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High-Density Challenge for Chinese New Towns Oriented at High-Speed Rail:

A Comparison of Urban Density of Station Node Area Developments between Hangzhou and Tokyo

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Abstract

This paper explores the understanding of how to increase the urban density of the emerging new towns around the station nodes of High-Speed Rail (HSR) in China, to achieve more effective urban land uses. The first part sets up a theoretical argument that high-density development represents the substantial demand in Chinese practice of developing new towns oriented at the HSR infrastructure. The second part compares two chosen cases of HSR oriented urban developments from Hangzhou, China and Tokyo, Japan. Through the comparison the author analyses the Chinese obstacles preventing urban densities from increasing. In conclusion, three of such observed obstacles are discussed, which are: the incomplete rail hierarchy system, the isolated urbanities from rail track penetration, and the universal design codes not applicable to the features of HSR oriented developments. Finally, four suggestions for increasing the "density ceiling" are provided.

1.0 Introduction

Since operating the first High-Speed Rail (HSR)[1] Line between Qinhuangdao and Shenyang[2] in October 2013, China has witnessed a large scale and fast development of the national HSR network during the past decade. According to report, by the end of 2012, an HSR network of near 10,000 kilometre tracks has been constructed in China.[3] By 2020, this network is predicted to connect every provincial capital city, as well as cities with population size above a half million in China, and over 90% of the national population will be served by the HSR infrastructure (Yu, et al., 2012). Studies have revealed that the large scale HSR connections will result further agglomerations between Chinese cities, reshape regional urban system and redefine urban functions (Yao, et al., 2011; Yin, et al., 2010).

On the other hand, for the connected cities, the HSR station nodes and around areas are described as "neurons", or in other words, "direct contact interfaces" to connect local economy into the inter-urban economical network based on the HSR infrastructure. We

[1] According to the International Union of Railways (UIC), HSR refers to "new lines designed for speeds above 250 km/h and upgraded lines for speeds up to 200 or even 220 km/h," see: http://www.uic.org/spip.php?article971

[2] This line is also named as Qin-Shen Line, with a total length of 405 kilometres, designed for trains running over 250 km/h, and is recognised as the first HSR line in China. Now operated as part of the Jing-Ha HSR Line (Beijing-Har'erbin)

[3] Lu (2012)

have therefore seen a tide of new development constructions around the station nodes along with the extension of HSR lines. It is worthy to note that most HSR stations are planned far away from conventional city centres (Yu, et al., 2012), which makes the concept of "New Town" reasonable to define the new developments. Through planning new towns around HSR stations, local governments are expecting both economic growth and releasing metropolitan population pressures generated by fast urbanisation during the past decades[4] (Chen, 2012).

During recent years, the Chinese academies have shown strong interests in the emerging urban type of "HSR Oriented New Towns" (HONT), followed by large number of valuable research outcomes. However, it is noticeable that, attitudes towards the urban development densities of new town planning are comparatively conservative. For example, Pan & Cheng (2010) concludes that "medium density" is considered appropriate for the new developments through studies of the urban traffics of typical HONT. As a combination of train terminal and urbanity, the HONT planning struggles to accommodate traffic generated by both. Taking the city of Hangzhou as an example, the new HSR terminal of Hangzhou East Station is scaled to serve 200,000 passengers daily. The HONT around the station, namely [New Eastern Town of Hangzhou],[5] occupies 9.3 square kilometre of land and is planning to accommodate another 200,000 urban residents. As traffic needs from both station and city are considered, "the development density of the area should take a medium figure, which is neither too high to affect the traffic, nor too low to support local growth"[6] appears to be a reasonable statement. From this we can find a dilemma between "airport" and "city centre" templates in the Chinese practice of HONT development.

Is it true that the *Traffic* defines the limits of *Density* in Chinese HONT practice? If referring to the development examples along the Shinkansen lines, we may easily find a large density gap between Chinese and Japanese practices. For instance, the Tokyo Station, which has the same number of track lines and platforms as Hangzhou East, supports both passengers and urban developments at a much higher level than its Chinese rival (details discussed below).

[4] According to the National Bureau of Statistics and Chinese Academy of Social Science, the urban population in China has increased from 35 million in 1949 up to 670 million in 2012, with urbanisation ratio rising from 7.3% to over 50% respectively. As Xu (2012) predicted, the urbanisation ratio will touch 65% in 2030, with a further 300 million urban dwellings in next two decades.
[5] The Romanised Chinese name (pinyin): "Hángzhōu Chéngdōng Xīnchéng "
[6] Pan & Cheng (2010: 129)

This observation raises another question: how to raise the “density ceiling” in Chinees HONT to promote effective urban land use?

This paper makes efforts to answer these questions. The first part will set up a theoretical argument that high-density development represents the substantial demand in Chinese HONT planning and design. The second part will analyse the obstacles preventing urban densities from increasing in Chinese HONT practice through comparison between cases in Hangzhou and Tokyo. Finally, suggestions for future practice will be provided through summarisation in the Conclusion part.

2.0 Need for Density: Chinese HONT Developments

This part will discuss the relationship between high density and Chinese HONT developments in theoretical frame. Three aspects are examined below: 1) the features of Chinese HSR and related urban developments, 2) the study of theories on European rail station node area developments, and 3) the study of theories and cases on Chinese metro rail transportation node area developments.

