For those university amenities with large scales, high qualities and good access especially located in the areas with short supplies, they are proposed to be regulated as urban infrastructures in the regulatory plan, by reaching an agreement between universities and local governments. Taking the core area of Wuhan "Univercity" as an example, it has been proposed that the co-sharing percentage of amenities between universities and cities should reach 70% at least in 2020 and 100% in 2030. Once the goal has been reached, it has been estimated that the amenity efficiencies will be improved at least 8 times in more than 60% of the residential areas (see Figure 8). Among those co-shared amenities, three university gyms have been selected to be reconstructed with local government funding and regulated as sports amenities at the municipal level.

Figure 8. Efficiency analysis of the university amenities in the core area of Wuhan "Univercity"



With the benefits of amenities from universities, local governments should focus on providing high-quality urban amenities with featured functions to meet the requirements of knowledge workers. The results of the survey carried out online and offline in Wuhan show that university students prefer the third spaces, apart from work and home, to have a mix of communications, retails and leisure functions as well as easy access due to their fast-paced life. Compared with local residents, they prefer a more diverse mix of functions with leisure activities and easier access within a 10-minutes walking distance from dormitories. Therefore, specialized amenities for potential knowledge workers with multi-functions including academic communications, residences, retails, leisure, offices, exhibitions, sports and apartments for undergraduates have been proposed to be built around universities, not only to cater for students in universities but also to improve the efficiency of land use. Not only built-up amenities have been proposed to be renovated and to be replaced with new functions incentivized by favorable policies on land use and funding, but also more new-built high-quality specialized amenities with multi-functions have been encouraged to be established in low-supply and high-demand areas (see Figure 9). According to the quality and quantity evaluations of current urban amenities in the core area of Wuhan "Univercity", it has been proposed to establish six specialized amenities, so as to retain more potential knowledge workers (see Figure 10). To encourage more specialized amenities provided by urban regeneration projects, policies have been proposed that their supposed FARs can be improved 1.1 to1.3 times as a reward. Besides, the coverage standards of new-built schools and hospitals have also been proposed to be improved to 10 minutes' walk distance.

The historical gated community mode has not only led to the underuse of amenities but also exerted a profound effect on the network system, resulting in heavy traffic jams. Therefore, to densify urban networks and improve transit efficiency, universities are also supposed to share their internal networks with the public without affecting daily basic activities. To ensure the safety in campuses, the premise would be transforming driveways in campuses by slow-down designs and formulate regulations concerning the management of universities before opening to the public (see Figure 11). Besides, a

Figure 9. Function analysis of the specialized amenities in universities

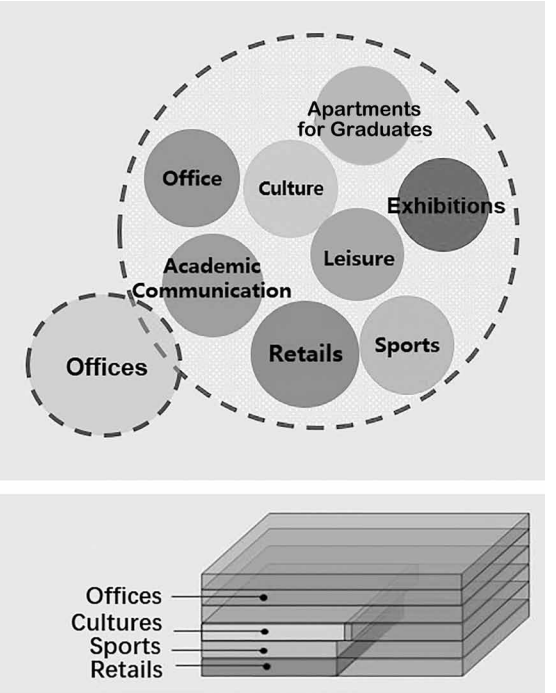


Figure 10. Layout of the urban amenities in the core area of Wuhan "Univercity"

