What Makes TOD Success?: Analysis of Japanese Suburban Center TOD by Comparison of Tachikawa Station and Machida Station

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Abstract: This paper compares the two suburban railway stations and the commercial development which showing the biggest difference in the ratio of sales and ridership among the seven suburban centers located in similar distances from the center of Tokyo. By comparing Tachikawa Station and Machida Station, this paper revealed that the difference of the compactness affected to the sales and the development of the commercial area around the station.

Transit-oriented development has been researched and implemented as one of the sustainable urban form, but not so much evaluated. Tokyo, as one of the famous transit-oriented cities, has several suburban areas to distribute the population concentration and provide affordable housing. Tachikawa Station and Machida Station area suburban centers based on the railway networks, but Tachikawa Station area records higher sales than Machida Station area. According to the analysis, this difference resulted from the compactness of the development of Tachikawa Station Area and the compactness seem draw positive image of area and transit users not only more development. And the compactness of the development was found that by the physical constraints of the area and the railway system also. Higher dependency on the railway system in Tachikawa area is considered expedited to the concentrated development to the Tachikawa.

Key Words: transit-oriented development (TOD), Tokyo, suburban development, transport behavior

1. INTRODUCTION

1.1 Transit-Oriented Development as a Sustainable Urban Form

Transit-oriented development (TOD) has been studied and practiced as one of sustainable urban forms in many places (Calthorpe 1993; Jenks et al. 1996; Cevero 1998; Dittmar et al.
Regardless of the agreement on better performance of transit to private cars in terms of land and fuel consumption, environmental burdens and social equality, transit supportive policies have faced the financial problem and economical sustainability, caused by insufficient ridership. Transit-oriented development promotes concentrated development within the walkable distance from the transit station, leading people to use transit and walk for their daily life. In 1900s, a Japanese business man, KOBAYASHI Ichizo, introduced to combine the railway development and suburban development to persuade the bankers for the feasibility of the business, and his value capture idea was a great success (TKDKK 1973; Cervero 1998; Sorensen 2002; Park 2005). Since then, the combination development of railways and urban development became a typical development pattern in big cities in Japan, and this lead Japanese-style transit oriented urban structure (Park 2005). With this competitive model, Japan still runs most railways as private, not public unlike many other countries.

For the economical sustainability, Japanese railway developers found concentration of commercial functions to the station effective. They utilized the land of the station fully by combining department stores to the terminal stations and grocery stores to the residential area stations. This mixed type of development compensated the income by the rent and sales, and also induced more people to stations, with high possibility to increase the ridership. Thus, the success of commercial area is highly related to the sustainability and success of the transit-oriented development. From the beginning, Japanese transit-oriented development was commercial-based.

This entrepreneurial TOD concept, borrowing Cervero’s term, not only affected to the development pattern of other private railway company but also that of government. The suburban area development driven by the government, such as Tama Newtown, followed this style: combining the suburban development with railway development and making the railway stations as the center of the area. However, a half century from this suburban center development has passed, but the evaluation of these areas was not done yet. Understanding whether they were success or not, how the development was differentiated, and what caused the differences may give a hint for the better design for TOD. Under this belief, this study focuses on how the suburban development in TMA became transit-oriented, why they were developed as commercial centers not other functions, and whether they have difference in development patterns. For the analysis, data of statistics, GIS and consumer surveys done by the city governments, as well as plans and laws were used.

1.2 Commercial Type TOD in Suburban Area of Tokyo

With the sudden economic development since 1950s, the population of Tokyo exploded from 3.5 million in 1945 to 10 million in 1960. To ease the urban problems caused by high concentration to Tokyo area, the government decided to develop suburban areas. Since 1958, five TMA Master Plans (Shutoken Kihon Keikaku) has been developed to promote sharing the function of the CBDs of Tokyo and increasing the viability of the suburban areas. According to the change of the industries and urban needs, the functions have been changed from factories to business centers and recently residencies (Table 1).

The national movement and arrangement for the current suburban centers was started by The Fourth National Grand Development Plan (Dai 4 ji Zenkoku Sougou Kaihatsu Keikaku) in 1987. To ease the high concentration problem in Tokyo, Multi-Polar and Dispersed National
Composition Promoting Law (Takyoku Bunsankata Kokudo Keisei Sokushinhou) was legislated and suburban centers were planned about 30 kilometer distance from the center of Tokyo. The major purposes of the suburban center development were disperse of urban population and functions, and supplying the affordable housing and good residential areas. With the collaboration of the law, The Fourth Tokyo Metropolitan Master Plan (Dai 4 ji Shutoken Kihon Keikaku) was set up, and four business center cities were designated: Oomiya, Hachioji, Tachikawa and Chiba. In 13 years later, The Fifth Tokyo Metropolitan Master Plan (Dai 5 ji Shutoken Kihon Keikaku) added two more: Machida and Kashiwa.

