Analysis on the Working-Living-Entertaining Spatial Relations of New Towns based on Mobile Location Data: The Case of the National Independent Innovation Zone of East Lake in China

(How do New Towns Relate with the Main City in Working-Living-Entertaining Aspects)

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Synopsis

This paper offers some structural thoughts of people-centered planning models which are to optimize the space supply according to the current human activities. By using mobile location data, we do not only describe the current human activities and interpret the reasons underneath, but also analyze whether the current model of space use is sustainable and the future model of space supply is necessary to be changed.

1. Introduction

As the new-rising innovation districts all over the world shows, a remarkable shift is occurring that a great emphasis has been put on the integration of working, living and entertaining, which is reshaping the spatial geography of innovation. In China, there has been a mass birth of new towns aiming at developing innovation economies and evacuating over-crowded population from the main city. Due to their common development process, the industries of new towns are often more-developed than residential functions which are still highly dependent on the main city, let alone the leisure ones. In the early 21th Century, new towns have emerged in Wuhan following the *Wuhan Master Plan (2006-2020)* which has proposed the spatial structure composed of one main city, six new towns and multiple centers. At present, revision is being made to the original plan which is becoming due. It has been proposed in the *Wuhan Master Plan (2016-2035)* that three of the six new towns will be promoted as anti-magnetic forces more independent from the main city[2](see Figure 1). As one of the three towns, the National Independent Innovation Zone of East Lake(NIIZEL)which was established in 1988 has been undergoing the transformation from an industrial district to a self-contained new town specialized in innovation economies. Therefore, one of the key questions to be answered is whether the NIIZEL has got the foundations to be promoted as a more independent town, which sets the background for the research.

Figure 1: The Spatial Structure of Wuhan in the Wuhan Master Plan (2016-2035)

As a typical high technology new town, the NIIZEL has been planned to be composed of five functional clusters including the Western Research District, the Central Service District, the Eastern Technology District, the Northern Technology District and the Southern Technology District (see Figure 2). Except the Western Research District is a built-up area, the other four are all new areas in construction. Being in quite different phases of development, those five clusters have all been confronted with problems of lacking residential and leisure functions while the industrial function has been over-developed. Aiming at the goals of a self-contained new town, it is necessary to make reasonable guidance on the space supplies of the NIIZEL based on the current human activities, which location data can be used to describe. In the case of the NIIZEL, we collected location data from mobile devices to evaluate the current working, living and entertaining activities and identify their spatial relations between the new town and the main city, so as to propose suggestions to optimize planning in the perspectives of human behaviors. This paper offers some structural thoughts of people-centered planning models which are to optimize space supply according to the current human activities rather than populations we commonly rely on. By using mobile location data, we do not only describe the current human activities and interpret the reasons underneath, but also analyze whether the current model of space use is sustainable and the future model of space supply is necessary to be changed.

Figure 2: The Functional Clusters of the NIIZEL

2. Study and Methodology

2.1 Literature Review
Most of the previous research on the relations between new towns and the main city focused on the spatial analysis of working and living activities like comparing employment and residence densities by using economic and population census statistics (Niu, Ding and Song, 2017). Recently, there have been some research using cell phone data to record human activities and analyzing the relations of working and living by recognizing the employment-dense and residence-dense areas (Zhou, Liu and Zhu, 2018). These new emerging research has made up for the shortcomings of traditional data which often focus on the relations of spaces, and also established balance indexes such as the ratio of local employment to residence, etc[3](Zhen, Xu, Zhang and Yu, 2015). Generally, there have been certain foundations for the relations of working and living between new towns and the main city. However, there are actually three aspects of basic functions including not only working and living but also entertaining. The previous research has focused on the relations of working and

living, but neglected the relations of working and entertaining, or living and entertaining, which would fail to provide sufficient evidences to evaluate the dependency of new towns.

2.2 Thoughts and Framework

Quite like cell phone data, location data from mobile devices are new emerging data which can not only record the activities of working, living and entertaining, but also can be obtained for a duration of time, so as can be used to analyze human behaviors. The relations of working, living and entertaining are influenced by the layout and transit of cities, which in reverse determines the spatial structure of cities (Zhen, Xu, Zhang and Yu, 2015). Therefore, it can play the roles of describing the current spatial structure and optimizing the future planning structure. Moving objects in cities especially like human and their behaviors are as important as still objects and if we do not know the flow, we can never define the evaluation standards of forms(Lynch,2001). Using location data from mobile devices by recording human behaviors, this paper attempts to follow the idea of people-centered planning which can be illustrated as that forms follow flows.

At first, location data from mobile devices can be used to describe current activities. Then the dense areas of working, living and entertaining activities were identified by analyzing the average densities, leading to a comparison about densities and area ranges between the new towns. After identifying the original and influential areas of the working, living and entertaining activities in the NIIZEL, we analyzed the relating directions, strengths and lengths among the original, influential and functional areas themselves. On the basis, an overall evaluation of the amounts, balance indexes and influencing ranges in different scales can be made on the relations of those three functions between the NIIZEL and other areas, which can be compared with the current and planned land use. In this way, problems can be discovered in the space supply, and evidences can be provided to optimize the current master plan scheme. By analyzing the differences between human activities and current spaces, whether the future model of space supply is sustainable can be determined, so as to provide suggestions to optimize the existing planning schemes, which can be considered as an upgradation for the traditional planning thoughts.

