CHAPTER I
INTRODUCTION

1.1 Research Background

The development of railway infrastructure in Japan has been conducted for more than 100 years. Since 1872, the railway network has been developed and operated by the public and private sectors and finally reorganized in 1949 under the name of a public corporation, the Japanese National Railway (JNR) (Terada, 2001). The government's focus on prioritizing the railways' transportation development for a long time has improved railway technology to promote more railway links in the country. As a result, governments and the private provide the possible railway route spread throughout the whole country in some types of railway transportation, including local trains, tram/street cars, shinkansen, and subways. The government action leads to the significant development of railway infrastructure to become more comprehensive in the country.

The railway development brings several social life changes. Concerning the environment, railway development promotes mass transportation, significantly reducing transportation emissions (Tsumura et al., 2019). Reducing CO2 through railway transportation in urban redevelopment is a strategic way to achieve a low-carbon society. Furthermore, One of the most significant impacts is the creation of a more efficient urban arrangement, which includes decreasing traffic congestion, increasing regional accessibility, and better neighborhood quality (Cervero & Duncan, 2001). These impacts are categorized as the indirect impact of the spillover effects that come along with the direct effect, which is the ticket revenue for the railway operator (Renzhi, 2019). Moreover, the change is a significant regional impact due to the increasing accessibility due to the construction of infrastructure projects, as in Kyushu, Japan (Kunimi & Seya, 2021). Using Generalized Synthetic Control, they divided the Kyushu area into a treatment group (near the railway) and a control group (another area). They concluded that most of the treatment groups experienced increased land prices. The regional impact causes the property value change, specifically, the land price near the railway's infrastructure.

Developing railway routes, specifically railway stations, boosts regional economic development. This development is closely related to the change in people's behavior or, to be more specific, people's consumption due to the improvement of accessibility. The increasing consumption also attracts more business types to operate around the stations, affecting land use (Wu et al., 2021). Many types of businesses prefer to build their base close to the stations because it is more efficient as closer to the market and factors of production (Polyakova & Borisova, 2019). To some extent, the increasing number of business facilities around the station shows that the land price will change due to the change in land use and accessibility. The demand for the land also changes as land adjacent to the stations becomes the preference of many new businesses to build. The analysis of this change subject is vital as it affects many aspects of sociodemography around the stations.

The studies of the impact of the new transportation infrastructure on land prices are not a new topic in academic and practical research. Shi et al., 2022 estimated the light rail transit project's impact on land price by employing Geographical Weighted Regression in Kaohsiung, Taiwan, and found the increasing land price of up to 1% at the area of 400 meters from the line. The stakeholders in the area enjoyed the increasing land price caused by the government project of the railway infrastructure, which was identified as an improvement in society. A study in Japan focused on the impacts of the Linear Chuo Shinkansen connecting Tokyo Station and Nagoya and Osaka Stations on land price found that the time of announcement of the construction decision is significant to the land price change (Kanasugi & Ushijima, 2018). The moment the public started to be aware of the new railway development in those three areas (Tokyo, Nagoya, and Osaka) marked the change in land prices. In Indonesia, research was conducted in the Serpong area to find the influence of railway stations on residential property values using the Spatial Hedonic Pricing model (Syabri, 2011). The research found a positive effect of the construction of rail stations on land prices in the surrounding area statistically. The study in China found a significant increase in land prices to 87% around the railway that helps the government cover almost 45% of the construction cost of the Beijing-Shanghai high-speed railway (Li et al., 2020).

However, railway development not only benefits society with some advantages but also has some negative impacts. For example, the negative effect of the railway station project was found in Dutch residential areas where the construction reduced the housing value due to noise factor (Debrezion et al., 2011). They found that houses located within 250 meters from the railway line were 5% less expensive than houses located 500 meters or more. Also, the issue of economic development due to the construction of infrastructure projects has been conducted by many researchers (Suzuki et al., 2015). The positive impacts of railway development can bring unfortunate to society if the status of the people cannot match the area development. In this case, based on the study in Nagoya, Japan, different levels of a household can maximize the benefits of the development only if they are put in the right area of railway development due to the heterogeneity of the neighborhood (Wang et al., 2021).