<table>
<thead>
<tr>
<th>Plan</th>
<th>Planning Year</th>
<th>Goal Year</th>
<th>Development Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>The 1st</td>
<td>1958</td>
<td>1975</td>
<td>• Greenbelt</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Stop the sprawl</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Suburban factories</td>
</tr>
<tr>
<td>The 2nd</td>
<td>1968</td>
<td>1975</td>
<td>• Distribute the central functions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Suburban development</td>
</tr>
<tr>
<td>The 3rd</td>
<td>1976</td>
<td>1986</td>
<td>• Strong to the natural disaster</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Multi-central structure</td>
</tr>
<tr>
<td>The 4th</td>
<td>1986</td>
<td>1981</td>
<td>• Self-sufficient suburban areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Business center suburbs</td>
</tr>
<tr>
<td>The 5th</td>
<td>1999</td>
<td>2015</td>
<td>• Distributive city network</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Redistribution of urban functions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• City center residency promotion</td>
</tr>
</tbody>
</table>

(Source: The 1st ~5th TMA Master Plans)

These suburban centers were selected based on the existing transport network, especially railways (Figure 1 and Table 2). This railway network based location decision of suburban center development provided the possibility of transit-oriented development of the suburban areas and of bed-town at the same time. The change of the strategy of the area development of TMA Master Plans from factory development to residential development reflects the change
of the characteristics of the area indirectly.

Table 2. Suburban center station information

<table>
<thead>
<tr>
<th>Station</th>
<th>First open</th>
<th>Daily users (including transfer)</th>
<th>Railways</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oomiya Station</td>
<td>1885</td>
<td>326,000</td>
<td>13 lines (among 5 Shinkansens)</td>
</tr>
<tr>
<td>Hachioji Station</td>
<td>1889</td>
<td>111,000</td>
<td>4 lines</td>
</tr>
<tr>
<td>Tachikawa Station</td>
<td>1889</td>
<td>191,000</td>
<td>5 lines</td>
</tr>
<tr>
<td>Machida Station</td>
<td>1908</td>
<td>254,000</td>
<td>2 lines</td>
</tr>
<tr>
<td>Chiba Station</td>
<td>1894</td>
<td>130,000</td>
<td>4 lines</td>
</tr>
<tr>
<td>Funabashi Station</td>
<td>1894</td>
<td>190,000</td>
<td>3 lines</td>
</tr>
<tr>
<td>Kashiwa Station</td>
<td>1896</td>
<td>194,000</td>
<td>3 lines</td>
</tr>
</tbody>
</table>


In developing the suburban cities, self-sufficiency is considered the ultimate goal for the original purpose of population distribution, but in reality, the close relationship with the mother city is preferred by people, especially in the beginning stage of the development. In addition, more commuting means more ridership for railway companies, thus developing self-sufficient cities are not preferable for them either. That is how most of suburban cities start with self-sufficient goal, but many of them remain as bed-towns.

As a result, the economically sustainable strategy for developing the station area often resulted in commercial centers. Transit users can save walks by stopping by the nearby shops and shops and restaurant users have more merit to use transit for their trips. With these reasons, concentrating commercial functions to the station areas is a good way to guarantee the railway ridership as well as the station area real estate development, for railway developers too.

1.3 Objective of This Study

This study is concentrated on the commercial success of the suburban central railway station areas in Tokyo Metropolitan Area. As described in the above, many suburban central station areas tend to be commercial areas because of the needs of residents, commuters and railway developers. Thus, the success of the commercial area of the station precincts is important criteria to the success of the transit-oriented development of the suburban areas too. Even though what is the success of TOD is very controversial, examining the relationship of commercial activities station area development composition, we believe, is important to find out the implication for the further transit-oriented developments.

Thus, this study aims to find out what are the success points to TODs in commercial based suburban centers by comparing two most different areas, Tachikawa and Machida, in terms of sales per ridership.

There are many studies distinguish transit-oriented development, transit-adjacent development, transit-adjunct development, and transit-joint development according to the level of coordination of transit and land-use, but it is very difficult to distinguish them quantitatively in reality. Since this study purposes the evaluate the commercial success for the economic sustainability of the transit services, any development enhancing the transit use and based on the transit use, often assumed just as transit-adjacent development and so on, are all considered as transit-oriented development in a large text.
2. STUDY SITE SELECTION

The success of TOD in Japan is closely related to the success of commercial area around the stations. Privatized railway systems, regardless of the public functions, are regarded and treated as private companies in Japan: high competition and no subsidy. Thus, the commercial success of the station area is directly connected to the real estate income and fare income to the railway companies. This is another reason we can call it entrepreneurial TOD.