2.3 Data Processing

With the location data from mobile devices during five weekdays of 2017, this study has collected and cleaned almost 11 million samples from more than 2.5 million mobile devices in the municipality of Wuhan. In this way, the activity ranges of working, living and entertaining can be defined by setting the standards of occurrence frequencies. For instance, the locations with the occurrences of mobile devices staying in the radius of 1000 meters from 9 to 12 o'clock which reach above 60% can be included in the range of working activities. Likewise, the locations with the occurrences of mobile devices from 19 to 21 o'clock and from 22 to 24 o'clock can be included in the range of entertaining and living activities separately.

3. Research Contents

Based on the statistic of the current residents and employees in the NIIZEL, the activities of living, working and entertaining have been analyzed in the aspects of distributions, relations and comparison with current land use. Then an overall evaluation has been made from the aspects of amounts, balance indexes and influencing ranges, so as to provide suggestive guidance for the planning optimization.

3.1 Current Population

Till the end of 2016, the number of residents in the NIIZEL has reached almost 1.08 million, taking a percentage of 9.8% in the municipality. With the immigrant amounts and resident density ranking top, the NIIZEL has become the area with the rapidest growing population and the largest amount of young people in Wuhan. Besides, the NIIZEL with a number of employees reaching 0.55 million and taking a percentage of 13% in Wuhan, has the densest job positions in Wuhan. Although the NIIZEL has played a key role of the economic

development in Wuhan, the current ratio of local employees to residents has only reached 0.63, which is below the acknowledged standard of 0.8(Cervero,1989&1991). With a quite unbalanced distribution, more than 80% of the populations of the NIIZEL have been centralized in the Western Research District (see Figure 3).
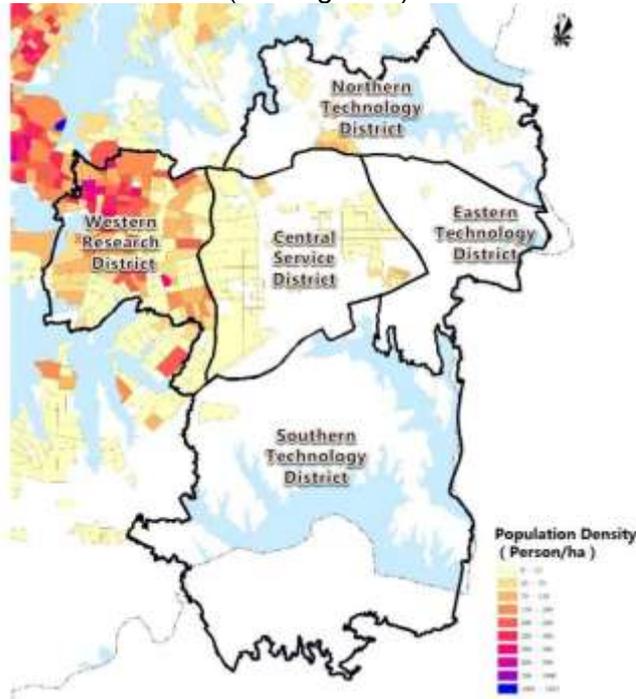

Figure 3: The Population Density Analysis of the NIIZEL

3.2 Activity Ranges

According to the location of mobile devices in the NIIZEL in the designated time, the average and maximal densities of living, working and entertaining activities can be demonstrated by grids of 100m*100m.Then the areas with higher densities in the level of significance by 5% can defined as working-dense areas, living-dense areas and entertaining-dense areas (see Table1 and Table 2). Based on this, the percentage of people coming to the NIIZEL from all the other places in the municipality engaging in all activities can also be defined. Once the percentage reaches above 50%, the places will be considered as the influencing areas of the NIIZEL.

Table 1: Analysis on all the activity-dense areas in the Municipality

Name	Working-dense Areas			Living-dense Areas			Entertaining-dense Areas		
	Percent	Average Density (person /k ㎡	Maximal Density (Person /k ㎡)	Percent	Average Density (person /k ㎡	Maximal Density (Person /k ㎡)	Percent	Average Density (person /k ㎡	Maximal Density (Person /k ㎡)
The NIIZEL	9.59%	153.4	8205.7	11.54%	207.4	11472.1	2.28%	32.2	1998.5
Airport Economic Zone	6.33%	102.9	7643.7	8.65%	137.4	7842.6	1.49%	26.3	2193.0
Economic Development Zone	3.91%	74.4	4068.6	6.12%	101.4	7145.9	0.78%	17.1	1041.5
Southern New Town	6.09%	102.9	6531.1	7.95%	147.6	9698.6	1.51%	23.6	1305.8
Eastern New Town	2.04%	46.1	3995.0	3.16%	57.3	5603.6	0.26%	9.8	941.2
Western New Town	6.35%	108.9	2080.2	9.84%	147.6	3055.8	0.87%	25.4	791.5
Main City	44.20%	683.4	12049.2	48.97%	907.5	14412.1	16.34%	143.5	3461.8