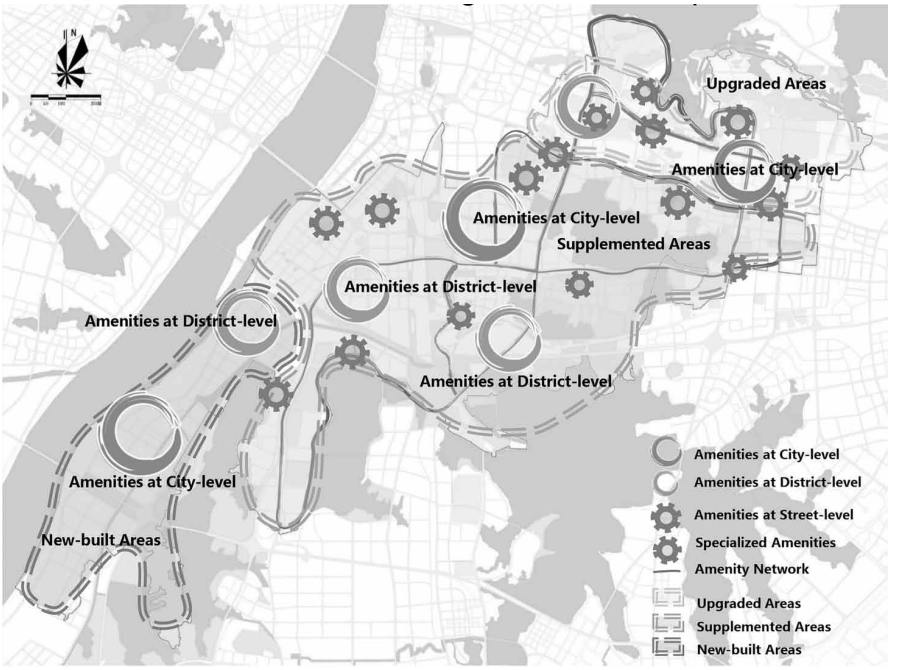
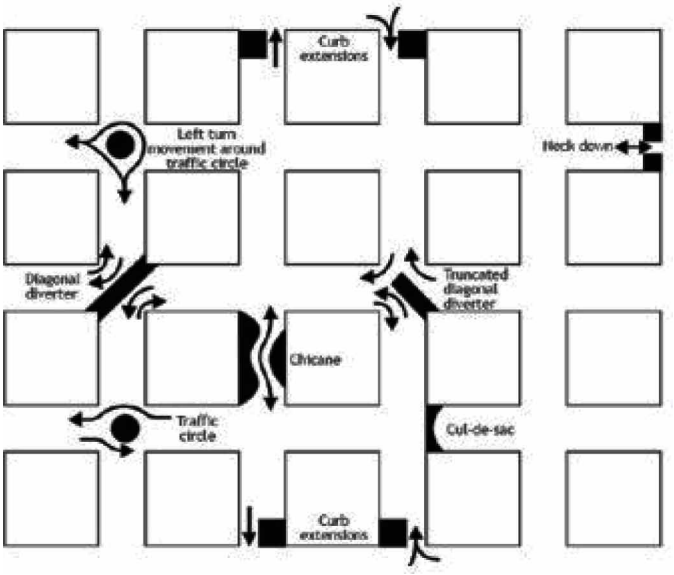


Figure 11. Analysis of the slow-down design



specialized public transport system including metros and buses has been proposed to be established door to door between universities (see Figure 12). Taking the core area of Wuhan "Univercity" for an example, a new ring of metro, as well as a specialized line of buses on land and water, have been supposed to add on the current transit system towards the problems of lacking minor roads and low efficiency of current public transport (see Figure 13).