2.1 High Density Defined by Features of Chinese HSR and HONT

Through comparing the HSR developments in China, Europe and Japan, Wang & Lin (2011) discovered that “different from the slow urbanisation process observed in other countries, the fast accelerating urbanisation ratio (in China) happens in parallel with the (Chinese) HSR developments… the construction of large scale HSR station hybrid nodes provides one of the key factors to guide urban space developments.”[7] Under the background of large scale and fast speed urbanisation in China, the HSR development is integrated into the internal re-structuring and external expanding of cities. Development around HSR station nodes channels growing demands for both.

Three features of Chinese HSR dictate the need for high-density developments around the station nodes.

Firstly, the national HSR network planning focuses on reshaping the national/regional economic systems, which provides enormous development opportunities around HSR

[7] Wang & Lin (2011: 17)

infrastructure. This is reflected both in macro (national) and micro (local/regional) scales. At the macro scale, it is pointed out that the HSR network stretches its coverage with economic/population importance instead of geographical destinations. According to statistics of Wang & Ding (2011), by the preliminary accomplish of Chinese HSR network in year 2015, "the percentages of one-hour commuting radius coverage are 40.9% in land area, 84.5% in population and 90.6% in total economy of the national figures in China."[8] This reveals that maximising the integration between economics and population on limited land has become one of the principles to challenge the HSR's infrastructure planning.

At the micro scale, Chinese cities have a long established feature of highly densified urban core area, inherited from the "walled-up" cities since the imperial ages. In today's urbanisation practice, however, the over-populated conventional centre is re-structured into a multi-centre system that balances both urban expansion and density, which has been widely observed. Among the emerging new centres planned with various "urban themes,"[9] the HONT is special in its relationship to the conventional centre. "(The HONT) is planned as an integrated urban centre and expected to play as the new growth pole, which targets at a high density and high quality urbanity instead of the small scale and low density new town templates that have been broadly practiced."[10]

Secondly, with the restructuring of regional urban system by HSR infrastructure, both major and minor cities have strong ambitions in actively reshaping urban industry and optimise economic structures. This initiates competitions of HONTs between cities connected into the HSR network. On one hand, the major city's influences and attractions over its hinterlands are reinforced by the HSR lines. Due to the fewer stops of fast trains, the mid-way and small scale cities are less accessible on HSR rides, which eventually powers relocation of the HSR related industries from these cities to the HONTs of major cities, further increasing development demands of the latter.

[8] Wang & Ding (2011: 50)
[9] The widely applied "urban themes" in Chinese new towns are such as "industrial park/high-tech park", "university town", "tourism town" and etc. As a centre with certain focused/amplified urban function, these "new towns" are however weak in facilities to sustain full experiences of urban life, and are therefore dependant on conventional centres.
[10] Yu, et al. (2012: 1042-3)

On the other hand, the mid-way and small cities are enthusiastic to project high expectations over development with HSR connections. These cities, as lacking of development opportunities and resources compared with the regional centres, have stronger desires to achieve urban expansion and upgrade through HSR infrastructure. For instance, Zheng & Zhang (2011) discovered that Jiaxing, a middle-sized city with about one-fifth population compared to its neighbour Shanghai, has planned a HONT with a size slightly beyond that of the HONT of Hongqiao HSR/Airport Terminal in Shanghai. Lin (2011) has further studied this phenomenon through summarising HONT development statistics picked from seventeen different cities. He finds that the HONTs in mid/small scale cities have fewer projects and are slower in developments, which is probably because of less passengers (fewer stops of trains) and worse connection services between HONT and conventional centres compared with the major cities. This verifies that the mid/small scale cities over expect the effectiveness of HONT developments than the major cities, which in turn, raises the question of compact and density development at reasonable sizes.

Thirdly, the scarcity of agricultural land resources challenges the develop mode of HONT. In 2008, the State Council of China set a national target of preserving 1.805 billion MU (120.3 million hectares) of cultivable land by 2020.[11] However, according to the Ministry of Land and Resources, 253,000 hectare of cultivatable land was developed for construction in 2011 alone, pushing further the reported figure of 1.826 billion MU (121.7 million hectares) in 2011[12] toward the 2020 target. While there are no available statistics for agricultural land "consumed" by HSR and related development, siting stations on remote and cultivable lands, as observed in most new HSR developments,[13] rapidly increase land values and create growing pressures on statistical land resource reports. It is clear that in the dilemma of value and land, a restrained land area customised with high-density development is the choice to achieve balance.

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[11] State Council of China (2008)

[12] Ministry of Land and Resources of China (2012)

[13] Wang & Liu (2012) studied HSR station and relative developments along four lines of Beijing-Shanghai, Nanjing-Hangzhou, Hangzhou-Ningbo, Shanghai-Nanjing. They summarise three categories of developments around HSR station nodes: New Town, New Area (partly integrated with conventional centre), and Old Town Upgrade. Over 95% of cases in their study fall into the first two categories.

2.2 High Density Examined by the Node-Place Model

The Transit Oriented Development (TOD) theories[14] have framed an understanding of improving urban density through organising urban life with public metropolitan transportation services. The HSR and local connection networks around the station node, by comparison, provides a much stronger and hybrid infrastructure system at both inter-city and metropolitan scales, which powers further demands for intensive and density developments.