Table 2: Analysis on all the activity-dense areas in the NIIZEL

Name	Working-dense Areas			Living-dense Areas			Entertaining-dense Areas		
	Percent	Average Density (person /k ㎡)	Maximal Density (Person /k ㎡)	Percent	Average Density (person /k ㎡)	Maximal Density (Person /k ㎡)	Percent	Average Density (person /k ㎡)	Maximal Density (Person /k ㎡)
Western Research District	88.14%	882.7	8205.7	84.63%	1102.9	10791.2	97%	169.25	3461.83
Central Service District	7.75%	73.0	3143.2	9.47%	83.4	6413.4	2%	15.26	857.24
Northern Technology District	2.18%	27.9	2585.5	2.95%	33.2	2455.5	——	5.12	478.81
Eastern Technology District	1.45%	19.0	1256.0	2.11%	24.6	1968.2	——	4.17	546.44
Southern Technology District	0.48%	4.5	2722.9	0.84%	6.2	5863.5	——	1.05	382.01
Main City	--	683.4	12049.2	48.97%	907.5	14412.1	——	143.5	3461.8

3.2.1 Working activities

According to the statistics of working-dense areas in the municipality, the scale of the NIIZEL ranks the second with the highest number of area percentage, average and maximal densities. Especially the maximal density of the NIIZEL has reached 1.5 times the one ranking second, which indicates its key role in industrial development (see Figure 4). For all the functional areas in the NIIZEL, the working-dense areas also demonstrates the over-centralized distribution with close to 90% of working activities gathering in the Western Research Area which has the average and maximal densities far above the others (see Figure 5). By comparing the working-dense areas with the maps of enterprises and the current land use, it is evident that there have been unofficial industrial spaces in residential lands with low cost of rents, which can offer finance, information and technology services for medium and small companies. Besides, the industrial lands have the largest area of working-dense areas but with the lowest maximal and average densities, which indicates the inefficiency of industrial land use. While the commercial lands have the highest maximal and average densities, the business lands have much lower densities close to the industrial lands due to the vacancy of current office buildings.
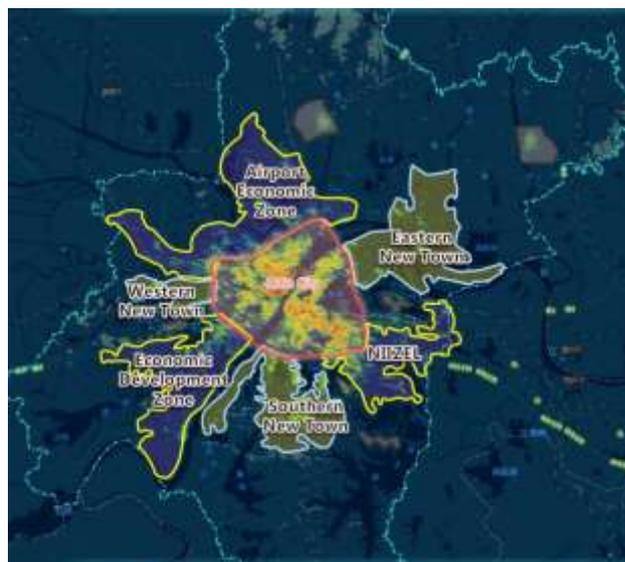

Figure 4: Analysis on the Working Activities in the Municipality
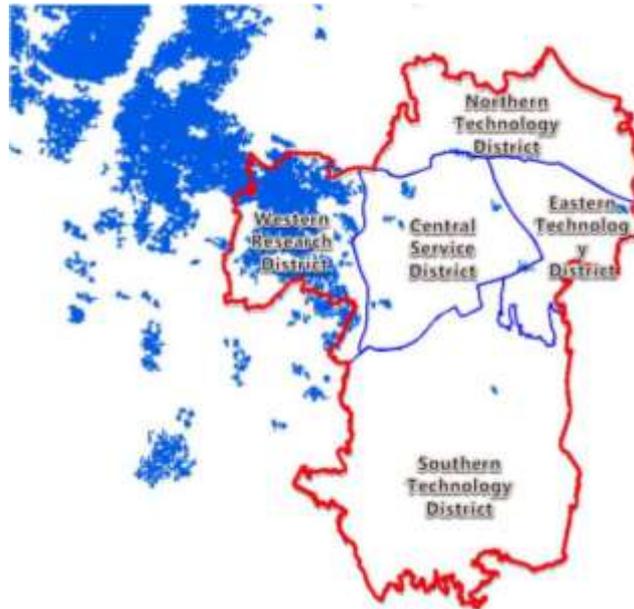
Figure 5: Analysis on the Working-dense Areas in the NIIZEL

It is evident that most of the people working in the NIIZEL come from the neighboring districts, which makes up a large portion with the percentage ranking the second in the municipality. By analyzing the influencing areas, it is estimated that almost 80% of the people working in the NIIZEL live in the circle at a radius of 15km and especially in the circle of 5-10km, which will take an hour to drive. Also there is also 10-20% of the people living almost 3 hours' drive from work, which indicates the strong force of long-distance employment of the NIIZEL. Except the Central Service District, all the other four districts have higher local residential ratios to employment than the average level of the municipality, which also indicates the lack of residential attraction for local employees in the Central Service District. The first choice where people working in the NIIZEL will live in is the Western Research District with its strong connection with the Central Service District. For the Western Research District itself, the ratio of local residence to employment is relatively higher than the other four districts, with a stronger connection outside of the NIIZEL than inside.

For the people working in the NIIZEL, the ratio of local leisure to employment is far behind to residence. Not only do people working in the NIIZEL tend to go entertaining in the neighboring districts and are also willing to drive relatively longer distance for leisure. All the five districts of the NIIZEL have lower ratios of local leisure to employment than the average level of the municipality, which indicates the lack of service functions. The first choice where people working in the NIIZEL will entertain themselves is also the Western Research District with a stronger connection outside of the NIIZEL than inside.

