Survey Method for Resident Travel Behavior: Analysis of Traditional and Modern Technological Methods

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Abstract: The resident travel habit survey is critical for transportation planning and policymaking. This article examines the benefits and drawbacks of old survey techniques vs current technologies. Traditional questionnaire and interview survey techniques offer depth and flexibility, but they confront constraints such as low data accuracy, high costs, severe sample bias, and design limits. Modern big data technologies, including as mobile signals, social media, and transportation system recording, have greatly expanded the breadth and efficiency of data collecting, but they are also limited by privacy concerns, data acquisition issues, and processing complexity. The video capturing technique in public spaces has significant promise in smart city building because to its privacy protection, impartiality, economy, and adaptability. Researchers may better assess people' travel behavior by optimizing technology and increasing policy standards, so enhancing the scientific process of traffic management and urban development.

1. Introduction

With urbanization accelerating and smart city building increasing, research on citizens' travel behavior has become a vital basis for urban transportation planning and policy design. Traditional questionnaire surveys and interviews, with their in-depth insights into individual behavior, have dominated travel behavior research. However, as society and technology evolve, the limits of these systems in terms of data quality, cost management, and sample representativeness become more obvious. At the same time, advances in big data technologies have revolutionized the research of inhabitants' travel habits. Researchers may get insights from a broader and more frequent set of data by using new methods such as mobile signals data, social media information, and public transit records. However, the implementation of these new technologies presents issues such as privacy protection, data gathering, and processing complexity. In this context, this paper conducts a comprehensive analysis of old and new technologies used in residents' travel behavior survey methodologies, as well as an exploration of the benefits and possibilities of employing public area video capturing methods as a novel way of providing reference for future study and practice.

2. Limitations Analysis of Traditional Travel Survey Methods

2.1. Problems Faced by Questionnaire Survey

2.1.1. Difficulty in Ensuring Data Accuracy

Although standard questionnaire surveys are often employed for resident travel surveys, the problem of data accuracy has long been a subject of numerous research. The difficulty of data accuracy is mostly due to respondents' memory bias, comprehension bias, and response motive. These variables combine to make it difficult for survey data to accurately represent actual travel behavior.

One of the most important elements influencing data accuracy is respondents' memory bias. Hu Mingwei's study [1] shown that when examining prior travel behaviors, people often struggle to

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properly remember crucial facts such as trip frequency, duration, distance, and so on, particularly when addressing all travel behaviors within a certain time period. This memory-dependent survey approach may easily result in omissions or erroneous descriptions, causing discrepancies between the final results and the real situation.

Even if the interviewee's recall of prior conduct is pretty clear, knowing bias might still have an impact on data accuracy. This variation might be due to an unclear questionnaire design or variances in respondents' interpretation of the questions. In their study, Guo Li et al. compared mobile signaling data to conventional resident travel surveys [2], pointing out that certain imprecise language in the questionnaire survey might lead to misconceptions and influence data accuracy.

The incentive of respondents to answer inquiries is an evident aspect that influences data accuracy. According to Xie Linhua et al. [3], in order to preserve the desired social image or safeguard personal privacy, respondents may deliberately or inadvertently supply biased information. False positives, whether deliberate or inadvertent, may jeopardize data dependability. Wang De et al.'s analysis [4] also mentioned the comparison of the accuracy of mobile communication signaling and traditional questionnaire survey data, emphasizing that in many cases, the description of the question does not match the respondents' understanding, or the respondents tend to provide so-called "normal" but false information in order to avoid appearing different in their responses. The loss in data accuracy produced by these variables might have major consequences for the study of citizens' travel behavior patterns, transportation planning and construction choices, and policy formation.

2.1.2. Burden of Investigation Costs

Although conventional questionnaire survey techniques are firmly ingrained in people's hearts and frequently employed in social science research, including the examination of residents' travel habits, their potential cost cannot be overlooked. The cost of researching, designing, and implementing questionnaire surveys is both an economic and a resource allocation problem. In the design phase of a questionnaire survey, deliberate question creation is critical to the quality and usefulness of the survey findings, which often requires a substantial amount of professional expertise, time, and effort. Hu Mingwei stressed the significance of survey questionnaire design in his study, including content correctness, questionnaire structure, and consideration of respondents' comprehension level. Experts' time certainly has a cost, which is frequently difficult to estimate during budget preparation.

