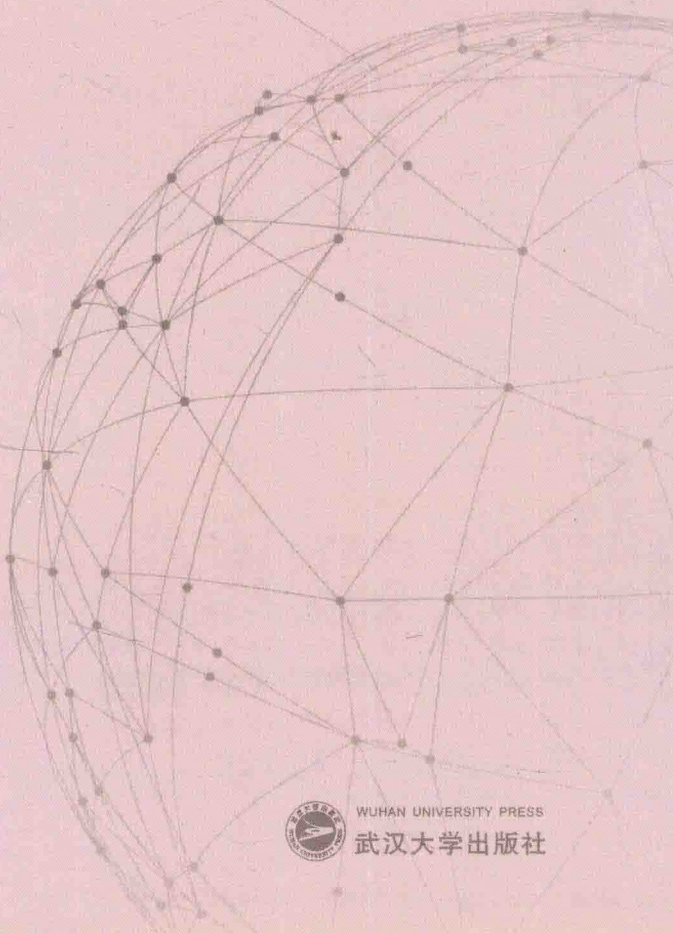
基于步行网络可达分析的公平性评价与优化模型

徐孟远　著



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图书在版编目(CIP)数据

基于步行网络可达分析的公平性评价与优化模型/徐孟远著. —武汉：武汉大学出版社，2016.12

ISBN 978-7-307-18813-6

Ⅰ.基… Ⅱ.徐… Ⅲ.城市公用设施—城市规划—研究 Ⅳ.TU99

中国版本图书馆 CIP 数据核字(2016)第 275207 号

责任编辑：黄金涛　　责任校对：汪欣怡　　版式设计：马　佳

出版发行：**武汉大学出版社**　(430072　武昌　珞珈山)

(电子邮件：cbs22@whu.edu.cn　网址：www.wdp.com.cn)

印刷：虎彩印艺股份有限公司

开本：720×1000　1/16　印张：14.5　字数：378 千字　插页：1

版次：2016 年 12 月第 1 版　2016 年 12 月第 1 次印刷

ISBN 978-7-307-18813-6　定价：55.00 元

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CHAPTER ONE INTRODUCTION

This chapter presents an introduction to this research and provides a brief background, the research context, the existing problem and justifications, research questions, the research goals, and definitions of terms.

1.1 Background

Walking is the most basic and fundamental form of transportation (Lee & Moudon, 2006; Litman, 2003). The terms "walkability" or "walkable" have been widely used in research papers related to built environments and walking behavior. However, conventional planning tends to pay less attention to walking activity compared to motorized travel.

Conventional planning considers walking as a minor mode of travel because it represents only one fiftieth the amount of vehicle travel in terms of person-miles (Litman, 2003). Therefore, the quality of walking environments has received little support in conventional planning (Moudon et al., 2008). However, more recently, the concepts of walkable communities and walkability have been receiving increasing research interest and attention with the growing body of findings that walkability is related to public welfare (Moudon et al., 2008; Ewing et al., 2006). Researchers from the healthcare field have been contributing a flourish of literature on the impacts of built environments on people's physical activity, which strongly influence people's health (Eyler et al., 2003; Haskell et al., 2007). Walking has also been considered by researchers to be vital for increasing social interaction with the local community (Leyden, 2003). In addition, walking itself also serves as a crucial part in the overall transportation system, especially for mobility-disadvantaged groups who lack basic mobility in an automobile-dependent community (Litman, 2003).

Among all the relative parts of the characteristics of a pedestrian environment, the distribution of critical urban services among urban residents has been a major focus in urban planning and policy making worldwide, because access to crucial life-needs services such as grocery stores, gathering places and green spaces are vital to people's welfare and

well-being (Beaulac et al., 2009; De Vries et al., 2003). The study of measuring access to public goods and services has received much interest for decades.