3.2.2 Living activities
Compared with the working activities, the current living activities of the NIIZEL have a larger scale and bigger spatial agglomeration. The scale of the current living-dense area ranks the second in the municipality with the percentage, average and maximal densities ranking the top among the new towns. Especially the maximal density of the NIIZEL is close to the main city and much higher than the other new towns (see Figure6). With a match to the distribution of local residents, the densities of current living activities of built-up areas and new areas are quite different. Especially the current living-dense activities of the Western Research District have larger scales than working-dense activities, with higher average densities than the main city. However, new areas like the Central Service District and the Eastern Technology district are lack of residents and thus have lower densities of living activities due to the implementation of residential lands (see Figure 7).

For the people living in the NIIZEL, the ratio of local employment is relatively higher, which indicates the residential function along with the strong force of employment. Due to the cost and distance, most of the people living outside of the NIIZEL will choose the neighboring districts. It is also estimated that almost 80% of the living activities stay in the circle at a radius of 15km and especially assemble in the circle at a radius of 5-10km.Compared with the working activities, the living-dense areas has been distributed more evenly with a weaker long-distance force than employment. Specifically, there is a higher ratio of local employment for the people living in the NIIZEL, which is higher than the average level of all the other new towns. The top choice that the people living in the NIIZEL will make to work in has proved to be the Central Service District, which indicates its strong force of employment. For the Western Research District, there is a smaller number of people living locally who choose to work outside of the district than people working locally who choose to live outside of the district, which indicates its strongest force for employment. Meanwhile, there is a larger ratio of local leisure to residence than to employment, which ranks top among all the new towns in the municipality. Especially, the Northern Technology District and the Central Service District are well-established with service facilities for residents. Most of the people living in the NIIZEL will choose to entertain in the Western Research District which proves to supply most of the leisure spaces.
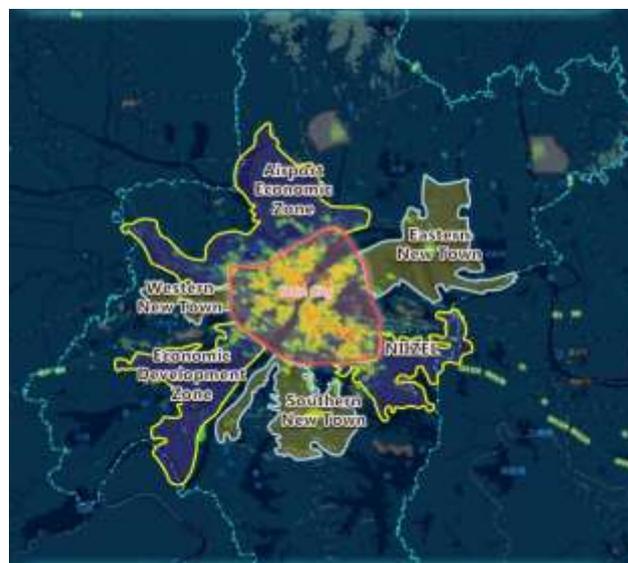

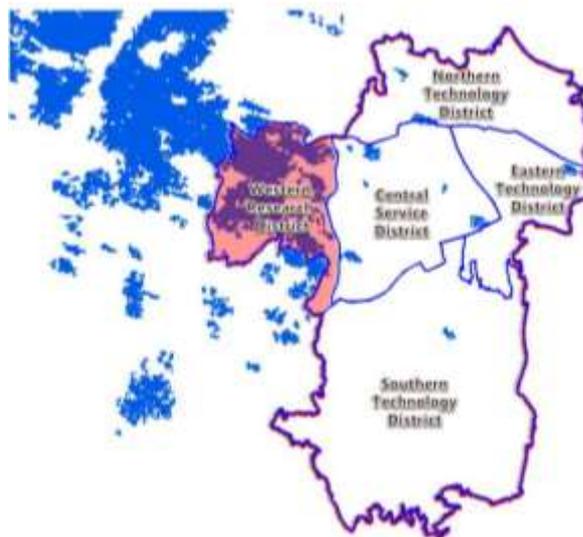Figure 6: Analysis on the Living Activities in the Municipality

Figure 7: Analysis on the Living-dense Areas in the NIIZEL

3.2.3 Entertaining activities

Compared with working and living activities, the scale of current entertaining activities in the NIIZEL is obviously smaller, which indicates the lack of service functions. Although the percentage of entertaining-dense areas and their average densities rank the top among all the new towns, but are much lower than the main city (see Figure 8). Close to 97% of entertaining-dense areas are centralized in the Western Research District with the average and maximal densities high above the main city. By comparing the entertaining-dense areas with the spatial distribution of current retail facilities, it is evident that there have been a large number of entertaining activities in the non-commercial areas of the Western Research District, which can be considered as unofficial spaces of leisure. On the contrary, new areas like the Central Service District have lower densities of entertaining activities due to the failure of implementation of commercial lands (see Figure 9).