In Japan, the station areas vary depending on the station's scale and location. In West Japan, for example, from the urban area in some Prefectures such as Osaka and Hyogo to the rural area in Shimane, Miyazaki Prefecture, or even in the islands of Okinawa, it is interesting to put together. The station type types are also not limited to one type of railway as most prefectures have at least three types of railway mode, such as shinkansen, local train, and tram. However, in the case of several railway modes located in one area, the impacts on the surrounding also vary. The evidence from Athens, for example, showed that types of railways have different influences on the land price, whereas metro, tram, and suburban had positive impacts. In contrast, ISAP (the old urban railway of Attica) gave the opposite (Efthymiou & Antoniou, 2013). The analysis can employ all kinds of railway station development to see the holistic impacts of rail transportation to nearby areas.

Furthermore, analyzing only the relationship between land price and transportation infrastructure projects is not enough, as many other variables are also involved (Renzhi, 2019). In this case, it involves the land use pattern changes due to the increasing demand for land around the transportation infrastructure. Proximity to the stations, for example, significantly affects land price changes (Cervero & Duncan, 2001). It is also important to include how the land use pattern changes due to the increasing demand for land around the transportation infrastructure (Cervero & Kockelman, 1997). In addition, the need for land is closely related to the change in the new transit area, especially accessibility caused by the new transportation infrastructure (Nyunt & Wongchavalidkul, 2020). The need for land is closely related to the change in the new transit area, especially accessibility caused by the new transportation infrastructure. Combining all these factors to see how they affect the land price partially and simultaneously produces an output on how the land price should be analyzed.

As much of the research focused on how the new railway development affects land prices in the surrounding area, the correlation with the urban redevelopment, especially how the business grows, has not caught the attention. The distance to the railway line or stations and the timing of the announcement by far are the most significant variable, while business facilities growth was not employed. Therefore, analyzing the effects of new infrastructure projects and business facilities density on the land price is interesting, not only by partially seeing the impact. In addition, putting the two factors not at the same level will be more challenging. In this case, the construction of the new station will be the primary treatment of the land price. The facility density is put into the analysis as the mediator that correlates simultaneously to the new stations and the land price.

1.2 Research Question

Based on the previous background, this research will focus on new railway stations, the change in business facility density, and how it affects land prices. There are some scope limitations related to the time of railways station development, business facilities' distance to the stations, and land parcel location related to distance to the stations. The primary analysis involves:

1. New railway stations in West Japan in 2015-2020,
2. The business facilities within 1kilometers from the new stations, and
3. Land parcel price released by the government of Japan.

The research question is, "**How much is the impact of the construction of new railway stations on land price changes by the influence of facility location/density?**".

1.3 Research Objective

The correlation between the three can be analyzed quantitatively to identify how the construction of railway stations affects the land price along with the influence of the facility density near the stations and the land parcel. It is also essential to measure the impact on the land price due to the change of railway stations and facility density in time series data. In the end, the result may help the government create a specific strategy in the station location regarding business licenses and land use to control the land price. In more detail, this research aims to "analyze the impacts of new railway station construction on land price and how changes in facility distributions in the surrounding area of the station mediate it."

1.4 Research Scopes

Substantially, this research studied the impact of railway station construction on land prices around the stations in West Japan. The analysis includes all railway station types, such as local trains, shinkansen, and trams. The types of stations include big stations (such as prefectural stations), into local stations considered small. The analysis period is six years, from 2015 to 2020, marked by the period when the stations started operationally or served the customers. Some stations were constructed years before opening; however, this research does not consider the construction date. In addition, the land price aspect used in this analysis refers to the price of the land parcel announced by the Japanese government.