This is verified by the "Node-Place" model from Bertolini (1999). "Node" defines the accessibility of an area, or, in the Chinese HONT practice, the "infrastructure", and "Place" refers to the activities of an area, which is translated into "development" of a HONT case. Through studying the "Node-Place" relationship in train stations in the Netherlands, Bertolini assumes that "equilibrium" will be achieved in the long term between "Node" and "Place", which means "… the demand for transportation services from the activity place and the demand for activities from the transportation node will find a (temporary) balance."[15] And further, this balance is achieved through a dynamic mechanism with either "strengthening of the Place" or "weakening of the Node". This model is designed for a wide coverage of "Nodes", i.e. different transportations including HSR.

However, it is interesting to find in the following research that HSR cases are regarded as a "robust" infrastructure, due to its large capacity and focus on central cities. The nature of HSR station as a strong "Node" allows us to assume that it sustains intensive development around the station area, which is verified by the success of Euralille in France (Bertolini, 2000). It is also true that, as is revealed by Peek et al. (2006), the HSR stations in the Netherlands are exclusively planned in the centres of major cities, and there is no available case in remote/suburban area to study. This is partly owing to the high concentration of urban population in the Netherlands. Meanwhile, the comprehensive public transportation system contributes to a hierarchy of services that cover various geographical locations with a range of efficiencies. This hierarchy gives HSR a flexibility of focusing on traffics between city centres.

[14] Carlthorpe 1993; Cevaro, 1998; Calthorpe & Fulton, 2001
[15] Bertonlini (1999: 203)

Provided there are enough urban flexibilities, the concept of "high density" is normally widely accepted for HSR oriented developments around established city centres, especially in the Asian cities that have inherited long history of high-density living. For instance, the redevelopment of Zhengzhou Rail Station area witnessed emerging of an intensive urbanity (Zhu et al. 2007). However, as described above, a great majority of Chinese HSR stations are away from the centres, no matter in big or small cities. As an example, the stations of Shanghai-Hangzhou HSR are averaged at nine-ten kilometres away from conventional city centres.[16] This reality presents a case that is not directly verified by Bertolini's model and studies in Europe: is high-density development applicable on HONT developments in remote area of Chinese cities?

If to simply follow the pure theory of Bertolini's model, one could assume that intensive "Place" (development) would surface around the remote HSR stations given the condition that this is a robust "Node" (infrastructure). This conclusion, however, is clearly inconsistent to the Chinese scholars' understanding of "mediated density". Where is the gap then?

2.3 High-Density Developments around Station Nodes of Metro Rails in China

Now we shift from the HSR to metro rails. The station node areas of the metro rails are far more developed than HSR thanks to their longer time of operation in China. Both theory and case study researches indicate that high density is key issue to station area developments around Chinese metro rail stations, which are examined below as references to understand HSR station nodes.

Different from the American TOD practice, which struggles to densify and enrich the extremely dispersed and homogenised urbanities, the Chinese practice is challenged by restructuring the traditionally over densified cities through planned urban infrastructure. This strategy looks at reshaping the conventional urban centre's function, population, and density through introducing new public transportations (such as metro rails). From this, new (minor) centres are formed around station nodes. In such way, the mono and intensive urban core is developed into "hybrid multi-centre urban network".[17] In this practice, the

[16] This is mainly for avoiding noise and vibration through penetrating built-up areas with trains running at 300km/h and above, while technical issues such as different turning circle radius by HSR from conventional rail is also an important reason for some towns.
[17] Pan (2007: 42)

metro rails are positive; not just in changing the way people commute and releasing road traffic pressure, but also in that they provide dense passenger streams for stations, giving the latter opportunities for developments. Lai (2005) further concludes that “urban developments around metro rail stations are comprehensive, which actively integrate urban land, urban function, and urban space centralisation. This is therefore an effective way to implement intensive urban development.”[18]

Based on the pedestrian connections from metropolitan rail stations, the radius of development boundary around station node is effectively reduced, which leads to “compact and intensive developments”. Zhou & Yang (2007) developed this idea into a “three-range” template which employs 200 metre and 500 metre along the radius from station as boundaries. The three areas defined from station to fringe are proposed for “high density”, “medium density” and “low density” developments accordingly, which integrates mixed urban uses.

On the other hand, case studies also support the density development around station nodes.[19] Pan & Ren (2005) have studied the developments around Xinzhuang Station of R1 Line (today’s Metro Line 1) in Shanghai. They find that between year 2000 and 2003, the percentage of land with intensive development rose from 4.9% up to 25.9%, which are “primarily within the 500 metre radius boundary around the station.”[20] According to Sheng (2012), “60% of the planned areas with concentrated employments and residences in Beijing are within the 750 metre radius boundary from metro rail stations”[21]. And in the urban planning and design practice of Beijing Yizhuang Light Rail Station area, Zhang (2009) suggests detailed high Floor Area Ratio (FAR) indexes to land plots. They are 3-5 between 400 and 500 metre radius boundary and 2-3 between 800 and 1,000 metre radius boundary, as well as suggestions for mixing uses.

