梗概

城市交通是城市规划与管理中的一个重要组成部分。交通拥堵，安全事故，环境污染等城市交通问题随着城市的发展而出现，同时又对城市的发展起到制约作用。当前日本正面临着严重的少子高龄化问题，而这一问题反映在日本的地方中心城市中，表现出了城市人口外迁，城市区域向外围扩散等后果，随之而来的是私家汽车的出行分担率持续上升以及交通拥堵等问题。那么从充分利用社会公共资源，环境保护的观点出发，如何提高公共交通的使用已经成为了日本各都市的重要课题。对于这一课题，首先需要充分把握影响公共交通客流量的关键因素，然后根据这些关键因素对客流量的影响，在未来的用地、建筑、设施等的规划方面提出针对性的改善方案，从而达到提高公共交通利用的目的。

Urban transport is an important part of urban planning and management. Urban traffic problems such as traffic congestion, traffic accident, and air pollution, always appear along with the development of the city, while they also restrict the development of the city simultaneously. At present, Japan is facing serious problems of aging society and low birthrate. Reflected in the local central cities of Japan, these problems are showing the trends that, the migration of population to the edge of the city and the spread of urban areas to the surrounding areas. What followed are the traffic congestion and the continuous increase in the traffic mode share of private cars. From the perspective of environmental protection and the full use of social public resources, how to improve the use of public transportation has become an important issue in all Japanese cities. To promote the utilization of public transit, it is necessary to explore and understand the determinants of transit ridership, based on which the specific improvement plan can be proposed regarding land use, buildings and facilities.

在这样的背景和需求下，本研究以日本地方中心城市的轨道交通系统为对象，来探索并定量解析影响城市轨道交通的关键因素，从而为未来规划的制订提供定参考依据。围绕该研究目的，论文分别从乘客的个人属性，车站的周边环境因素，车站与车站之间的OD客流移动三个角度对福冈市轨道交通利用的影响展开分析。根据以上提出的研究目的，论文组织为6个章节，各章节内容如下。

With such background and demand, this study aims to explore and quantitatively analyze the determinants affecting urban rail transit by using the rail transit system of Fukuoka, which is a typical local central city in Japan, as the study case, so as to provide references for future planning. Around the purpose of this research, this dissertation mainly explores and discusses the determinants of Fukuoka rail transit ridership from 3 aspects: passenger attributes, environmental factors around the station, and passenger transfer between station and station. According to the research purpose proposed above, this dissertation is organized into six chapters, and the contents of each chapter are as follows.

第1章，首先对研究背景进行了阐述，根据日本地方中心城市中存在的现实问题提出了论文总体的研究目的和研究内容。然后通过对该领域的既往研究进行整理和总结，针对分析轨道交通客流量的影响因素过程中出现的一些技术细节，提出了具体的研究点。最后，选择福冈市的轨道交通系统作为研究对象，围绕总体研究目的，根据具体的研究点，整理出全文结构。

In chapter 1, the research background is elaborated. Firstly, according to the practical problems existing in most cities around the world particularly in the local central cities of Japan, the overall research purpose is put forward. Then through the collation and summary of the previous studies, some specific research questions area extracted in terms of the details in analyzing the determinants of rail transit ridership. Finally, the rail transit system of Fukuoka City is selected as the research object, and around the research purpose, the content of this dissertation is organized according to the specific research points.

第2章，从乘客属性的角度，综合考虑个人特性（性别，年龄，职业等），出行特性（出行时间，出行目的等）因素的基础上，考察不同属性的乘客的步行时间特征，从而把握对轨道交通的利用趋势。研究首先对乘客属性与步行时间进行了回归分析，结果显示两者之间并不存在显著关系。

Chapter 2 focuses on passengers’ attributes, including socio-economic attributes, trip chain information, to explain the variation in walking access amongst individuals, so as to grasp the utilization trend of rail transit. It has been confirmed in many studies that there is no linear relationship between the dependent variable of walking access and the explanatory variables.