The distribution of questionnaires, especially when conducting large-scale travel surveys with a significant number of people, necessitates consideration of actual operational costs. Traditional distribution techniques may include mailing, in-person visits, or telephone surveys, all of which incur expenditures such as printing, travel, and communication. In their study, Yang Chao et al. discussed the high expenses and organizational problems that traffic surveys confront throughout implementation [5]. These expenditures often rise rapidly as the survey's size and coverage region expand.

The cost of processing and analyzing obtained questionnaire data must also be addressed. According to Wang De et al.'s analysis, data input, cleaning, and analysis necessitate the allocation of appropriate human and technical resources [4]. As the volume of data grows, traditional data processing methods may become inefficient and costly, resulting in budget constraints and compelling researchers to compromise on research design and execution. Furthermore, researchers face additional follow-up work due to poor questionnaire response rates and the costs associated with incentive systems created to boost response rates. These incentives (such as little gifts, cash draws, and so on) may seem insignificant, but they can add up to a big cost when dealing with a large sample size. Xie Linhua et al. hypothesized that combining mobile signaling with questionnaire surveys can lower survey expenses while increasing data accuracy and recovery rates [3].

Cost effectiveness is a crucial consideration in a research setting with constrained resources. An excessively high questionnaire survey cost may restrict the range of applications it may be used for, particularly in the resource-constrained area of socioeconomic research. Thus, the cost of questionnaire surveys has long been a topic of discussion and an area that academics and researchers have tried to improve.

2.1.3. The Impact of Sample Bias

Sample bias is a significant problem in resident travel survey research that impacts the reliability and generalizability of survey findings. Sample bias typically arises when the survey sample is unable to accurately reflect the target population as a whole, or when particular subgroups are ignored or misinformed in the survey. This results in systematic bias in research findings and makes it impossible for the survey to accurately reflect the needs and travel habits of the entire population.

In her research, Lv Yanqing pointed out the necessity of mining silent travel needs and pointed out that due to the lack of voice in certain groups, the survey sample may not accurately represent the entire population, resulting in specific needs being ignored in the planning and decision-making process [6]. Similarly, in the research of Wang De et al., it was mentioned that the travel measurement of mobile signaling data can to some extent capture travel behavior comprehensively, while traditional questionnaire surveys are prone to overlooking data of certain populations due to sample selection bias [4].

Sample bias may also be created by respondents' misinterpretation of the survey. For example, if the questionnaire's questions are misinterpreted owing to language hurdles, or if the difficulty is too great for responders to understand, the total sample's representativeness suffers. This argument was raised in the study of Xie Linhua et al., who boosted sample variety and accuracy by simplifying questions and procedures when combining mobile signals with questionnaire surveys [3].

The disparity in educational level is also a significant influence in sampling bias. Groups with low educational levels may struggle to interpret complicated questionnaire instructions, reducing participation rates and questionnaire filling accuracy. Individuals from various educational backgrounds may respond differently to surveys, as shown by Yang Chao et al.'s research, which discovered that educational level influences the reporting of residents' travel behavior [5].

In recent years, privacy issues have gained prominence in questionnaire surveys. When people believe their information will be exploited or made public, they may opt not to participate in the survey or offer incorrect answers on the questionnaire. Guo Li et al. addressed this problem in their study, demonstrating how technology tools may assist individuals in participating in surveys while maintaining anonymity. Potential cultural variations, gender, age, and socioeconomic level all contribute to sample bias, which urban transportation planners must take into account. Policies that fail to include the perspectives of all relevant groups may result in inefficient allocation of public resources or concerns of social fairness.