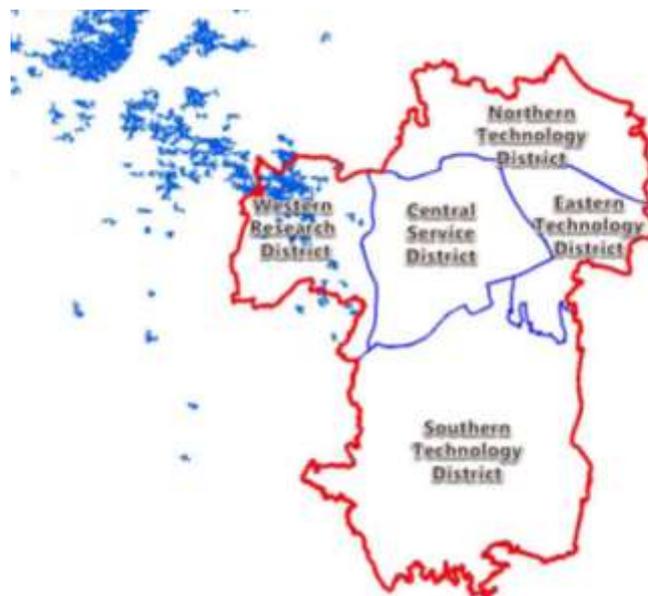*Figure 8: Analysis on the Entertaining Activities in the Municipality*

Figure 9: Analysis on the Entertaining-dense Areas in the NIIZEL

Quite unlike the ratio of local leisure to employment, the ratio of local employment to leisure ranks the bottom among the new towns, which indicates that the local service facilities of the

NIIZEL lack of influences. All the functional clusters have relatively low ratios of local employment to leisure, especially new areas like the Central Service District, the Eastern Technology District and the Northern Technology District. Most of the entertaining activities in the NIIZEL are undertaken by the people working in the Central Service District, which proves to be the most service-insufficient cluster. Although there has been a strong force of the service facilities in the Western Research District for the people working in the Central Service District, it still lacks of attraction for people working outside of the NIIZEL.

On the other hand, the ratio of local residence to leisure ranks ahead of most of the new towns, which indicates its stronger influences of service facilities for residents. Although there is an obvious difference in the efficiency of leisure functions for every cluster, the ratios of local residence to leisure for new areas are quite low. Planned as the central activity zone in the NIIZEL, the Central Service District fails to provide leisure functions for people living there who end up going to the other clusters. And the Western Research District proves to be the first choice where people living in the other four clusters who will go to entertain themselves, which indicates the district has equal influences of leisure between employment and residential functions. By analyzing the influencing areas of the leisure function of the NIIZEL, it is evident that more than 80% of the entertaining activities can attract people living and working in the circle at a radius of 15km. More specifically, they are centralized in the circle at a radius of 5km, which indicates that distance is a major factor for leisure function.

3.3 Overall Evaluations

From the scales of the municipality, functional clusters and plots of the NIIZEL, overall evaluations have been made in the aspects of amounts, influencing areas and balance indexes of the working, living and entertaining activities, so as to provide suggestions for the space supply of future activities.

3.3.1 Amounts
The amounts of working, living and entertaining activities can be used as indicators to evaluate the basic functions of employment, residence and leisure. For the NIIZEL, the amounts of working, living and entertaining activities all rank the second among all the new towns. On one hand, the amount ratio of working to living activities is close to 1, which is to some extent different from the amount ratio commuted by populations. On the other hand, the amount ratio of working to living and entertaining is fall behind other new towns, which indicates the lacking of leisure functions (see Figure 10). Specifically, there is quite a difference in the amounts of working, living and entertaining activities for every functional cluster. The entertaining activities of the Western Research District is relatively small to working and living, while the other four districts are all underdeveloped in all the activities (see Figure 11). By comparing the working, living and entertaining activities of every plots, evaluations can be made on the degrees of muti-functions. It is evident that the muti-functional plots have been centralized in the Western Research District while plots of the other four districts are mostly single-functioned. Considering the overall ratio of implementation to plan schemes has reached above 70% with the industrial functions overdeveloped than residential and leisure functions, it has been proposed to improve the degree of muti-functions for every plot unimplemented as plans so as to keep up the supplies of service facilities with rapid urbanization.
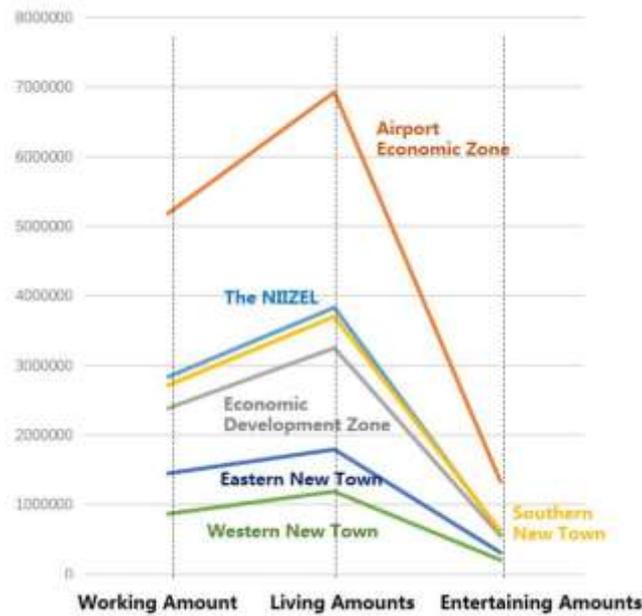
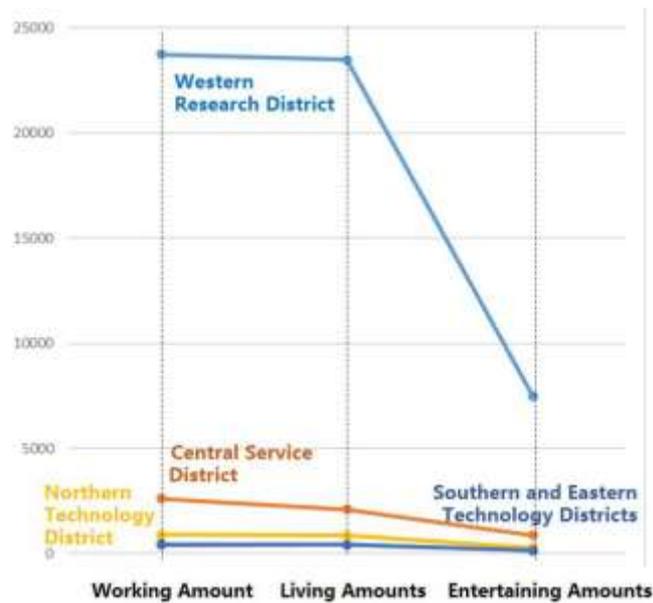*Figure 10: Analysis on the Activity Amounts in the Municipality*