Comparatively, the hierarchy of metro rail and its connection system is far more flattened than the HSR system, which, as indicated above, can be as simple as the “rail + pedestrian” template. Substantially, both the HSR and metro rail infrastructures are demanding high-

[18] Lai (2005: 50)
[19] Unfortunately metro rails are operated in very limited number of cities in China, these studies are constrained within the major urbanities such as Beijing, Shanghai, and Guangzhou.
[20] Pan & Ren (2005: 78)
[21] Sheng (2012: 166)

density developments around their station nodes. Based on the dominant public transportation that generates streams of passengers, the city finds opportunities to restructure itself and demands for further developments. And the compact/densified development is achieved through carefully planned connection infrastructure at the lower level. Nevertheless, the HSR operates at a larger scale and more issues are involved by building its own network and connection hierarchy, which presents an ambiguous image for developments around station nodes in front of us.

To summarise, the demand for high-density development in Chinese HONT practice is clear. At one hand, both the background of Chinese urbanisation and the HSR's planning target of regional economic resource integration dictate the large development demand around HSR station nodes. Although stations are in large percentage planned away from conventional centres, it is safe to predict that "compact" and "high density" modes are appropriate to tick given the understanding of scarce agricultural lands.

On the other hand, by extending Bertolini's model into Chinese practice, we may project a future with intensive developments for Chinese HONT, although no existing examples are available yet. By employing studies of Chinese metro rail stations, we can indirectly verify this future. This is even true by the fact that most HSR stations in the major Chinese cities are served by metro lines.

3.0 Comparison Studies between Hangzhou and Tokyo

We come back to the earlier question now, to find the gap between the concluded "medium density" and demanded "high density". This will be studied through a comparison of developments around HSR stations in Hangzhou, China and Tokyo, Japan. We have to agree that these two cities are not equivalent in many aspects, they are on different levels in the urban hierarchy system within their own countries, and therefore incomparable in urban function, scale, population, and etc. However, as Hangzhou is a late example among the major Chinese cities to develop the HONT,[22] namely "New Eastern Town" (NET) of Hangzhou, it has learned experiences from the precedents. The NET has planned a comparably higher

[22] This is due to late connection to the HSR network.

density with a more reasonable size.[23] On the other hand, the Marunouchi District, Tokyo's version of "HONT", has experienced over a century's development with successful integration of rail and urban hierarchies, and achieved intensified urbanity and urban life that is far beyond Hangzhou's planning. Through this comparison between two "incomparable" samples, we expect to clarify the relationship between urban infrastructure and physical developments in the HSR scenario. This comparison does not mean that Hangzhou's NET targets its future at Marunouchi template, but it will find further flexibilities in urban density planning through measuring the distance "from head to ceiling".

3.1 The NET of Hangzhou

It wasn't until 2006, one year after the operation of Wuhan-Guangzhou HSR Line, that Hangzhou's HSR station site was officially recognised. Unusual from many other cities' HSR stations that are built from scratch, Hangzhou decided to have its twenty-four-year-old "Hangzhou East Station"[24] upgraded into one of the largest HSR terminals of scale in China. This terminal houses five HSR lines and one maglev line directly links to Shanghai, Nanjing, Ningbo, Changsha and Huangshan, and further connects to all domestic destinations. According to the brief, the new Hangzhou East Station Terminal has fifteen platforms and thirty track lines, with a total built-up area of 200,000 square metres, designed to serve 200,000 passengers daily. The new terminal is proposed to open in June, 2013.

Along with the terminal building, the planning of Hangzhou's HONT was soon initiated. This new town, named NET, is five kilometres east to the conventional centre, which makes it distinguishable among its many Chinese equivalents: Guangzhou which is seventeen kilometres and Changsha which is fifteen kilometres between HONT and centre. The 9.3 square kilometre site, although close to city centre, is developed mostly on "agriculture" defined lands. This is in large due to the historically shaped urban form of Hangzhou, which is extensive south-north but narrow east-west. The selected site is dense with spontaneously developed buildings which are low, but dense for footprints and served by rare urban facilities. Such an ambiguous picture between urban and village triggers a strong willing of

[23] For example, major cities along the Wuhan-Guangzhou HSR (opened in 2005) have earlier but ambitious planning of HONT, such as Guangzhou of 35 square kilometres, Changsha of 29 square kilometres, compared with Hangzhou's 9.3 square kilometres.

[24] The old "Hangzhou East Station" was built in 1992, as a complementary to the city's main railway station, "Chéngzhàn" in city centre.

urbanisation/modernisation from the local government, which is also partly why the new HSR terminal is sited here. This means the new town is developed on a "demolish and build" process[25] with opportunities of land release and replanning.

Beyond the above expensive way of land acquisition, the government expects the NET to be a new hub that integrates Hangzhou into the national HSR economy, especially with the Lower Yangtze Delta Region centred by Shanghai. Efforts are therefore made for intensive developments despite the relatively smaller site with boundaries set by four freeways. Over fourteen million square metre buildings are planned, with a half of residential to accommodate the proposed 200,000 urban dwellers. The average FAR of the town is about 1.5, higher than most of other HONTs such as Guangzhou's 0.6 (21.73 million square metre buildings over 31.2 square kilometre). Two metro lines are proposed to link the NET to city centre: one was opened in October 2012 while the other is still in proposal by the time of this paper.