To evaluate the use of the transit and commercial activities in the transit area, ridership and annual sales were examined. The commercial activities around the station areas can be diverse, but we simplified and quantified them as the amount of annual sales within the 300 meters from the each station using annual sales data of the area in 2002. The ratios of annual sales and daily ridership of the seven station areas were plotted in the Figure 2.

![Figure 2. The amount of sales in the suburban center station area within 300 meters radius according to the railway passengers (Data: Yearbook of each city in 2002)](image)

Under a general trend of proportional relationship between transit users and sales in general, variation of the ratio among the stations can be also observed. Considering the number of transit users, Tachikawa shows very high sales especially, recording 2.5 times of Machida in terms of the ratio. What makes it different? Does it related to the transit-oriented design? These most distinctive sites, Tachikawa and Machida were chosen as study sites, to find out the relationship between the sales of the area and the transit-oriented design and development. For the analysis, area location, the station and surrounding area development history, commercial area development and distribution, people’s behavior at the station and perception for the station were compared.

3. COMPARISON OF TACHIKAWA STATION AND MACHIDA STATION

3.1 Location and Station Composition
3.1.1 Tachikawa

Tachikawa City is located about 30km west from the center of Tokyo, in Tama Area, along Tama River, with the area of 24km$^2$ and population of 180,000 (Figure 3). People started to live in this area since Edo period (1603~1868), by agriculture and sericulture based on the plentiful water. When the Koubu Railway was open in 1889, the station was located in the center of Tachikawa City. After then, five lines – Chuo Line, Aoume Line, Nambu Line, Itsukaichi Railway, and Tama City Monorail – were developed, and Tachikawa Station now became one of the major stations in Tama Area, with the daily passenger about 40,000 people.

![Figure 3. The location of Tachikawa City and Tachikawa Station with railway network](image)

3.1.2 Machida

Machida City is located about 30 to 40 km southwest from the center of Tokyo with the area of 72km$^2$ and population of 420,000 (Figure 4). This three times large city to Tachikawa City, is the second largest city in Tokyo-to. While Tachikawa City was agricultural, Machida was commercial-oriented, and became a city since Atsuchimomoyama Period (1568~1603). Since 1586, “Market on the Two Day”, held market on every 2, 12, 22 of each month, gathered people and population increased, and this became the archetype of current Haramchida Commercial Strip (Figure 5).

![Figure 4. The location of Machida City and Machida Station with railway network](image)
Machida Staion was open in 1908, and Odakyu Line passed after 30 year. As one of the suburban cities of Tokyo, the daily user of Machida Station is up to 60,000 these days.

3.2 Difference in Station Development

3.2.1 Railway Development

Both Tachikawa Station and Machida Station were developed as sub center station in early stage between the late 19\textsuperscript{th} century and early 20\textsuperscript{th} century. As shown in Figure 6, however, the number of lines, road conditions and arrangement of stations are different, and this difference is considered as one of the reasons of different TOD in these areas.

Since the Tachikawa area was agricultural field, it can be located in the center of the city, and the following lines were crossing the Tachikawa station, composing a concentrated station. In Machida area, on the other hand, commercial areas were already developed, thus, the railway lines and stations should consider that. The first line, Yokohama Railway was developed along the commercial strip, which devoted to the liveliness of the commercial area. But the second
line, Odakyu Railway came across to the strong opposition when building by the residents, because it divided the community into two, and the station should be settled remote to the first station about 700 meters. The remoteness of the two stations is considered to have brought not only inconvenience of transferring, but also the spread of commercial development.

3.2.2 Physical Constraint in Tachikawa Station Area

One of the contributors of compact development around the Tachikawa Station was military facilities. In 1923, the military airport was moved in to the northwest of the Tachikawa Station area, and this area has been changed to U.S.A. military base in 1945, and Disaster Defense Base and park in 1990 after then (Figure 7). Located by housing area in southern part of the station, the station area was strictly restricted to spread at least to the northwest.

![Figure 7. Tachikawa Station Area Change](image)

3.3 Spatial Difference in Commercial Development

To see the spatial difference in commercial development, we analyzed the commercial distribution in two scales: 300 meters and 10 kilometers from the station. For this analysis, the data of large-scale shops (LSSs) were used, based on the availability. Japanese Law designates shops with more than 1,000 square meters as “large-scale shops” and regulated separately to save the small-scale local shops.