2.1.4. Limitations of Questionnaire Design

A survey's success or failure is heavily influenced by the design of its questionnaire. Creating a questionnaire that can reliably capture the necessary information is a complex process, and poor design can not only damage data reliability but also result in insufficient or wrong responses from participants. The questionnaire's questions must be simple and direct in order to accurately collect information without confusing the respondents. Hu Mingwei's research emphasizes the need of avoiding misleading or inappropriate concerns in order to maintain the dataset's quality and breadth. Complex or confusing question structures may reduce the interviewee's understanding, resulting in erroneous explanations and answers, compromising the dependability of the results.

Language problems may make it difficult for some groups or individuals to comprehend the questionnaire material. If the language employed in the questionnaire is excessively formal or overly scholarly, it may reject persons who lack the necessary background knowledge. Shi Lei's research highlighted the numerous problems of conducting online surveys, such as language hurdles and the impact of participants' educational backgrounds on question responses [7]. Inappropriate language and expression choices can have an impact on data representation and information quality.

The complexity of questions and duration of the survey are critical for keeping participants engaged. A questionnaire that is too lengthy or contains too many questions may cause participants to abandon it halfway through, as shown by Liu Ri's study, showing that survey design must consider the load on users and guarantee that it does not result in survey participation loss [8]. Inappropriate questionnaire design choices, such as unnecessary or long questions or too complicated alternatives,

might result in erroneous or inadequate data gathering. Jiang Liren and Du Hongbo's study suggested the use of cellphones in questionnaire surveys, which may alleviate design issues while improving data accuracy and response rates via more dynamic and engaging mobile platforms [9].

Limitations in questionnaire design influence not just data collecting but also the marketing and use of research findings. The issue for researchers is to construct a questionnaire that represents the study aims while reducing the stress on participants, ensuring that survey results accurately and thoroughly reflect people' travel habits.

2.1.5. Low Questionnaire Response Rate

Questionnaire surveys, as one of the basic travel survey methodologies, have long been an essential tool for examining citizens' travel behavior. However, this strategy has several practical obstacles, the most prominent of which being the questionnaire's overall low response rate. Li Wenping et al. found that the usefulness of statistical analysis techniques for residents' trip OD survey data is often restricted by the efficiency of questionnaire collecting [10]. The low response rate of questionnaires not only impacts the representativeness and accuracy of survey data, but it may also contribute to bias in study conclusions.

It is impossible to ensure that the questionnaire will be comprehensive and detailed. Shi Lei examined the limitations of online surveys in his research and concluded that low questionnaire response rates may result in survey results that do not fully reflect the target group's actual situation, particularly when information gaps caused by low participation of certain groups cannot be compensated for by increasing response rates [7]. Low response rates have been a source of contention due to citizens' lack of motivation to engage or flaws in the questionnaire distribution procedure.

The authenticity and quality of the survey data are impacted. According to Li Dingjie's study, poor recovery rates might cause considerable biases in data samples, reducing the dependability of survey data [11]. The fact is that when a substantial number of questionnaires are not gathered, the data received often loses statistical significance when assessing people' travel behavior patterns owing to sampling bias.

The questionnaire survey approach addresses the present issue of low involvement motivation in contemporary culture. Liu Mengqi said in her study that conventional paper-based questionnaire surveys lack appropriate incentive mechanisms to entice respondents to submit their replies, and the filling procedure is time-consuming, which is contrary to the current lifestyle of chasing high efficiency [12]. As technology advances, people's need for quick and accessible means to transmit information grows, making conventional questionnaire survey formats increasingly difficult for respondents to accept. The poor questionnaire response rate has a direct impact on the quality and reliability of residents' trip survey data. A reduced recovery rate not only affects sample representativeness, but it may also make survey research findings more difficult to accurately and thoroughly reflect people' travel habits and behavioral traits. As a result, in light of the fast growth of contemporary information, researchers must investigate new ways or tactics to enhance questionnaire response rates, assuring the quality and scientific validity of survey data.