3.2 The Marunouchi District of Tokyo

Sitting between the Tokyo Railway Station and the Japanese Imperial Palace with dense office/commercial urban blocks, the 120 hectare Marunouchi District is identified as the centre of Tokyo City. In the 2012 report by Mitsubishi Estate Group (2012), this area is described as "the gateway to Tokyo" and "the leading international business centre in Japan." According to the same document, over 4,200 companies have offices in this area with an employment population of 230,000. According to the statistics of Zhou (2010), a wide range of industries are covered in Marunouchi, including building, manufacture, information/telecom, finance/insurance, real estate, etc. Finance and insurance take the largest percentage of share at 26.6%. Zhou describes this area as "centre of Japanese economy … and a place that provides the most frequent, most convenient, and most efficient financial activities in the world."[26]

[25] Briefly, this means local residents are paid for move away for a period (normally 3 years) and their buildings bought by government to demolish. These people will move back to new high-rise apartment buildings built by government with equivalent size, and other lands released are planned into plots for sale. This process is therefore expensive to operate.

[26] Zhou (2010: 107)

Over one hundred years' development history has shaped today's hyper densities in Marunouchi. Dating back to 1890, the Meiji Government released most of Marunouchi land, which was described "inhospitable", to the MitsubishiSha through purchase, and; therefore, it was not an optimistic business. However, Mitsubishi set its ambition to propose "building an office district like London",[27] which was fully powered in 1914 by the opening of Tokyo Railway Station on the site. By 1922, this area was chosen by over one third of the largest companies in Japan for their headquarters.[28] During the 1970s/80s, the soaring Japanese economy further consolidated Marunouchi's identity as the national business and financial centre. Utill the 1990s, the coming of globalisation and information tides initiated a redevelopment of this area, to "fully develop Marunouchi's potential as the engine to power Tokyo's vitality, and further enhance the competitiveness of Japanese economy."[29] This redevelopment, proposed to end by 2013, is under collaboration between metropolitan and local governments in Tokyo, as well as local institutions. According to Mitsubishi Estate Group (2012), there are 109 buildings in Marunouchi by 2012, with total built-up area of 7.09 million square metres, and an average regional FAR of 5.9. It is worth mentioning that six projects on site were approved to further increase their FARs through the [*Special Volume Application and Standard Act for Otemachi, Marunouchi, and Yurakucho Areas*][30] during the redevelopment. The range of FARs rose from 9-13 up to 13-16 of these six projects, and they had opportunities to convert from pure office blocks into mixtures of hotel, commercial and office.

The robust railway system, as we have discovered, successfully supports the hyper-density developments in Marunouchi. This is a complete rail hierarchy structured by Shinkansen (HSR), main lines (conventional rail operated at domestic and district scales), and metro lines (metropolitan rails), with a total of twenty lines integrated to serve the daily commuting

[27] Mitsubishi Estate Group (2012: 1)
[28] Sunderberg (2013)
[29] Zhou (2010: 108)
[30] Tokyo Metropolitan Government (2005). First version was issued by the Tokyo Metropolitan Government in 2002, and third (final) amendment was issued in 2005. This *Act*, targeting at raising funding to restore the historical three-storey Tokyo Station building, innovates to sell the station building's potential high-rise floor areas to the surrounding urban blocks, or, "air rights" (*Nikkei Real Estate Market Report*, October 2012). The restored station building was opened in October 2012, costing about fifty billion Japanese Dollars, of which most were from the 180,000 square metres' virtual space sale (Nakata, 2012) to the around six redeveloped high-rise buildings.

passengers of 2 million. Within any of the fourteen stations[31] in Marunouchi, a passenger can find the route to any destination at either the domestic, district or metropolitan scale. The Tokyo Railway Station, as the hub terminal to connect various scales of destinations, has fifteen platforms and thirty track lines above/under the ground, while the rest 13 stations provide pedestrian access to every urban block in Marunouchi within a 200 metre radius.

3.3 Comparison Studies

By putting the railway terminals together, we find Hangzhou and Tokyo have the same size of the station terminal, of fifteen platforms and thirty track lines. However, there is a huge gap between both for the rest of comparison. Only one-tenth daily passengers travel on rail of in NET compared with Marunouchi; and the urban density of the former is far behind the latter, 1.5 compared with 5.9 in terms of the regional FAR index. Even if we focus on the densified 268 hectare Central Business District (CBD) area of NET, the FAR is planned as 2.0, about one-third of average Marunouchi. It should be explained that the current planning of NET has been negotiated to the maximum FAR allowed by various regulations and planning/design codes. Both Hangzhou's NET and Tokyo's Marunouchi are developed on the robust national HSR network of similar sizes, which, according to Bertolini's model, are infrastructures that should power similar size of developments. What factor(s), then, has led to such significant gap?

3.3.1 Supports from the Rail Hierarchy System

The comparison reveals that NET and Marunouchi have different rail hierarchies. Beneath the HSR infrastructures that are similar between both, the NET has much weaker local rail connections. This is represented by two facts:

First, apart from the HSR station, there are only three metro stations found in NET area, compared with twelve in Marunouchi, while the former has a CBD area of over two times larger[32] than the latter. And the rest areas in NET, mostly residential, are rarely covered by metro lines with convenient access. Through drawing 400 metre radius circles around each station in the NET, we may find large gaps between edges, compared with the dense overlaps of 200 metre circles found in Marunouchi.