The Figure 8 shows the distribution of the LSSs and the relationship of the station location in both stations. LSSs are highly concentrated centering Tachikawa Station, and they are spread to the Southeast in Machida Station. Not only the building areas, but also the accumulated floor areas are higher in Tachikawa Station, thus, the total sales area in Tachikawa Station is 64% more within the 300 meter radius area from the station (Table 3).
Figure 8. The composition of stations and distribution of large-scale shops around Tachikawa Station (left) and Machida Station (right) (Data source: Base map- Google map, LSS data – Data Bank)

Table 3. The large-scale shop profile within 300 meters from the station

<table>
<thead>
<tr>
<th>Station</th>
<th>Number of LSS</th>
<th>Total area of LSS</th>
<th>Average area per LSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tachikawa Station</td>
<td>14</td>
<td>217,000</td>
<td>15,500</td>
</tr>
<tr>
<td>Machida Station</td>
<td>12</td>
<td>132,000</td>
<td>11,000</td>
</tr>
</tbody>
</table>

(Source: Data Bank (2009) National Large-scale Shops Data Book, in Japanese)

One reason that the commercial areas are spread in Machida Station is due to the separation of stations. In Tachikawa station, five lines are crossing, but four of them are JR lines, so the station is combined. Unlike in Tachikawa Station, however, the two lines of JR and Odakyu Line are crossing but the stations are not combined. The two platforms are about 200 meters away, and commercial areas also developed more spread than in Tachikawa Station. This is one of the typical situations in Japanese railways; one company hardly cooperates for the transfer to another company. It turned out not only to cause inconvenience to passengers, but also to hinder the compact area development.

Another way to look at the development concentration is development volume. In order to see the relationship of the sales and concentration of the commercial area, we collected the accumulated floor area according to the distance from the each station, within the radius of 500 meters. Even though only the data of LSS was included because of the data availability, the negligence of the area of small shops is acceptable considering the portion of them. The distributions of commercial area of the two stations are as Figure 9.

Figure 9. The distribution of commercial area within the 500 meter radius from the station of Tachikawa (left) and Machida (right).
As seen in Figure 9, commercial area is highly concentrated within 300 meters distance from the Tachikawa Station, as a total area of 215,000 square meters. This is almost two times of that of Machida Station. On the other hand, it is more spread in Machida station, and the area of commerce between the distance of 300 meters and 500 meters is 37,000 square meters, which is nine times to the same distance of Tachikawa Station.

Another indicator showing the higher concentration of Tachikawa Station is commercial floor area ratio. This is calculated as accumulated commercial floor area divided the land area. The line graph in Figure 8 shows the FAR distribution according to the distance from the stations. Comparing to the distribution of FAR in Tachikawa Station, it is flatter in Machida Station, which means disperse of commercial area and less-friendly to railway users.

Looking from the larger scale, more LSSs are distributed along the railway network in Tachikawa Station, while along the road network in Machida Station (Figure 10). Not only in micro scale but also macro scale, Tachikawa Area shows more railway-oriented commercial development pattern than Machida Area. Since 1980 the total number of car ownership in Machida has surpassed that in Tachikawa, and since 1985 the car ownership per person in Machida has surpassed that in Tachikawa. Higher car ownership and roadside LSSs seem to have encouraged each other and contributed to commercial area spread further.
Another way to evaluate the transit-oriented development is examining the behavior and perception of people who use the place. How people come to the area, what they do, and how they feel are closely related to the transit use and commercial sales, which are connected to the success of transit-oriented development. For the comparison of the two stations, we used the survey data performed by Tachigawa City and Machida City separately in 2007 (Table 4).

Table 4. Data profile used for the analysis

<table>
<thead>
<tr>
<th>Data</th>
<th>Tachikawa Station</th>
<th>Machida Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewees</td>
<td>JR Tachikawa Station and surrounding area visitors</td>
<td>JR and Odakyu Machida Station and surrounding area visitors</td>
</tr>
<tr>
<td>Date</td>
<td>Sunday, 26 Nov. 2006</td>
<td>Saturday, 25 Nov. 2007</td>
</tr>
<tr>
<td></td>
<td>Sunday, 18 Feb 2007</td>
<td></td>
</tr>
<tr>
<td>Samples</td>
<td>252</td>
<td>396</td>
</tr>
<tr>
<td>Surveyer</td>
<td>Tachikawa City</td>
<td>Machida City</td>
</tr>
</tbody>
</table>