Spatially, the analysis focused on Japan's West Area, as shown in Figure 1.1. The area covers 24 Prefectures spread over four regions, including Kansai (or Kinki), Chugoku, Shikoku, and Kyushu (includes Okinawa). These four regions are half of the Japan area to the western and southern areas. The West Japan area consists of several areas, from the metropolitan area in Osaka to the islands area of Okinawa. Between Osaka and Okinawa lies the Chugoku area, a mixed area between rural and urban areas. Meanwhile, in the Shikoku area, the big island provides more mountainous and rural areas. This enormous gap between each region in terms of geographic area, economy, and population is interesting to analyze because it will provide a rich analysis of transportation development's impact on land prices.

Source: (Isshiki et al., 2021)

FIGURE 1.1
Regions of Japan

In the analysis, all railway stations were identified based on the stations' launching year in each region, from 2015 to 2020. The buffer area of analysis is 1 kilometer from each station. The buffer area covers the business facilities and the land parcel price within the fixed distance. The 1-kilometer distance is chosen due to the difference in distance of each station. For example, the distance is more moderate in rural areas, while in urban areas, many stations are close to each other, especially tram stations.

1.5 Research Originality

As many kinds of research were conducted related to land price and transportation infrastructure, this research continues to analyze the correlation by adding one significant variable as the mediator, in this case, the telepoint pack database, to analyze the role of the new facility around the stations. By having this additional mediator, the impact could be more profound, as the mediator not only stands as the independent variable but also puts the other independent variable influences into this variable. Ultimately, the total impact on the outcome, land price, will be accumulated after being partially regressed.

This result's output will show the land price change because of the construction of new railway stations and facilities. As the independent variable and mediator significantly affect the land price, the government can use this information to control the land price around the station and consider how they will develop the stations' areas by giving permits/business licenses for a particular type of business around the station. In the end, the land price and land use also can be more manageable.

1.6 Research Benefits

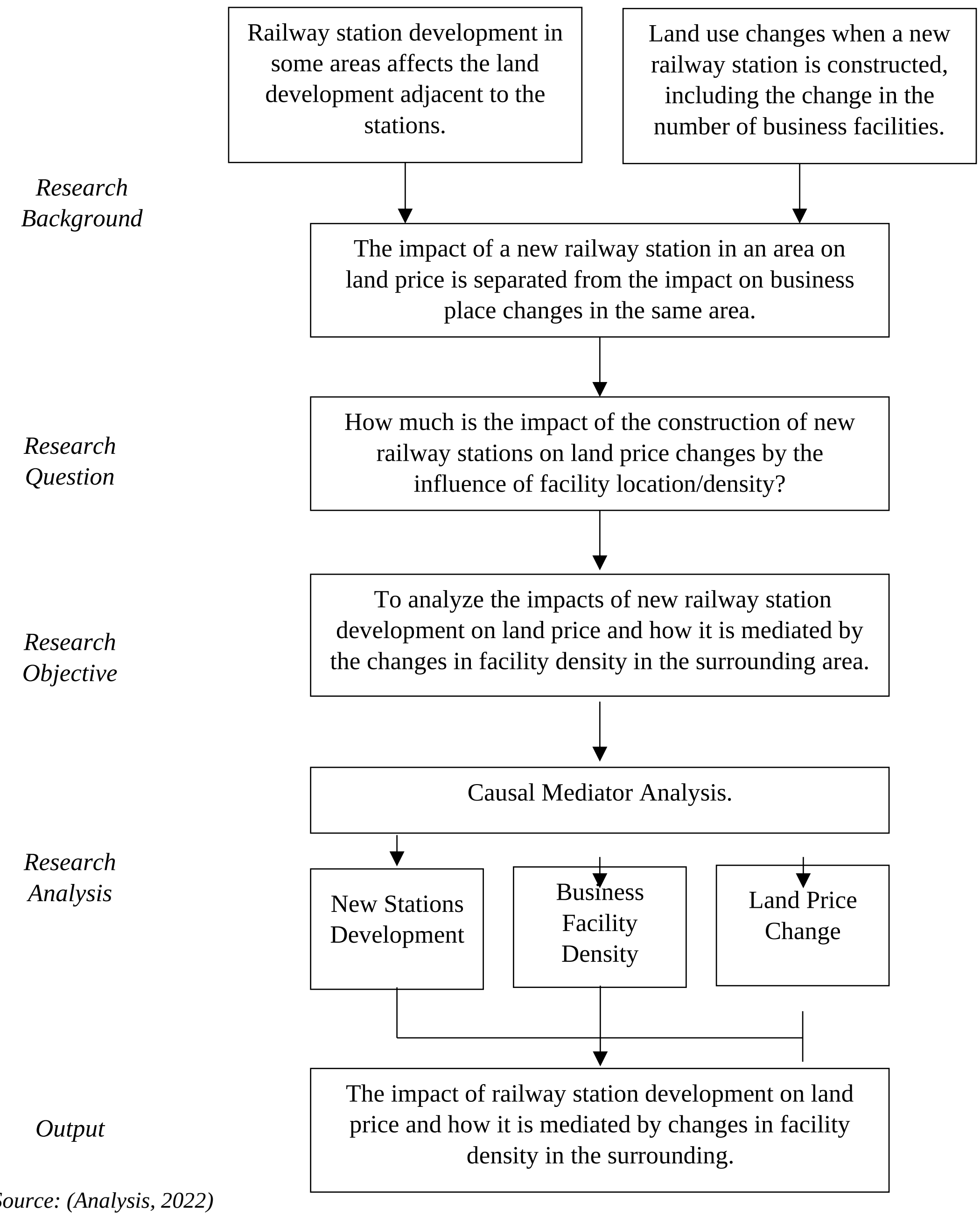
This study aims to find the impact of railway station development on land price by counting the role of business facilities density around the station. The benefits of this study are:

1. The educational benefit this study found is the direct impact of the existence of railway stations on land prices in the surrounding area. In addition, the influence of business facilities density was also considered as an indirect impact and its proportion on how land price changes after a new railway station operates in the area.
2. On the practical side, this study provides inputs and overviews to the government on how the land price changes after a new station are constructed and operated in one area. Furthermore, the density of business facilities also plays a role to some extent in suggesting a consideration to the government on how they manage the land use around stations, including in giving the business license and building construction permits.

1.7 Research Framework

The research related to transportation infrastructure and land price change involves the analysis of time series data on how the dependent variable, land price, changes during some periods. The new infrastructure's impact is then analyzed before and after its existence. The model also employs facility density as the mediator, and the time series data is also used to see the effects in some periods.

The framework of this research is shown in Figure 1.2. The study process started with the railway's development analysis in West Japan to see how the development, especially the new stations, increased. Then, with all new stations being constructed, the next step is to analyze the land price fluctuation in time series data, including the price level before and after the stations are built.



Source: (Analysis, 2022)

FIGURE 1.2
Research Framework

In the next step, the land price fluctuation is also included in the analysis of the business facility density change in the land area changes in some periods. The business facility density was generated from the ownership of fixed phones in the station area. In this case, fixed phones for business are significant as the ownership shows the location of each facility. Lastly, the correlation between these aspects is examined to see how they affect each other. The analysis started individually, such as stations and land price only, then followed by combining the business facility density as the mediator using the method chosen. In the end, the impact of railway station development on land prices can be generated.

All railways are identified here as transportation infrastructure development and highlighted by combining all station and shelter types for the local train, shinkansen, and tram. All new stations that started operational during 2015-2020 are counted in this research. Land attributes are considered the land price at some period within 1 kilometer of the stations. The telepoint pack database is the business/facilities density in the station's area in the same period.

1.8 Research Method

Examining the correlation between explanatory and explained variables could be complex, primarily when other factors affect the relationship. In this case, the role of a mediator is considered to make differences in the result of correlation analysis between dependent and independent variables. Therefore, Causal Mediator Analysis (CMA) was used in this research to see the impact of treatment (construction of station) on the land price changes by the mediator's role, facility location, or density. Through CMA, there is a mediation analysis to learn the direct impacts of exposure on the outcome and mediated impacts on the correlation from exposure to outcome (Cai et al., 2022). As mentioned in the research framework, the steps of analyses required some equations to support the analysis for each direct and indirect effect. A set of models were proposed to estimate the effects, specifically the partially linear model for each variable selected.