[31] 12 metro line stations and 2 combined Shinkansen/main line/metro line stations.
[32] 268 hectares in NET compared with 120 hectares in Marunouchi

Secondly, the numbers of rail/metro lines serving these two rival areas are not equal. Only two metro lines for the NET with only one in operation and the other still in proposal, and the extension of both is limited within the metropolitan boundary. In Marunouchi, however, seven district/metro lines are operated to connect to regional and metropolitan destinations.

The weak local rail hierarchy beneath the HSR infrastructure in Hangzhou means the road/vehicle transportation is heavily relied in the NET planning, for both HSR station connections and urban life of NET. Two direct consequences are obvious: extra land resources are consumed for artery roads with 6 lanes or over, while fewer lands available for developments. It is even worse that as the connection traffic for HSR station occupies a large percentage of road resource[33], there is less road resources available to urban developments and eventually limits the of development demand, or, in the planning language, a lower FAR index. The lower transportation capacity of roads set ceilings to the NET's development FAR of 1.5 in average. It should be explained that various efforts have been made to maximise land use efficiency such as promoting "HSR Commuting" and "Local Employment" life styles.[34] Conversely, as an inter-city infrastructure, HSR targets at promoting interactive communications between cities, which will extend much further than the station areas. Therefore the invention of isolating the station area's daily life from cities to save road resource does not correspond to the long term trend of HSR related developments.

3.3.2 Urban Penetration of HSR Tracks

The second significant difference comes from the way that HSR tracks penetrate urbanities. Technically, HSR tracks need solid concrete foundation to support fast running. In the NET, this is realised through piling up on the ground, making a huge winding wall cutting the town into two; while in Marunouchi, tracks are elevated and ground is released.

Different urban forms are formed based on the two urban penetration modes. In the NET, the ground links are blocked from both sides of the tracks, despite of the five vehicle tunnels struggling to connect, and the access of the railway terminal from neighbouring blocks is

[33] According to the traffic analysis of NET, the HSR station takes about 30% road resource for local connections during working day morning peak times.
[34] "HSR Commuting" tries to introduce living and working both around different HSR stations while commuting on HSR tracks; and "Local Employment" balances living and working at the same place. Both are attempting to minimise road use in daily life and support further HONT developments without support of road resources.

restrained. As a consequence, another 3.7 kilometre long “development corridor” of the CBD was invented by the planners, which is vertical to the rail tracks, covering the route of metro lines as a secondary support from the rails. The inefficient contact between developments and terminal building means a longer corridor and increased amount of lands are needed to channel the development demands, although influence from the terminal is faint on the remote ends and density descends. In Marunouchi, however, the free access on ground provides maximum contact surfaces with the terminal building, and we see a 1.7 kilometre density strip in parallel with the rail tracks.

3.3.3 Design Codes Applied for Urban Developments

Thirdly, by focusing on the individual urban development projects, we may find various design code strategies have shaped different density responses. In the NET, local codes applied for the conventional urban developments are used, without adapting to the special needs of the HONT type urbanity. For instance, in a town oriented at the rail infrastructure, we see the same requirement of car parking facility design in individual projects as other parts of the city. In detail, for every commercial project within the NET area, there should be 10-12 car park spaces designed for every 1,000 square metre built-up areas,[35] of which 10% should be arranged on the ground. By compare, the buildings in Marunouchi have fewer problems with parking. For instance, the Tokyo Sankei Building and Marunouchi Building provide 2.5 parking lots of every 1,000 square metre built-up areas, only one-fourth to Hangzhou’s standard. This difference also verifies the influences from various transportation modes on urban developments.

The high demand on parking facilities not only restrains the size of built-up area, on the other hand, due to the 10% ground surface parking policy, architects find difficult to improve the building footprint size. As a result, the footprint densities of most NET projects are found below 40%, while in Marunouchi, this figure is normally close to 50% (Tokyo Sankei Building 47%; Pacific Century Place Marunouchi Building 47%). Additionally, the smaller footprint leaves large gaps between buildings, which eventually isolates urban lives and makes vehicles even important.

[35] According to relative clauses from: Hangzhou Metropolitan Government (2009)

Beyond the above three factors, further aspects like urban functions and urban ecologies are important to shape the hyper-density urban developments. And apart from pure figure indexes, these factors interpret more understandings about “high quality densities”, which will be elaborated in the following papers.

4.0 Conclusion and Suggestion

In theory, we learn the assumption that large capacity infrastructure triggers high demand of urban developments around the station nodes through Bertolini’s model. However, the key question is whether the HSR itself can be recognised as “high capacity infrastructure”? Undoubtedly, HSR dominates the highest level of rail hierarchy with its high capacity and efficiency, but without supports from lower levels -- i.e. connection lines at regional/local scales -- the entire system is difficult to sustain. In other words, if the huge passenger streams from HSR are heavily relied on the road system and not appropriately channelled through another level of rails, we will find huge negative influences on the urban developments from the fragile roads.

The “FAR index ceiling” in Hangzhou’s NET has clearly supported this argument. The so defined “large capacity infrastructure”, therefore, is not represented by the performance of the hierarchy’s top level, but an entire system without any short board. On the contrary, as we may assume, a homogeneous HSR station without efficient support from local connections will eventually face crisis of losing passengers, and even worse, reduce demands for station area developments.