Figure 11: Analysis on the Activity Amounts in the NIIZEL

3.3.2 Influencing ranges

The influencing range can be an important indicator to evaluate the attraction and influence of some function. It is evident that the influencing ranges of the current working, living and entertaining activities are all to the south of the Yangtze River, with their amounts and ranges decreasing one by one. The working activities have the strongest pull for long-distance employment, while the living activities are more dispersed and the entertaining activities are more influenced by walk-able distances. With the implementation of the master plan, the center of the NIIZEL will move to the east. In that case, not only the influencing range of the working activities will enlarge further due to the long-distance attraction, but also the entertaining activities will probably expand the outer ring and shrink the inner ring, leading to more long-distance commutes (see Figure12). Considering the lack of regional transit for the NIIZEL at present, it is proposed that the transport planning need to be optimized at a larger scale.
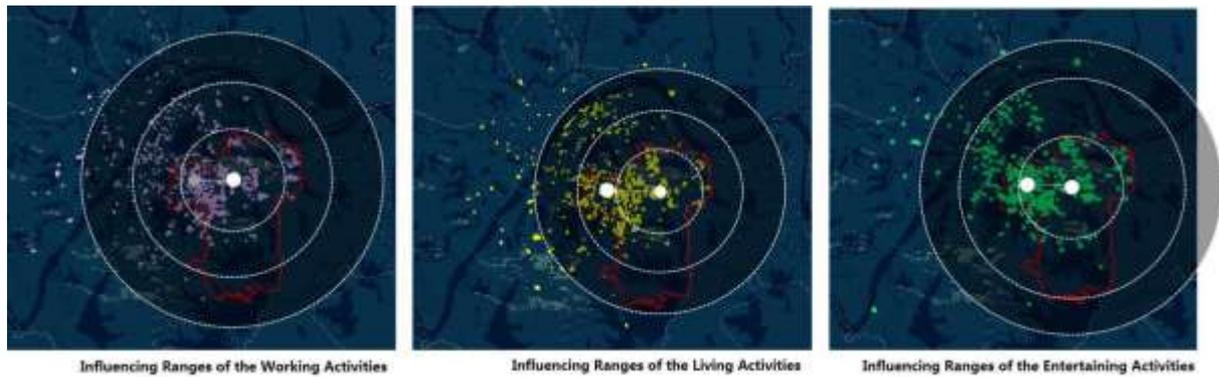
Influencing Ranges of the Working Activities   Influencing Ranges of the Living Activities   Influencing Ranges of the Entertaining Activities

Figure 12: Analysis on the Influencing Ranges of Activities in the NIIZEL

3.3.3 Balance indexes

As an indicator to reflect the relations between the functions, balance index has been commuted as the ratio between every two of the three activities namely working, living and entertaining, which can be used to evaluate the development of new towns[4]. Except the ratios of local residence and leisure to employment are relatively low, all the balance indexes reached above the average levels of the new towns (see Figure13). Among these, the ratio of local employment to residence proves to be the highest, while the ratio of local leisure to employment is the lowest. Especially the Central Service District and the Northern Technology District which can offer large amounts of opportunities for employment though are underdeveloped with their residential and leisure functions (see Figure14). It is also evident that the Western Research District, as the connection node between the NIIZEL with other new towns, has confronted with a series of urban diseases due to its role as the only gateway. Considering the weak links between the NIIZEL with other areas and between the functional clusters, it is supposed that balances between working, living and entertaining should be kept at a smaller scale in every functional cluster or every plot. Following the standards of appropriate commuting distances between working and living as well as between living and entertaining[5], evaluations have been made for every plot of the NIIZEL from the aspects of local residence to employment, local leisure to residence and local leisure to employment (see Figure15). It is evident that the balance index of local residence to employment is relatively higher than the ratios of local leisure to residence and to employment.
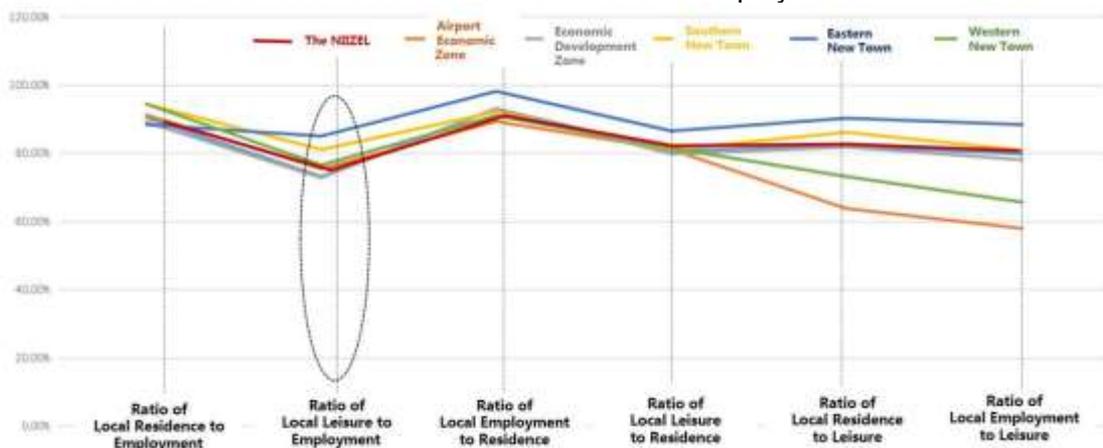