This study employed the Causal Mediator Analysis (CMA) is used to minimize the complexity of the relationship between many variables. Usually, the traditional method handles the multiple variables correlation using multivariable regression models. However, this method fails to elaborate on the primary or principal relationship that caused the correlation, which often needs to deepen the analysis (Zhang et al., 2016). The mechanism of how the intervention affects the outcome became the basic principle to understanding the total relationship. In addition, through the mediator variables, the output exploration shows the total exposure effects into the direct and indirect effects (Rijnhart et al., 2021).

To analyze these relationships, the framework to follow for this research is shown in Table I.1:

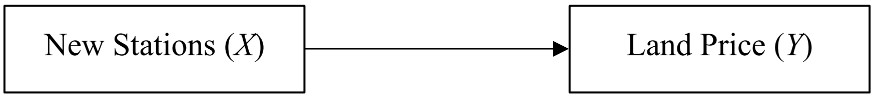
TABLE I.1
Causal Mediator Analysis Framework

Objective: To analyze the impact of the new stations on the land price by the influence of facility density.	**Methods:** Causal Mediator Analysis	**Analyzing** • Generating the new railway stations in West Japan • Listing the buffer area of land price within 1km from each station • Calculate the facility location and density based on the telepoint pack point database	**Output** Direct effect, indirect effect, the total effect.

Source: (Analysis, 2022)

From this framework, we can see the original illustration of the variable's correlation. Then, the causal mediation analyzes the three correlations between variables to see the possible estimation of causal effects (Imai; et al., 2010). This study used the single mediator as only one factor was used as the mediator to the central Equation. Using the single mediator, we performed the traditional mediation analysis because of the potential outcome of the framework, followed by the exploration of the connection between the variables (Cai et al., 2022).

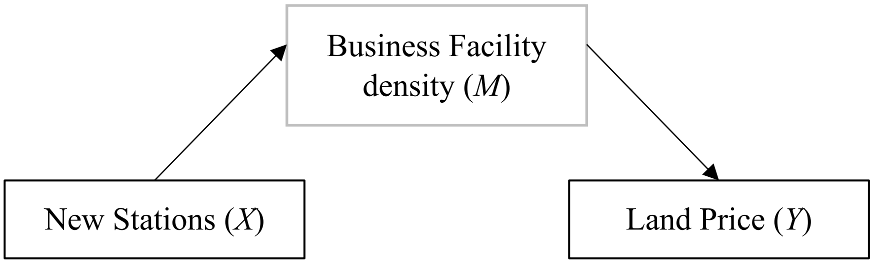
In the first connection, we observed how the construction of new railway stations affects land prices, as shown in Figure 1.3. The new stations variable is the independent variable connected with land price, the dependent variable. This connection was analyzed by linear regression to see how the independent variable affects the dependent variable. Zero external influence affects this first connection, directly affected by one variable called the direct effect.



Source: (Analysis, 2022)

FIGURE 1.3
Treatment and Dependent Variable

Then, we put the new variable categorized as the mediator that affected the original correlation, as Figure 1.4 shows. The new stations still become the independent variables or treatments that affect the outcome of land price change.

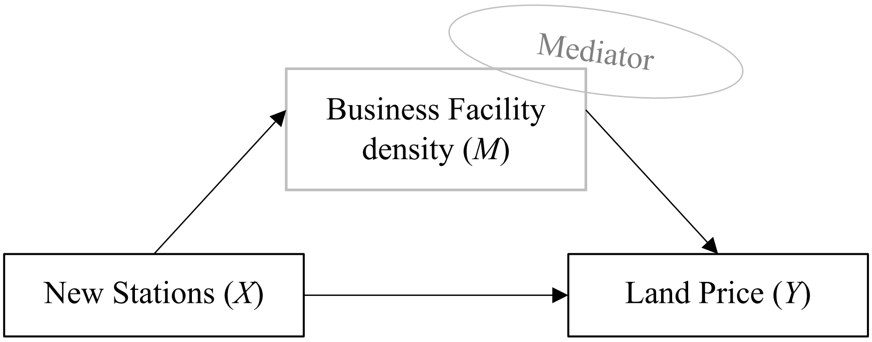


Source: (Analysis, 2022)