Figure 12. Analysis of the specialized public transport system between universities

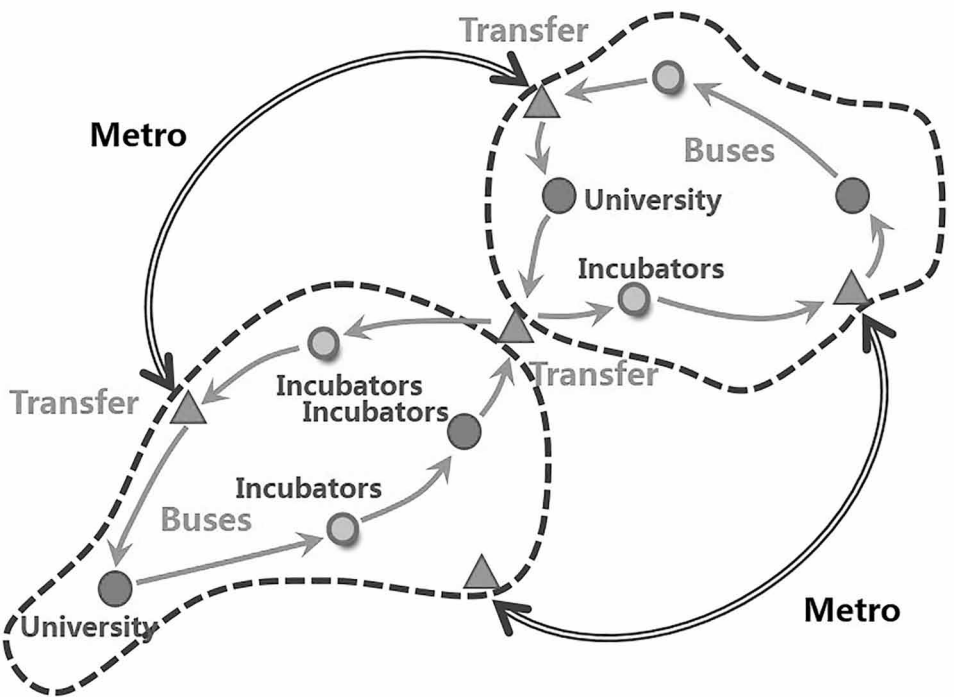
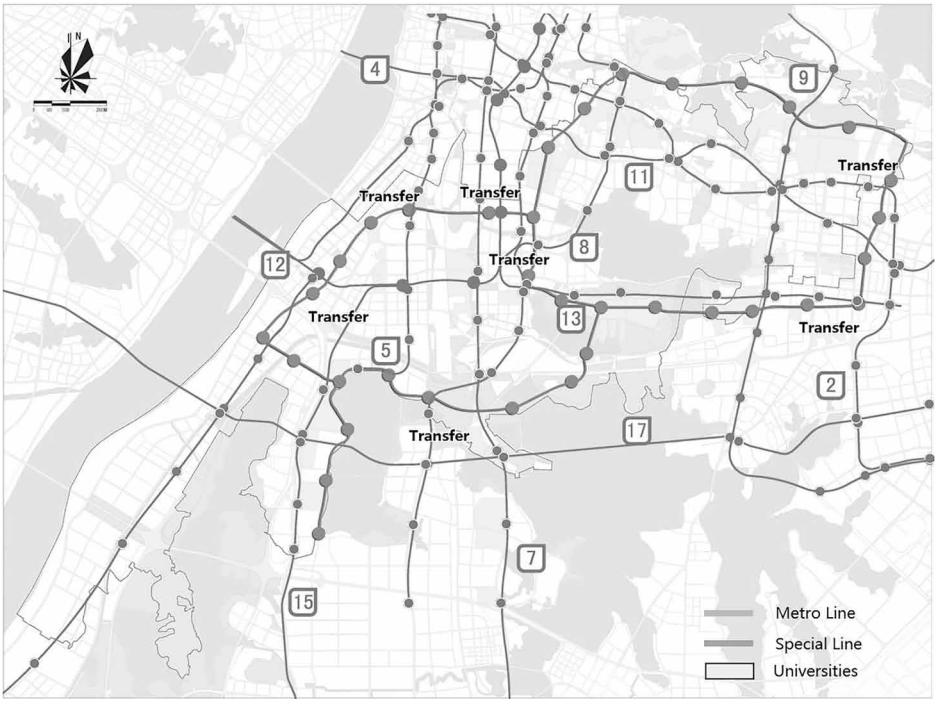