The first criterion to check for TOD is transport behavior. As seen in Figure 12, both areas show high dependency on railways. This is partly because the survey was performed to those who visited the stations and the surrounding areas. Considering that, however, we can see the higher dependency on railways in Tachikawa, while more than 2 times of car and motor cycle use in Machida. As we checked already, Machida has more spread urban texture in terms of commercial area distribution and more car ownership. Car-dependent life patterns are also revealed in the transport mode selection survey. Transit-oriented design and environment can be said more desperate in Machida area, not only because current higher car-users, but also the higher walkers and bicycle users. At this moment, there are more than two times of pedestrians and bicycle users in Machida. However, if the environment becomes no more pedestrian and bicycle user friendly, they can switch to car/ motor cycle any time.
According to the surveys, the major purposes people visit the areas were for shopping (almost 50%) and restaurants and cafés (20%). If the survey had been performed on weekdays, the result must be different. Regardless of this distortion, it is true that shopping is one of the major transport causes. One of the interesting results of the surveys is that more than half of people in Tachikawa picked station area for a major shopping place (Figure 13). Visit station areas not only to use the train, but also to shop, to eat, to meet, to work or to place is not a new phenomenon any more. The fact that people choose station areas for shopping means the station area is attractive place for being or at least functionally assorted. Either way can become an indirect prove of successive TOD.

Regarding to people’s perception on the stations, it was found that people feel Tachikawa Station is more convenient, safe and fun to shop and spend time. Even though they evaluated not so different in the closeness, compactness and facilities for shopping in both stations, people thought Tachikawa Station more attractive in general. This perception must be reflected to the more frequent visit to the station for shopping to Tachikawa Sataion.
Figure 14. Perception on the stations (-2: very bad, -1: bad, 0: normal, 1: good, 2: very good)

4. CONCLUSIONS AND LESSONS

4.1 Summaries of the Results

This paper examined the suburban center development in Tokyo Metropolitan Area from the perspective of transit-oriented development. Admitting that sales of the transit area is just one of many criteria to evaluate the success of TOD, we still believe the commercial success of the station area is important to sustain the quality of transit service especially in Japan, where railway services were privatized. To find out the difference in commercial activities in the suburban station areas, we selected Tachikawa and Machida, the most different areas in terms of the ratio of sales per ridership, and compared the compactness of the commercial area, layout of the transit and people’s behavior and perception of the stations. The sales of Tachikawa Station area were more than two times than that of Machida Station considering the station users, and we inferred the reason from the following observations.

Firstly, the compactness of the commercial area in Tachikawa resulted in higher sales than Machida. As shown in Figure 8 and Table 3, more large scale shopping centers are located in Tachikawa than Machida within 300 meters from the station. In other words, Tachikawa Station area is more compactly developed than Machida Station in commercial development. For this, two reasons can be inferred: physical constraints and disperse of stations. For Tachikawa, the northwest area of the station has been occupied by airport since 1920s, U.S.A. military base since 1940s and park and disaster defense base since 1990s, thus expansion of the commercial area and development were physically constraint, and this is considered to help the development compact. On the other hand, the failure of the integration of the stations by two different railway companies of Odakyu and Japan Rail (JR) in Machida Station seemed to affect the spread of the commercial development. The tendency of radial spread of
commercial area from the station, the two separate stations with 700 meter distance can cause more spread commercial areas.

Secondly, Tachikawa Station seems more centripetal force than Machida Station. According to the people’s behavior survey, more than 70% people who access to Tachikawa used railways while less than 50% people chose railways to access to Machida. The concentration of the transit use as railways must concentrate the commercial development to the station areas in Tachikawa, but the diverse of the transport use can also diverse the commercial area development to the larger area in Machida.

Thirdly, people feel Tachikawa Station area is newer, safer and more enjoyable than Machida Station area, and this perception seem to interact the station centripetal force. From this study and survey, the direct relationship between the compactness of the commercial area and the positive image cannot be explained. It can be inferred, however, the compactness of the Tachikawa many provide safer and more convenient environment for users and that this may trigger more development and management to keep the area newer and more enjoyable.

4.2 Lessons

From this study, we can imply the followings:

Firstly, physical constraints work as an important factor to draw compact development. In Tachikawa’s case, the airport and U.S.A. military base were the physical constraint to make Tachikawa Station area development compact, while there was no such constraint in Machida. Such physical constraints can be substituted by institutions, such as restrictive land use development and volume control around the station areas.

Secondly, compactness of the station area seems to be important in commercial success in suburban area stations. The failure in integration of the stations of transferring seems to have effect to disperse the development and this might affect the image of the station users. Considering that the users’ image is not only directly affect the sales of the area but also can has the potential to drawing the further investment to the area, station area compact development should be seriously considered in suburban areas.

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