经过分析得出可能原因有：调查获取的乘客步行时间是乘客出发地到车站之间距离的反映，与乘客特性并不存在直接联系；此外，在调查数据集中，被调查对象往往较为倾向于给出一个宽泛的回答，而造成调查结果的误差。因此直接考察乘客属性与步行时间的关系往往难以得到理想的结果。但根据既往研究的结论，乘客属性与步行时间之间应该存在关联性。为了进一步探究两者的关联性，本研究尝试考察在几个特定步行时间上的乘客属性的特征，从而把握具有不同属性的乘客在关于步行距离上对轨道交通车站的利用趋势。于是将该问题转换为考察具有不同属性的乘客其步行时间大于给定步行时间的概率。分析方法上，首先采用方差分析在给定步行时间上对有效乘客属性进行提取，然后使用提取出来的有效属性对步行时间大于给定时间的概率进行预测，从而根据预测准确性对乘客属性提取的结果进行验证。

To further explore the relationship between walking access and passengers’ attributes, this study examines the attribute characteristics of passengers who walked the given walking duration or more, thus trying to explain the preference on walking access towards different passenger attributes. The research object is the probability that passengers’ walking access more than the given threshold of walking duration. For the analysis method, the ANOVA is used to extract the effective passenger attribute at each given walking duration, and then the extracted effective attribute is used to predict the probability that the walking access is greater than the given threshold, so as to verify the effectiveness of extracted passenger attribute through the prediction accuracy.

由于是对乘客属性特征的探索性分析，在难以预判因变量和解释变量以及解释变量之间的关系的情况下，采用对各类数据适应性较强的随机森林决策树模型进行预测。研究选择了5，8，13分钟三个步行时间进行考察，特征提取显示，65岁以上、无职业、出行目的为公务、私人、回家这些属性的乘客更倾向于5分钟以上的步行时间；出行目的为公务、私人、回家这些属性的乘客更能够接受8分钟以上的步行时间；只有私人出行目的的乘客倾向于接受13分钟以上的步行时间。根据预测结果的评价，在5分钟步行时间上提取出的乘客属性能够较好的反映出乘客的步行时间分布，13分钟步行时间上乘客属性对步行时间分布的解释能力稍弱，8分钟上提取出的乘客属性解释能力相对较低。

Three thresholds of walking duration 5, 8, 13-minute are selected to examine in this chapter. Based on the results of feature extraction and probability prediction, passengers with the attributes of more than 65 years of age, unemployment, and business, private or going home travel purposes are more likely to walk for more than 5-minute; passengers who travel for business, private or going home purposes are more inclined to accept a walking duration longer than 8-minute; only the passengers with private travel purposes are more likely to accept a more than 13-minute walking duration. According to the evaluation of the prediction results, the passenger attributes extracted at the 5-minute walking duration have relatively strong explanatory power in explaining the walking duration preference; the explanatory power at 13-minute walking duration is slightly weaker than that at the 5-minute threshold; the explanatory power at 8-minute is relatively low.

第3章，对福冈市各地铁站客流量的特征，以及同时期车站周边的土地利用特征进行考察。根据各个车站的周边土地利用特征将全体车站分为低密度住宅，高密度住宅，商业中心，公务，教育5大类型，并对各类型车站的客流量特征进行了总结。最后用数量化1方法对土地利用与站点客流量的关系进行了估计。并得出结论商业和办公建筑面积是客流量的重要影响因素，人口密度对于客流量增长起到重要作用。

Chapter 3 examines all the subway stations in Fukuoka City regarding the characteristics of rail transit ridership, also the characteristics of land use around the station. The subway stations are classified into 5 types (low-density residence, high-density residence, downtown commerce, office, and education respectively) according to the land use characteristics, then the characteristics of transit ridership are summarized in terms of the 5 types. On the basis of fully grasping the characteristics of both transit ridership and land use, the relationship between land use and passenger flow is estimated by Quantification I Method. It is concluded that the building area of commerce and office is important on affecting transit ridership, while population density plays an important role in the growth of transit ridership.