Figure 13. Analysis of the specialized public transport system in the core area of Wuhan "Univercity"



Unlike urban amenities and traffic infrastructures, open spaces have played the role not only as the public domain for communications but also could be the image of the "Univercity". However, they have also been underused due to the historical gated community modes. Therefore, public spaces in campuses like squares, parks and sidewalks have been proposed to be remade as landscape nodes to present the iconic images of the "Univercity". Meanwhile, various themed campus festivals can be planned and guided routes within campuses can also be organized to enhance the contacts between universities and cities. As for cities, pocket parks with sizes ranging from 400 to 10000 square meters have also been proposed to be built around universities so as to provide spaces for the informal communications between knowledge workers. As for universities, green networks linking campuses with adjacent mountains and water have been proposed to be established so as to create more interfaces with natures and more accesses for the public (see Figure 14). The core area of Wuhan "Univercity", as an example, though with abundant resources of natural landscapes, has been suffering the problems of insufficient public spaces and obscure image identities (see Figure 15). Therefore, it has been proposed to link campuses parks with the adjacent mountains, rivers and lakes by greenways and water networks. In this way, a green loop surrounding universities has been proposed to be established by linking urban parks, campus parks, water networks and greenways, which will contribute to integrating universities with cities. Along with the above place-based initiatives with the premises of opening campuses, it is also suggested that universities should endeavor to formulate regulations concerning the management and governance of campuses with regard to potential safety issues.

To implement the strategies of local spatial developments (see Table 2), local governments have made short-term, mid-term and long-term plans respectively. For the short-term plan before 2020, a list of 94 projects has been made targeting the six areas surrounding universities. As all of these projects are still in progress, the outcome of the spatial developments remains as yet to be proven, especially regarding the effects on knowledge workers, knowledge economies and knowledge cities in the long run. What is obvious is the change in the culture to encourage more

Figure 14. Analysis of green networks linking campuses with the adjacent sceneries