FIGURE 1.4
Mediator and Treatment

When the new station affects the output, the other variable, namely the facility density around the station, affects the land price. The change in business facility density has a connection to some extent with the existence of the new stations. The new stations' role as the independent variable in this second model also changes the business facility density. Ultimately, the business facility density changes affect the land price somewhat. The land price did not specifically change caused by the new stations, but the change was indirectly affected by changes in the business facility density. That brings this second model to the category named the indirect effect.

Lastly, the correlation between those three variables is shown in Figure 1.5, which estimates the connection between X, Y, and M representing the new stations, land price, and business facility, respectively. As the dependent variable, land price (Y) directly correlates with the independent variable, new stations (*X*). On the other side, new stations also influence the growing number of facility densities, which impacts the total land price to some extent. The indirect effect is the last correlation between business facility density and land price. The accumulation of the direct and the indirect effect is the total effect on the dependent variable, which later on is categorized as the outcome of the causal analysis through the mediator role to some extent.



Source: (Analysis, 2022)

FIGURE 1.5
Treatment, Mediator, and Dependent Variable

The Causal Mediator Analysis employs the Ordinary Least Squares (OLS) regression that consists of three equations. By the mediator's influence, the treatment variable and the outcome explain the individual and causal relationships. The treatment we put in the Equation is the construction of the new stations in the areas. Mediation involves the variable, including *X*, as the treatment variable; *Y*, the dependent variable; and *M* as the mediator. Firstly, measuring the treatment's effect on the dependent variable using Equation (1).

Equation (1) calculates the land price in one specific area within 1km of each railway station by the impact of the construction of the new station. The new station becomes the treatment in the Equation to see how the land price changed before and after the station operated during the six years. This research uses the railway station data in West Japan constructed in 2015-2020. Every station has a buffer area of 1km to identify each land parcel and price to be examined.

$$Y_{ijt} = C_1 + \beta_{TE} D_{ijt} + \varepsilon_1 \quad (1)$$

Where:

Y_{ijt} = land price at spot i in buffer zone j in time t

C_1 = constant term

β_{TE} = total effect of treatment (new stations) to land price at spot i in buffer zone j in time t

D_{ijt} = treatment (new stations) to land price at spot i in buffer zone j in time t

ε_1 = error term

Equation (2) shows the treatment and mediator correlation; in this case, the mediator is the dependent variable affected by the station's development. The mediator (M_{ijt}) represents the mediator at one land parcel within the buffer zone at a particular time, in this case, the six years. As the new station exists, this mediator was calculated and put into the regression and used the density based on the available data. It is expected that the first period of the analysis, 2015, has a lower number of business facility densities compared to the following years as more stations and business facilities are expected to grow in number, considering that the government builds more new railway stations every year. The railway development increases market accessibility and opportunity, especially for local people, to provide a better and more comprehensive network in terms of facilities, including business facilities.

$$M_{ijt} = C_3 + \beta_{DE} D_{ijt} + \varepsilon_3 \quad (2)$$

Where:

M_{ijt} = mediator at spot i in buffer zone j in time t (facility density)

C_3 = constant term

β_{TE} = total effect of treatment (new stations) to land price at spot i in buffer zone j in time t

D_{ijt} = treatment (new stations) to land price at spot i in buffer zone j in time t