第4章，从车站周边环境因素的角度探寻对于车站乘客量的有效影响指标，并定量估计其对于客流量的影响程度。针对福冈市的小样本案例，本章提出了回归模型中有效指标的提取方法，并最终选取了9个有效影指标。同时考虑到地铁客流量回归中，部分指标存在一定的空间依赖关系，因此引入Moran指数对各指标的空间相关性进行描述，并依据此判别全局变量和局部变量，最终采用混合地理加重回归模型对该9个指标的影响程度进行估计。结果显示筛选出的9个指标均具有统计显著性，其中官公厅用地、交通设施用地、土地利用聚集度、换乘站、自行车停车位、公交可达性这6个指标的增加能够引起轨道车站乘客量的增长。模型精度上来看，通过对残差以及残差空间分布情况的对比，混合地理加重模型的结果相对普通线性回归也有明显改善。

Chapter 4 explore and estimate the influencing factors on transit ridership at station level. Aiming at a small sample case of Fukuoka City, this chapter proposes a method to extract effective influencing factors in the regression model, and finally, 9 effective indicators are identified. Also, with the consideration of the problem resulted from the spatial autocorrelation of explanatory variables, Moran index is introduced to describe this spatial autocorrelation, thus discriminating the global and local indicators. Then the Mixed Geographically Weighted Regression model is used to estimate the impact of the discriminated global and local indicators. The results show that all the 9 selected indicators are statistically significant. Among them, raising the indicators of official office area, transportation facility area, land use aggregation, transfer station, bicycle parking, and bus accessibility can lead to an increase in rail transit ridership. In terms of model accuracy, by comparing the residuals and the spatial distribution of residuals, it is clear that the results from MGWR have a significant improvement than that from OLR

第5章，从站与站之间的OD客流量的关系出发，考察土地利用类型对于乘客对于目的地选择的影响。本章提出乘客对目的地的选择概率会受到其出发站以及到达站周边土地利用类型的影响，并建立了二项选择logistic回归模型描述这个问题。研究方法上，根据第2章得到的站点周边的土地利用类型的分类，从各车站类型中分别选取一个典型车站作为研究案例，将其作为出发车站，分析目的地车站周边土地利用类型的差异是否会导致选择该目的地车站的概率发生变化。根据logistic回归结果，车站周边土地利用类型对于目的地车站的选择概率的影响存在统计学上的显著性，验证了本章提出的假说。结果显示，低密度住宅型出发站的乘客，在目的地选择上没有明显的倾向性；教育类用地为主的目的地车站对各类型出发站的乘客都有较强的吸引力；乘客在目的地选择上不倾向于选择与出发车站土地利用类型相同的目的地车站。

Chapter 5 examines the influence of land use types on passengers' choice of destination from the perspective of OD transit ridership. This chapter proposes that the probability of choosing destination station will be affected by the type of land use around the departure stations. Based on this argument, this research question is converted to a binary choice issue and is described by the logistic regression. Using the classification of stations obtained from chapter 2, several typical stations selected from each type are used as the research objects, they are used as the destination station to analyze if the land use types around the departure station affect the probability of choosing them as the destination. According to the results of logistic regression, the land use type around the departure station has significant influences on the probability of choosing the destination, based on which the argument proposed in this chapter can be verified. The results show that the probability of choosing a destination belong to low-density residence type has no tend to raise regarding to the variation of land use in the departure station; for the destination station of any type, the education land use in the departure station contributes to an increase in the probability of being chosen as the destination; the probability of destination station being chosen tend to decrease if the land use types are similar between the departure and destination stations.

第6章，对本研究中的发现和结论进行总结，并对乘客的个人属性，车站的周边环境因素，车站与车站之间的OD客流移动三个角度整合进行客流预测的可能性给出了提案，期望能够在未来研究中达到精确预测客流量的目的。

Chapter 6 summarizes the findings and conclusions of each chapter in this dissertation. In the recommendation part, the feasibility of integrating passenger attributes, environmental factors around the station, and ridership transfer between OD station to predict rail transit ridership is put forward, which is expected to be used to improve the accuracy of transit ridership forecasting.