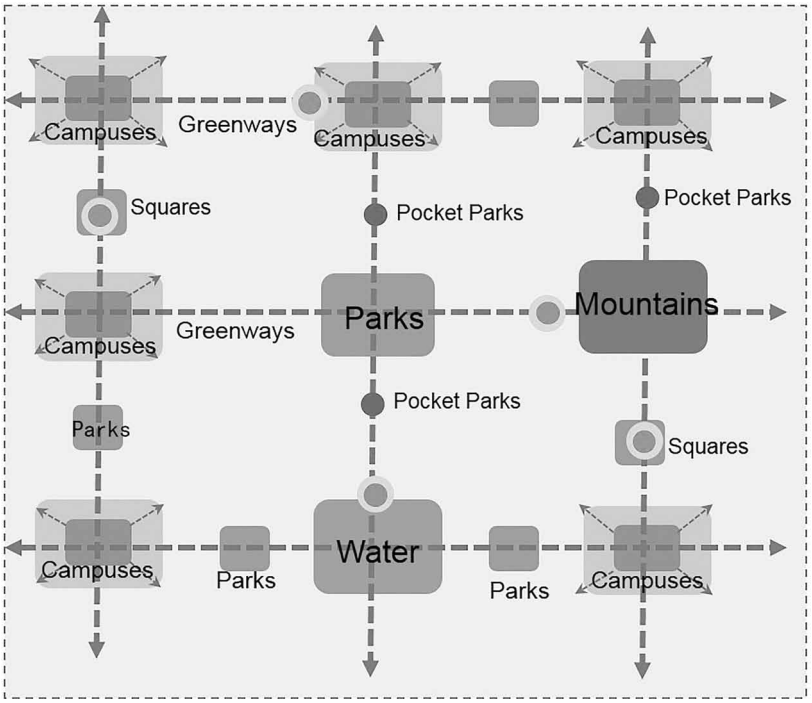
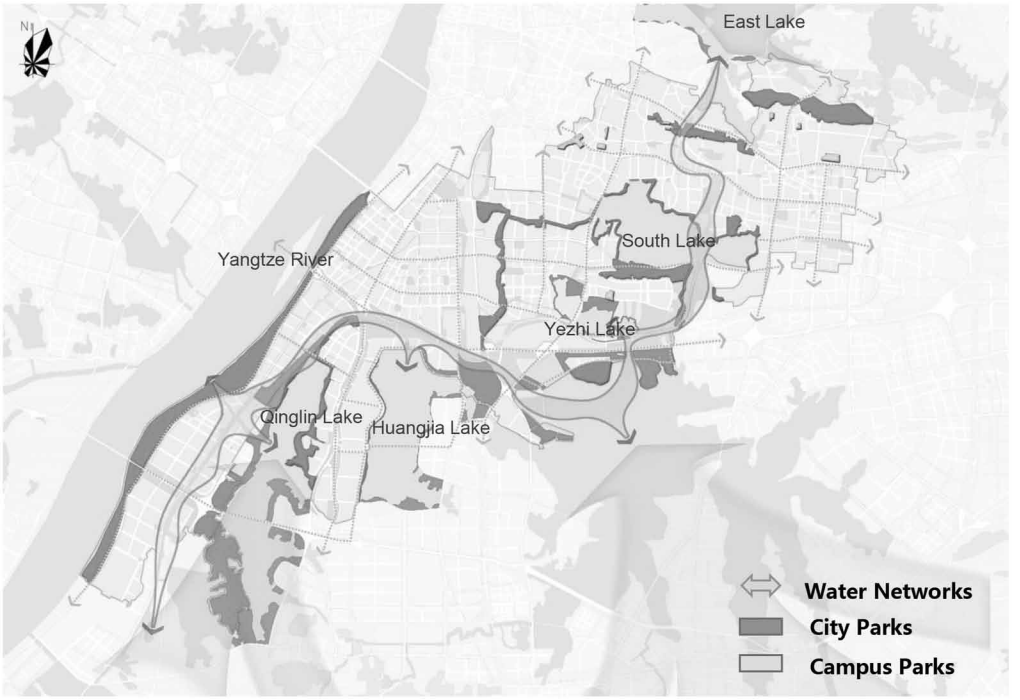


Figure 15. Analysis of the green networks in the core area of Wuhan "Univercity"



co-operation between universities, enterprises and governments, and the rise in the percentages of undergraduates staying in Wuhan, which was 20.4% in 2018. To evaluate the effects of the spatial strategies in the future, it is suggested that the key indexes of "Univercity" could be used to establish the framework of monitoring systems.

CONCLUSION

How to understand the university-city relationship in the whole picture of local contexts? How to adapt to local needs and make spatial strategies to enhance the relationship based on the spatial modes? These questions have been answered by providing a literature review and the case study, which has shown that universities have been key players in the knowledge-based development in the aspects of fostering knowledge workers, supporting knowledge economies and building knowledge cities. With the evolution of universities' role in civic engagement, the basic principle to enhance the cooperation between universities and cities lies in the above three dimensions even though new concepts have been emerging. The findings of the Wuhan case study have not only exemplified this point of view but has also suggested that the university-city relationship should be understood in the local contexts. Based on the analysis of the historical interactions between universities and Wuhan as well as its future ambitions, the new concept "Univercity" has been elaborated in the three dimensions and also addressing local needs by both qualitative and quantitative methods. Though the university-city relationship goes beyond spatial factors, geographical settings have been acknowledged to be an important condition to achieve mutual goals. After the interpretation of the new concept "Univercity" as local spatial developments strategies to enhance the interaction between universities, local businesses and cities to co-foster knowledge workers, co-support knowledge economies and co-build knowledge, the findings of this case study has not only exemplified the shifts of campus

Table 2. The strategies of local spatial development in the case of Wuhan "Univercity"