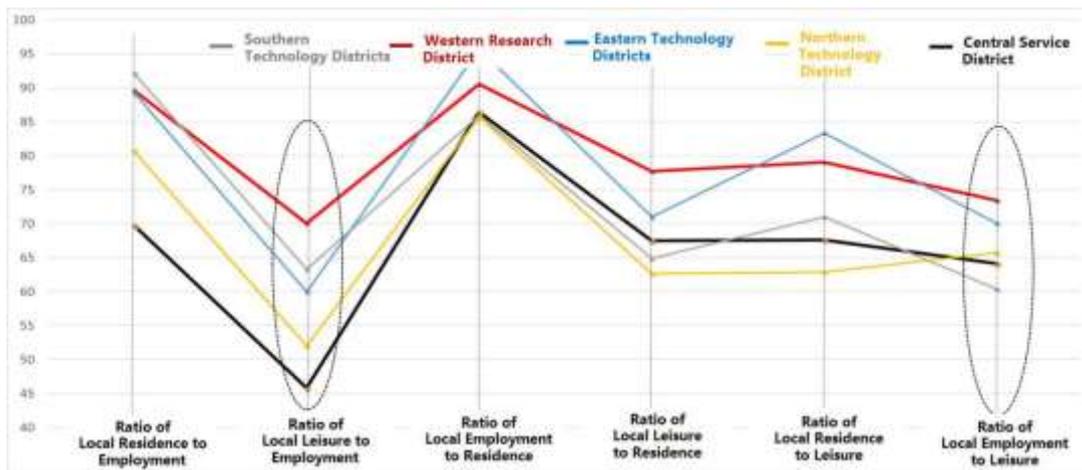Figure 13: Analysis on the Balance Indexes of the New Towns

Figure 14: Analysis on the Balance Indexes of the Functional Clusters in the NIIZEL
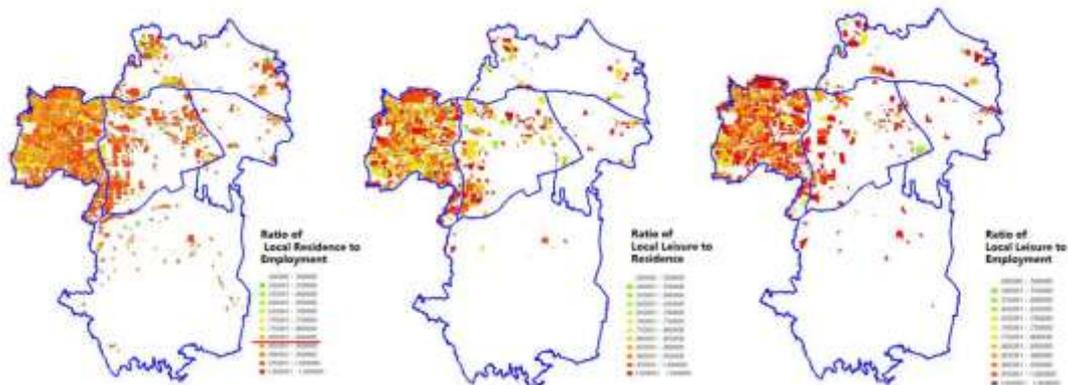

Figure 15: Analysis on the Balance Indexes of the Plots in the NIIZEL

4. Applications of the Results

By the evaluations of amounts, influencing ranges and balance indexes, it is evident that the NIIZEL has the foundations to be promoted as a more independent town. And strategies have been given at different scales to optimize planning as the applications of the results.

4.1 Strategies at the Scale of the Municipality
By analyzing the amounts of current working, living and entertaining activities, it is evident that the NIIZEL ranks far head of the other new towns and proves to be one of the major new towns in the whole municipality but with limited access. Thus the strategies at the scale of the municipality should focus on the regional functional balances to improve the access of the NIIZEL. It is proposed to improve the role of the NIIZEL further in the long-term plan and the NIIZEL should be integrated with its neighboring district considering their close connections. On one hand, the functional axes between the NIIZEL and other new towns as well as the main city should be re-stressed in the existing master plan of the municipality, so as to establish an innovation system centered at the NIIZEL. On the other hand, rapid transit including highways and metros between the NIIZEL and other new towns as well as the main city has also been suggested to make, so as to deal with the future change of the influencing ranges of human activities.