Considering that the study of accessibility deals with the distribution of certain urban resources among certain groups of people, it is naturally related to the notions of equity as well as efficiency. Both equity and efficiency have been considered critical factors to improve the performance of an urban environment (Talen, 2011; Dietz & Atkinson, 2010; le Grand, 1990). Equity is related to demands and available resources among social groups, and efficiency is how well the infrastructure serves the groups to a maximized degree. However, although equity is widely considered as a vital principle among policy makers and planners (Talen, 1997), the notion of equity remains a very ambiguous term and is usually addressed from a broader view of social analysis (Smith, 1994). There is no common agreement on what an equitable distribution would be due to the complex nature of the issue (Blanchard, 1986).

At the same time, the notion of efficiency is interpreted differently by different researchers, which leads to a variety of measures of efficiency. In other words, despite continuing research interest and numerous geographic studies that have discussed and contributed to the notions of equity and efficiency, researchers may not mean the same thing when they use the concepts due to the fact that transportation equity analysis of accessibility involves multiple dimensions of issues and various approaches to define and measure them (Litman, 2003). Considering that the lack of consensus on a consistent understanding of the notions would hamper further discussion on this issue, it is necessary to firstly clarify and define the notions of equity and efficiency based on the topic at hand in a transportation planning context.

A theoretical foundation is proposed with a definition of the relative notions of walkability and accessibility in the context of this research. The comprehension of this conceptual set not only leads to a framework that provides comprehensive grounds for future research, but also may make progress towards a new sophisticated way of analyzing equity that planners and researchers can use. Furthermore, when it comes to the destinations to which access should be provided, there is a lack of a consensus in existing literature on the framework of categories of critical urban services, which is referred to here as Life-Needs Service Facilities. A well-formed category of the service facilities can be of large assistance for future discussion and model building.

The primary objective of research on measuring the accessibility to urban service facilities based on spatial and demographic patterns is to propose a potential prioritization of improvements to achieve a more efficient or equitable system. Despite continuing

research interest in this field, the question of whether or not these social services are equally distributed has "largely remained unsolved" (Talen, 1996). The performance measures of the efficiency of a system are developed in very different ways based on various focuses and scales of the research. So, there is a great need for a sophisticated model with quantitative accessibility measures to study walking activity and evaluate the pedestrian environment. In addition, in the context of limited resources and budgets for delivering future plans, it is vital to consider how to improve the way that services should be delivered. In order to achieve maximized benefits, approaches are required to identity the importance of each specific segment of the infrastructure in the overall network in order to decide their prioritization for fixing, and a number of previous studies have proposed different approaches. As a result, it is vital to prioritize future improvements based on their importance by responding to these criteria.

Computer-aided design technology has been widely used in the process of design since the 1980s. However, the roles of most current computer-aided design tools (such as AutoCAD and Photoshop) are generally limited to drafting and documenting. Similar to traditional drafting boards and manual drawings, these traditional design tools still act as "representational tools," which are facilitated to visually represent either existing conditions or proposed designs while not actively participating in the design thought process or the decision-making process (Kotnik, 2010). It is considered that we are currently at the digital threshold of the evolution of computer-aided design tools from representational tools to the next stage of "simulation tools." Facilitated by quantitative spatial analysis tools, simulation tools are able to provide in-depth information related to design goals and thus optimize the decision-making process. The shift of paradigm from representational tools to the next stage represents the trend of computer-aided tools evolving from representative tools of describing "what it is" to stimulation tools that are able to describe "what can be" based upon various proposals. In other words, tools in the next stage would support more active design decisions, helping designers to find the optimal solution by providing real-time feedback to proposed design scenarios.

With powerful abilities to store, manage, analyze and present spatial data, GIS provides great convenience for planners to create models to simulate a built environment. GIS enables the operation of spatial measures of the built environment that provide spatial linkages that integrate demographic data, spatial patterns, and other relative environmental factors with the outstanding capacity of enabling visual representation. These advantages help the decision-making process for urban planners and make the GIS an ideal platform of analysis. The concepts of GeoDesign and Geovisualization are adopted to reflect

this shift. First proposed by Dangermond (2008), the concept of GeoDesign was to integrate geographic analysis into the design decision making process. A GeoDesign platform is able to combine a variety of database layers describing social and physical factors related to the design project. This platform provides a framework that allows a GeoDesign model to draw different design scenarios in digital format, which not only represents the design product, but more importantly, provides analysis tools that assist designers to explore the optimal design scenario based on certain criteria. For the pedestrian accessibility analysis in this study, socio-demographic factors are considered as significant components in assessment and prioritization process. The GeoDesign concept provides guidance to integrate socio-demographic layers into a spatial analysis model to create assessment and prioritization tools, which can be used to assist urban planners and policy makers to explore optimal design scenarios. On the other hand, the concept of Geovisualization represents the idea that the model would take advantage of the ability to visually present changes in real time and allow for a more interactive process, which would better facilitate the planning process among various stake holders (Talen, 2011). The concept of Geovisualization is also reflected in this study. This analysis model provides a customizable prioritization criteria and the model is able to visualize different scenarios based on different settings.