Dimensions	Spatial Strategies		Corresponding Policy Implications
Co-foster Knowledge workers	Optimize Inner Spaces of Campuses	Evacuate the existing logistic services	Improve the intensities and densities when the lands originally used for college education are transformed into key technological infrastructures.
		Remake as national key technological facilities or research cooperation platforms	
Co-support Knowledge Industries	Provide Various Innovation Spaces	Locate nursery incubators for new-born startups surrounding old residential areas, commercial facilities and offices	1. Control the scales and locations of all kinds of innovation spaces by using the index of the percentage of lands used for innovation in regulatory plans; 2. Reward with FARs when urban regeneration projects provide innovation spaces;
		Locate incubators for startups in well-developed industrial parks	
		Locate incubators for large-scale startups in industrial parks with abundant lands	
Co-build Knowledge Cities	Co-share Public Infrastructures	Co-share art, cultural and sports amenities of universities with the public	Reward with funding when university gyms have been reconstructed as urban amenities;
		Provide specialized amenities with multi-functions including academic communications, residences, retails, leisure, offices, exhibitions and sports;	Reward with FARs when urban regeneration projects provide specialized amenities;
		Co-share internal networks within campuses with the public	1. Transform the driveways in campuses by slow-down designs; 2. Formulate regulations concerning the management and governance of campuses
		Establish a specialized public transport system including metros and buses door to door between universities	
		Plan themed campus festivals and touring routes within campuses	
		Provide urban pocket parks with sizes ranging from 400 to 10000 square meters	
		Open campuses and establish greenways to link with adjacent landscapes	Formulate regulations concerning the management and governance of campuses

from spatial separations to integration and mono-function to multi-function but also improved the existing work on the five spatial modes. First, it has added more details to the modes by analyzing the spatial elements in the interaction between universities and cities. Second, it used the modes as theoretic bases to make local spatial strategies by addressing local problems and fulfill local goals.

One thing to be mentioned is that all the spatial elements of the "Univercity" concept are actually difficult to differentiate between each other. All the spatial strategies have interacted with each other, indirectly affecting issues concerning ownership and governance, which may even lead to safety issues within campuses. Therefore, the implementation of the spatial development strategies depends not only on the willingness of universities to make their spaces available and open, but also on the management skills of universities and the policy to institutionalize the links between universities, local businesses, and cities. What's more important is more attention should be paid to the innovation in policymaking in the fields of land use planning, industries, talents, taxation, finance, research commercialization, and intellectual property. It has been suggested that further studies need to be conducted on how to make land use policies and incentives which correspond to the spatial development strategies. Based on the current planning systems in Wuhan, a framework of the regulation system for all the spatial elements could be established (see Table 3). In this way, all the spatial elements of the "Univercity" can

Table 3. The controlled land use of all the spatial elements in the case of Wuhan "Univercity"

Spatial Elements	Controlled Land Use
Universities	Lands used for higher education, Lands used for science and research
Innovation Spaces	Lands used for business, Lands used for industries, Lands used for higher education, Lands used for science and research, Lands used for residences, Lands used for culture, Lands used for retails, Lands used for sports, Lands used for leisure
Urban Amenities	Lands used for business, Lands used for culture, Lands used for retails, Lands used for sports, Lands used for leisure, Lands used for parks, Lands used for schools, Lands used for hospitals
Traffic Infrastructures	Roads, Metros, Traffic hubs, Parking lots

be regulated in the statutory plans as well as master plans of universities so as to make guidance for environmental designs inside and outside campuses. Influenced by traditional ideologies, it will be a long learning process to integrate universities with cities, but only further steps on policymaking would integrate universities and cities both physically and operationally.

Although Wuhan may still be at its teething stage in moving towards a fully-developed knowledge city and can only represent cities with top-down planning systems, the lessons from this case study have managed to establish a framework of local spatial developments which can prove useful for other cities aiming to make strategic vision and actions even in different ecosystems.

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ENDNOTES

[1] There are 37 universities, 17 national labs and 594 thousand undergraduates which take up 46%, 59% and 50% of the municipality accordingly in the core area of Wuhan "Univercity" scaled at 134.66 km^2.

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