Interestingly enough, this assumption partly verifies Bertolini’s hypothesis that “an ‘unsustained node’ can … fall down-because of (relative) weakening of the node.”[36]

In addition, the comparison between Hangzhou’s NET and Tokyo Marunouchi indicates other effective factors, such as urban penetration and local design codes which are typical in Chinese HONT practice and also involved for density developments. Objectively speaking, the development demand around HSR station nodes is normally dictated by issues such as economic scale, industry layout, population planning, and other factors The Marunouchi template of hyper density is not applicable for most cities. However, as nearly every Chinese

[36] Bertolini (1999: 205-6)

city along the HSR line is cheering for the coming connection and making ambitious development planning, the question of “how to grow” seems to be more urgent to answer.

Under the strong wills of state power, major Chinese cities have been exclusively integrated into the national HSR network in very short period of time. Nevertheless, the fact that most cities are struggling to provide highly efficient public transportation system to connect the HSR stations indicates that these cities are far from “prepared” for the emerging “HSR Economy”, or, more precisely, a new urban development template that is fully oriented at the HSR infrastructure. This is even true with the observation that very few design codes are customised to the Chinese HONT developments.

The following suggestions may apply for increasing the “density ceiling” in Chinese HONT practice:

(1) Planning a complete rail hierarchy covering regional/local scales to support HSR infrastructure. This is surely not easy, cheap, nor quick, but it should be steadily targeted by local governments as a long term strategy, since the HSR has been operated without negotiation.

(2) At the short term scale when the new HSR stations are not running at their full capacities, a complementary (light) urban rail system within the HONT area is probably an option to release road resources and support further developments, depending on the HONT size and passenger stream. This (light) urban rail system is proposed to connect to the larger scale metropolitan network in future, but as a short term strategy, bus/park & ride connections on the edge of HONT area are considerable.

(3) Rethinking and amending of local codes is strongly suggested for the local governments to serve the unique features of HONT developments. This covers both planning and design issues and benefits of public transportation are recommended to be maximised. In addition, flexibilities for future density increase on major blocks are suggested to be considered, preparing for complete of rail hierarchy.

(4) For the HONT penetrated by “snaky wall” tracks, connections between both sides are key factor for urban success. Beyond the expensive conventional tunnels, links between blocks in the air may be worth to innovate. It is especially worthwhile to build direct dialogues

between the HSR terminal building and nearby projects, to maximise the contact surface between HSR infrastructure and urbanity.

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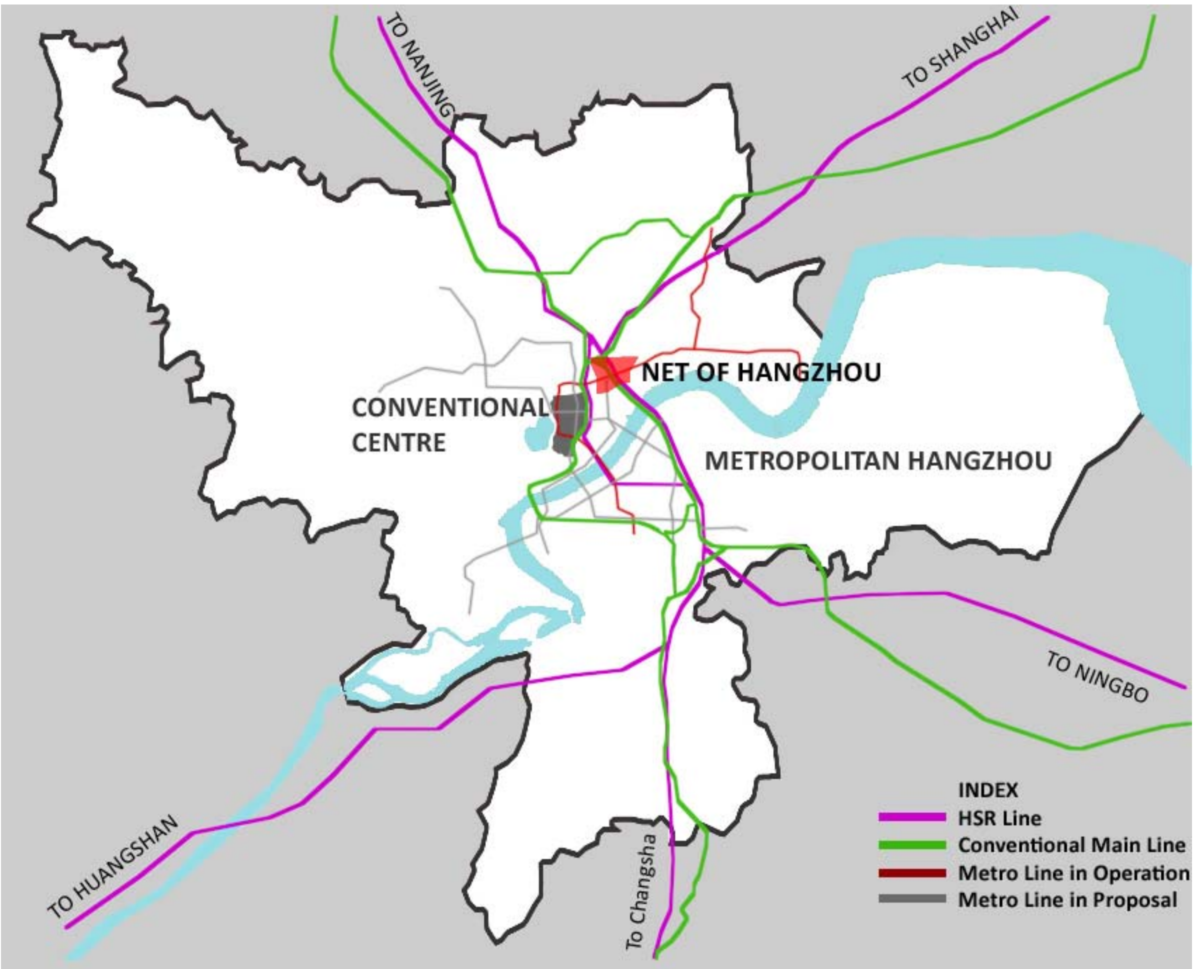