4.2 Strategies for Every Functional Cluster at the Scale of the NIIZEL
Considering the underdevelopment of functions in every cluster of the NIIZEL and the role of the Western Research District as the only gateway, it has been proposed that multiple connections should be set up between every functional cluster of the NIIZEL. Thus the strategies at the scale of every functional clusters in the NIIZEL are proposed to focus on the

structural function balances by remaking connections. Based on the existing plans, suggestions have been made about adding two north-south axes on both sides of the original axis and stressing the connections between the clusters. Taking references from other innovation districts, it has been proposed that the functional clusters should be recategorized as knowledge innovation, technology innovation and service innovation models. Besides, all kinds of service centers should be added in every cluster so as to improve the rate of local leisure to employment and residence. According to the statistics of the implementation, the original spatial structure of facilities should also be optimized by upgrading the service facilities for living and adding more service facilities for working.

4.3 Strategies for every plot at the Scale of the NIIZEL

According to the evaluations at the scale of every plot in the NIIZEL, it has been proposed to stress the function balances at human scales by improving the degrees of muti-functions. Based on the current land use, missing functions have been proposed to add to the lands which haven't been implemented as plans and transits have been also suggested to rebuild for the plots with functional connections but lack of access. Then following the latest regulations on land use, optimizing work can be done by regulating the muti-functions of every plot in accordance with the regulatory plans. To fulfill the goals of function balances at human scales, the spatial modes of innovation cells have been proposed and further study will be made to give instructions on land use planning.

5. Conclusions

By using location data from mobile devices, this study attempts to analyze the spatial distributions and relations of the working, living and entertaining activities, so as to reflect the features of human behaviors. After comparing the human activities with the current and planned spaces, it proposes corresponding strategies at different scales so as to play the role of optimizing spatial supplies. As a supportive study for the Master Plan of Wuhan, some suggestions has been absorbed into the undergoing plan so as to give further instructions. Meanwhile, this study also gives a structural framework on the Wuhan Planning Lab[6], so as to play the role of evaluation, monitoring, warning and dynamic regulations. It is also necessary to mention that there is some shortcomings and problems with the data processing. On one hand, the data can only be used to recognize human activities by common senses due to the lack of behaviors information. On the other hand, the statistics can only be used to compared with and need to be expanded with a larger sample.

Endnotes
[1]Han ZOU is the corresponding author, email zouhangogo@qq.com .
[2]It has been proposed that there will be six new towns in the spatial structure of *Wuhan Master Plan (2006-2020)*, including the NIIZEL, Airport Economic Zone, Economic Development Zone, Eastern New Town, Southern New Town and Western New Town. In the Wuhan Master Plan (2016-2035), the NIIZEL, Airport Economic Zone and Economic Development Zone has been promoted as anti-magnetic forces more independent from the main city.
[3]The balance indexes have been established such as the ratio of local employment to residence and the ratio of local residence to employment. The former indicates the ratio of residents who working in a certain range to the residents, while the latter means the ratio of employees who living in a certain range to the employees.
[4]Based on the concepts like the ratio of local employment to residence and the ratio of local residence to employment, this study proposed balance indexes like the ratio of local leisure to

employment, the ratio of local leisure to residence, the ratio of local residence to leisure and the ratio of local employment to leisure.

[5]It has been proposed in the *Research on the Distribution of Current Population and Balance of Local Employment to Residence in Wuhan* that the appropriate distance between working and living is 12km and the one between living and entertaining is 15minites' walk.

[6]Wuhan Planning Lab, funded by Wuhan Planning Bureau, is an intelligent decision-making platform by using big data to describe human activities, monitor city functions, simulate urban systems and predict future space supplies.

References:

Cervero, Robert (1989) Jobs–housing Balance and regional mobility. Journal of the American Planning Association, Vol.55 No.2.

Cervero, Robert (1991) Jobs–housing balance as public policy. Urban Land, Vol.50 No.10.

Sun,bingdong, Wei, Xuhong(2014) The Evolvement Features of the Employment and Population in the Metropolitan Area of Shanghai", Journal of Geography, Vol.69 No.6.

Lynch, Kevin (2001) City Image, Beijing: Huaxia Press.

Niu, Xinyi, Ding, Liang, Song, Xiaodong (2017) The Development of the New Towns in Shanghai based on the Spatial Analysis of Employment and Residence", City Planning, Vol.41 No4.

Wuhan Planning Bureau and Planning Information Center (2016) Research on the Distribution of Current Population and Balance of Employment to Residence in Wuhan.

Zhou, Yongjie, Liu, Jiezhen, Zhu, Jinfeng (2018) Analysis on the Spatial Features of Pearl River Delta Megapolitan based on the Cell Phone Data", Planner, Vol.34 NO.1.

Zhen, Siqi, Xu, Yangfei, Zhang, Xiaonan, Yu, Du (2015) Analysis on the Balance Index of Local Employment to Residence and Its Spatial Differentiation: Taking Beijing as an Example", Journal of Qinghua University, Vol.55 No4.

Zhen, Siqi (2012) The Spatial Structure of Urban Economics: Residence, Employment and their Derivative Problems, Beijing: Press of Qinghua University.