Recently, some analysis tools based on the GIS database have been developed by researchers. However, existing accessibility equity measures suffer from some disadvantages. First, transportation equity analysis is highly affected by the modes on which the research focuses. The majority of existing research favors motorized accessibility, and relatively little attention has been paid to non-motorized or pedestrian accessibility (Litman, 2003). The notion and measures of pedestrian accessibility still have not been thoroughly discussed, and this paper fills the gap in the literature. Furthermore, even in recent physical activity research focusing on the pedestrian environment, street networks tended to be used for connectivity analysis of the built environment, whereas a true pedestrian network might be very different from a street network in regard to connectivity calculation (Chin et al., 2008).

Another significant deficiency is that previous measures tended to divide individual socio-economic and socio-demographic status from their geographical context (Weber & Kwan, 2003). Considering that the level of accessibility is largely affected by the social characteristics of households rather than just the built environment, it is necessary to relate accessibility to social inequity and social stratification (Hanson & Pratt, 1988). So, there is a need to further examine the association between accessibility and social characteristics

of the population groups.

This significance of this study is its thorough discussion of the ambiguous notions of equity and accessibility from a transportation planning standpoint. Addressing the needs for filling gaps in existing studies, it synthesizes studies from various fields, including urban planning and sociology, and establishes a theoretical framework for future studies. This book discusses the significance and development of a methodology for creating a GIS-based accessibility measurement model in the Spokane PTBA (Public Transit Benefit Area) for mobility-disadvantaged groups based on information from previous studies. Significant improvement in the methodology and tool development can be drawn from this research. An integrated GIS tool was designed to provide broad spectrum analysis and real-time feedback for equitable as well as efficient urban development. The model not only helps visually illustrate potential accessibility inequities to life-need service locations across the whole study area, but also shows potential changes in terms of the level of accessibility based on the improvement of pedestrian facilities or newly added service locations. It is also a design-decision support tool that helps planners identify the priority of improvement and find optimal scenarios based on principles of efficiency and equity.

1.2 Research Question

This research addresses the question of how to develop a GIS-based model that can measure pedestrian accessibility and prioritize potential improvement based on the criteria of equity and efficiency. In order to answer this question, there are a few aspects that need to be explored. First, it is necessary to review the measures of accessibility (or the distribution of urban services among citizens) in the context of transport and urban planning. Second, it is important to understand how to establish the accessibility model of a pedestrian environment on a GIS platform. Third, it is necessary to clarify the notions of equity and efficiency in the context of urban planning and to propose how to interpret these two notions in the assessment and prioritization model. These topics are discussed in Chapter 2 in detail.

1.3 Research Goals

The aims of this research are to achieve the following goals:

(1) *Contribute to the literature on the notions of equity and efficiency in terms of accessibility to critical urban services.* Both equity and efficiency have been ambiguous terms

in previous studies due to various research focuses and opinions. So, the primary object is to review the relevant literature and then to thoroughly discuss and understand the notions of equity and efficiency in terms of accessibility analysis and related social factors in the context of transportation planning.

(2) *Creation of a sophisticated GIS-based model of the pedestrian environment in the study area.* Due to its powerful functions in data management, analysis, and representation, GIS is an ideal platform for the model of pedestrian environment. The previous models of pedestrian environment were created in different ways and may have certain disadvantages. For example, most current accessibility analysis researches employ street network based instead of true pedestrian network, which could be misleading (Chin et al., 2008). Based the present research question, the first objective is to discuss how pedestrian environment can be represented and modeled in the GIS. The second objective is to propose a model with detailed demographic and geographic data on the Census block level as well as true pedestrian network data.

(3) *Proposal of pedestrian accessibility measurement approaches in this GIS-based model so it can evaluate the accessibility patterns in the study area.* Previous research implemented various approaches to measure the accessibility based on various research contexts, so it is important to conduct a comprehensive review of these different approaches before proposing an appropriate measure for this specific research topic.

(4) *Developing a methodology to prioritize potential infrastructure improvements in the context of limited resources and budgets based on the trade-off of equity and efficiency.* The notions of both equity and efficiency are ambiguous in previous studies. As a result, it is necessary to clarify these two notions in the present research and thus interpret them into measures in the prioritization model.

1.4 Contents of the Document

This book is comprised of five chapters. The beginning of each chapter contains a short summary of the subject to be covered. The first chapter is the introduction which presents a brief background of the research context, research question, and research goals. The second chapter is the literature review. It presents the theoretical background of the study which provides a review of the research topics, including walkability, pedestrian environment, notion of accessibility, notion of equity and efficiency. The third chapter presents the theoretical framework and methodology of data preparation as well as data analysis procedures that are used in the research. Figure 11 shows the overall data analysis

procedures. The fourth chapter presents the results of the research model applied to Spokane Public Transit Benefit Area. The fifth chapter contains the discussion and limitation of the study, and potential future study.