2.2. Difficulties in Interview Investigation

2.2.1. Strong Subjectivity Issues

The qualitative research approach of interview surveys offers distinct benefits in exposing respondents' underlying travel motives, attitudes, and emotions. However, it confronts data dependability concerns due to the subjectivity of survey implementers and respondents. The interviewer's personal style, asking abilities, and even body language and exterior appearance may unintentionally influence the authenticity of the interviewee's responses. As Qian Changli and Shi Quan noted out in their study, small variations in nonverbal communication might affect the quality and substance of information supplied by respondents [13]. Subjective difficulties are an evident obstacle in interviews, and when compared to questionnaire surveys, the subjective elements are more complicated and harder to manage [14]. This necessitates interviewers' impartiality, sensitivity, and flexibility while planning and conducting interviews, assuring the reliability and usefulness of the

acquired data.

2.2.2. Information Bias Risk

Interview surveys are a frequent approach for analyzing citizens' travel habits, although information bias has long been a big concern. Both the interviewer and the interviewee may exhibit information bias, which can result in one-sided and inaccurate study findings.

From the interviewer's perspective, they may approach the research process with certain preconceived notions, which may unwittingly influence their asking style and even selectively listen to the replies. This problem was examined by Li Wenping et al. [10], who noted that in the statistical analysis of residents' travel data, researchers' subjective biases may contribute to distortion in data interpretation.

The effect of social expectations mostly reflects respondents' information bias. According to Wang Ke et al. [15], many individuals change their replies depending on what they believe to be societal expectations. They investigated Shanghai residents' outdoor activities and travel patterns and discovered that respondents are more inclined to provide "correct" or more socially acceptable replies. When it comes to personal privacy or sensitive themes, respondents may be more likely to avoid giving honest responses or supply incorrect information, raising the danger of information bias.

According to Mao Xiaowen's study, individual memory constraints may impair survey data accuracy [16]. Researchers discovered that everyone's memory and intellect are restricted, and responders may be unable to recall all facts or may forget certain vacation experiences. This artificial memory bias is mirrored in Xiao Guangnian's study on the approach for identifying residents' activity travel characteristics, since individual memory limits may impair survey data accuracy [17]. Information bias is an issue that should be avoided when using interview survey methodologies since it has a direct impact on the credibility and scientificity of study findings. To gain more trustworthy data, this risk must be carefully considered and mitigated.

2.2.3. Record Error Issues

Another major concern in interview survey methodologies is recording error, which affects both the quality of data collecting and the precision of the following data organization process. Recording errors during the interview process may be produced by a variety of circumstances, including mistakes in the interviewee's listening and explanation during the recording of replies, pen errors, or misunderstandings and omissions during note taking and recording. In the context of viewing interview and survey recordings, Liu Peng [18] said that utilizing cellphones in home visit surveys may eliminate certain human recording mistakes, but there are still numerous practical problems. For example, recording equipment might degrade recording quality owing to incorrect operation, ambient noise, or technical difficulties, introducing faults in future transcribing operations. Interviewers may miss important elements in the survey owing to time restrictions or personal bias. According to Zhang Zhihua [19] in his study, the extraction of journey information based on GPS trajectories is critical for correct data recording, emphasizing the possible influence of recording mistakes on the findings. Even after the interview, mistakes in data post-processing may occur, such as transcription problems in interview material, coding issues, or misunderstandings throughout the analytic process. This implies that recording mistakes occur not only during the on-site recording stage, but also throughout the data processing cycle. Recording mistakes are a possible danger to the accuracy of interview survey data and may occur at any level from data collecting to data processing. Evaluating and managing these flaws is critical to assuring the quality of the inquiry.

2.2.4. Psychological Pressure of Respondents

In interview surveys, respondents may feel significant pressure due to various factors, including concerns about privacy, unfamiliar interview environments, sensitivity to a particular topic, and interview methods. This pressure may affect the interviewee's response, causing intentional or unintentional distortion of information. Lu Junli's research suggests that establishing good relationships and ensuring anonymity and confidentiality before interviews can help reduce the psychological pressure on respondents and obtain more authentic information [20]. For example, a

respondent may avoid sharing their true opinions due to concerns that their answers may have a negative impact on them personally. On the other hand, the attitude and questioning style of the interviewer may also make the interviewee feel the need to answer in some expected way. This phenomenon was reflected in the research of Xie Linhua et al., which explored the impact of reducing subjectivity in interviews through the use of new technologies [21]. To reduce this pressure, interviewers need to establish good relationships before the interview, ensure that the interviewee understands the purpose of the interview, and guarantee the anonymity and confidentiality of the information provided. In addition, appropriate verbal and nonverbal communication skills are crucial for alleviating the interviewee's nervousness and strengthening trust.