ε_1 = error term

In the last model, we put all three aspects in one Equation to see how they perform their role in the analysis. Equation (3) shows the complete correlation between the treatment (*D*), outcome (*Y*), and the mediator (*M*). The new stations (D_{ijt}) directly connected to the land price (Y_{ijt}) either positive or negative and at the same time connected to the mediator (M_{ijt}). There will be a possibility that the effect of *D* on *Y* will disappear entirely, and then M becomes a complete mediation to the case. If the effect of *D* on *Y* still exists but in a small proportion, it means *M* plays partial mediation. When the effect of D on Y dominates the resulting outcome, the model is categorized as a zero mediator.

$$Y_{ijt} = C_2 + \gamma_{TE}D_{ijt} + \alpha_{TE}M_{ijt} + \varepsilon_3 \quad (3)$$

Where:

Y_{ijt} = land price at spot i in buffer zone j in time t

M_{ijt} = mediator at spot i in buffer zone j in time t (facility density)

C_3 = constant term

α_{TE} = total effect of treatment (new stations) to mediator (new facilities) at spot i in buffer zone j in time t

$\gamma_{\text{D.E.}}$ = direct effect of treatment (new stations) at spot i in buffer zone j in time t by controlling mediator

D_{ijt} = treatment (new stations) to land price at spot i in buffer zone j in time t

ε_1 = error term

The mediator variable employed in this research is the facility density generated from the telepoint pack database. By analyzing the density of the facility with spatial tools, the change in geographical point patterns can be determined (Anderson, 2009). Kernel Density Estimation (KDE) is used to identify the spread of the facility density around the station. The histogram form of the smoothing result of KDE derives the samples' probability density function. It shows the nonparametric approach to estimating the probability density function of a random variable from time series data with no distribution assumption of the samples (Xue et al., 2020). The objective of using this density method is to identify and conclude a particular inference about the probability of the density. In the end, the contribution of each telepoint data is smoothed into the histogram of the whole region of West Japan.

The original data set for this research is obtained in 2022. The analysis period is six years, marked by the year when each station started open for the public or started operationally. Land price and business facilities quantity changes are observed based on the year the station started its operation, in this case, the condition in the years before and after its operation. The land price growth and the density of business facilities are provided by the time series data based on the station's construction.

Two primary data collection methods in this research are used for the analysis. The first data is related to railway construction in Japan, consisting of all railway types in Japan, including local trains, shinkansen, trams, and subways. In this data, we found the name of the stations, years of construction, and the location of every station. The second data is land price information related to the price of land parcels in Japan during some periods, including spread near the stations. These two data will be collected from the National Land Information Division, National Spatial Planning and Regional Policy Bureau, Ministry of Land, Infrastructure, Transport and Tourism, Japan (MLIT).

The second data is the time series data for business facility locations. In this case, it is indicated from the Telepoint Pack database in Japan some periods, the specific focus of the business fixed-phone, not individual fixed-phone. The density and location are then calculated to see each area's total fixed-phone fluctuation. This data will be acquired from Zenrin Co., Ltd.

1.9 Research Systematic

This research is planned considerably to prepare the result and report for the thesis entitled "The Impact of The Railway Stations Development on Land Price: A Case in West Japan." Each part of this thesis was organized systematically to provide a comprehensive report. The parts of the thesis started with the introduction of the topic and area to the conclusion and recommendation. In more detail, each part of the thesis includes:

1. Introduction

   This chapter mainly explains the background of the research and briefly the expected result that will follow. The main objective and the research question also appear in this part, followed by the research framework and the method used to analyze the data.

2. Literature Review

   This part mainly elaborates on the previous studies related to the research topic and the gap that will be filled in this research. This part also provides the theories from some experts implemented for the research background and methodology used.

3. Study Area

   This chapter explains the study area of the research. The explanation includes the area profile that supports the analysis in this research. In general, this part will discuss all the data collected during the research and how it was employed during the analysis.

4. Result and Analysis

   In this chapter, the results of the data calculation are presented, followed by the analysis and interpretation of the results. The discussion also includes the study of the previous result to show how this research produces a new understanding and results.

5. Conclusion and Recommendation

   In the end, the conclusion of this research is provided in the last chapter, and the recommendations are reliable for the shareholders. In addition, the limitations of the research and the future direction are shown to support the related study in the future.