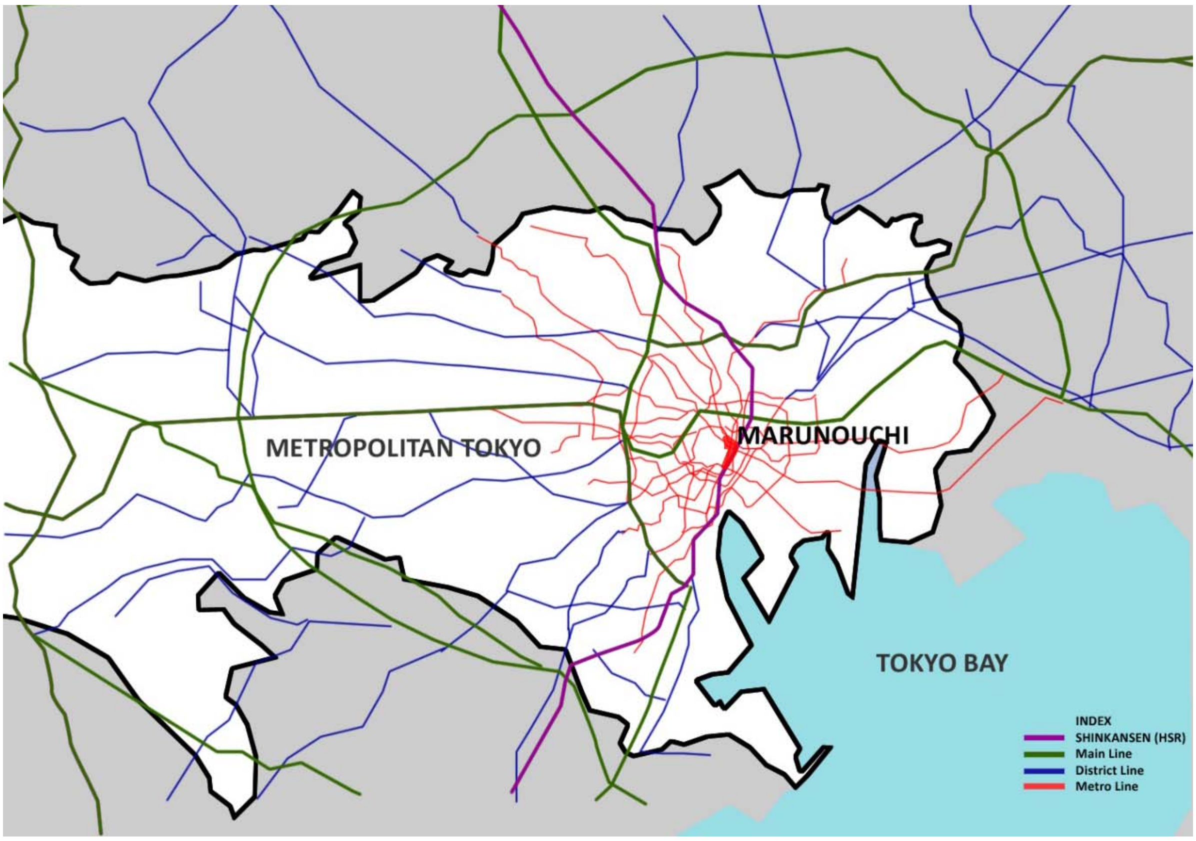

Figure 1 Rail Hierarchy and NET/Marunouchi of Metropolitan Hangzhou/Tokyo

		Tokyo Marunouchi District	Hangzhou NET CBD Area
Density	FAR	5.9	2.0
	People/sq km (Station passengers NOT incl.)	191,670	21,500
Daily Travels on Rail		2 m passenger/d	0.2 m passenger/d
Land Size		120 ha	268 ha
Total Built-up Area		709 ha	534 ha
Rail Hierarchy	Domestic Connection Lines	13 Lines (JR, incl. 2 Direct Shinkansen Connections)	6 HSR (incl. 1 Meglev) and Conventional Rail Lines
	Regional & Local Connection Lines	7 (6 Metro)	2 (Metro, 1 in operation, 1 in proposal)
	Layout of Stations in the Area	Robust Centre Stn + Area Network	Strong Centre Stn + Axial Network
Urban Form	Relationship to the Railway	In parallel with the railway	Vertical to the railway
	Stretch	1.7 km	3.7 km
	Depth	0.78 km (max.)	1 km (max.)

Table 1 Comparison List of Rail Hierarchy/Urbanity between Tokyo Marunouchi District and Hangzhou NET CBD Area

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