2.2.5. Consideration of Resource Consumption

Interviews, being a qualitative research tool, entail a high cost for gathering detailed information. Professionals often communicate with interviewers one-on-one or in groups, which not only takes time but also demands financial assistance. From interviewer preparation to interview conduct to final transcription and analysis, all of these phases need a large investment of human and material resources. According to Xiong Zhuang's study, preparing and implementing interview surveys requires a large amount of resources [22]. Wang De et al. found that mobile signaling data, when compared to standard data gathering techniques, may enhance inquiry efficiency and coverage while reducing resources [4]. Yu Danyang et al. investigated innovative strategies of lowering interview time and expense using new technology tools in their study [23]. Based on this, interviews not only need careful planning to maximize the information value derived from resource investment, but also encourage researchers to discover and develop more efficient procedures and methods for gathering and evaluating residents' trip data. This continual innovation is not just required in academics, but is also critical for the urgent need to optimize transportation planning work in reality.

3. Limitations Analysis of Resident Travel Behavior Methods under Big Data Technology

Big data technology has enabled dramatic advances in study approaches for inhabitants' travel habits. Several major techniques of data collecting are listed below:

Mobile signaling data: Mobile signaling data is the interaction information between signal base stations and consumers acquired by mobile communication networks. This sort of data may be utilized to determine the user's travel path and location. Mobile signaling data is often utilized to build urban traffic models. As Li Zhenming et al. point out, mobile signaling data may help design more efficient traffic models and is significant in both theory and practice [24]. Similarly, Wang Dianhai et al. used Bayesian optimization approaches to mobile signaling data to increase journey chain detection and data analysis accuracy [25].

Social Media Data: Social media collects users' dynamic and geographic location information, which can be used to assess people' travel preferences and habits. For example, Ye Gui et al. employed social media text mining algorithms to examine users' low-carbon travel plans, demonstrating the utility of social media data in behavior prediction [26]. At the same time, social media data can be used to study the impact of certain events (such as "check-in" behavior while travel) on travel behavior, as Yan Yan's research demonstrates [27].

Transportation System Travel Records: These records give direct evidence for investigating the use of public transportation such as subways, buses, and taxis, as well as records of private cars entering and exiting parking lots. Jiang Baiyang investigated the shifting patterns of taxi OD (starting point to destination) network structure before and after the subway's opening, demonstrating the use of big data in the analysis of public transportation development [28].

Consumption Records of Public Service Facilities: Residents' spending habits in public places like shopping malls and movies can indirectly reflect their travel routes and goals. Lv Xiaoyong et al. applied urban network analytic methodologies to optimize service facility allocation and resident travel environments, demonstrating the importance of such data in urban planning [29].

However, the use of the aforementioned big data technologies in residential travel research is limited by a variety of variables. Legal limits on personal privacy protection and security issues with

user personal data; The collecting of these data is not always easy, and there are limitations on rights and channels. The quality of data varies frequently, and there are differences between data obtained from different sources and collection methods, posing challenges for data processing and analysis; relevant policies and technical standards are not yet complete, limiting the standardized use of data and popularization of methods. Although these data gathering approaches have played an important role in the study of residents' travel behavior, they are also confronted with obstacles such as privacy protection, data acquisition difficulty, data quality, and technical standards, all of which have emerged as hot research topics.

3.1. Difficulties in Protecting Personal Privacy

Although the study of people' travel behavior has provided numerous benefits under big data technology, it has also presented a serious issue: the protection of personal privacy. Mobile signaling data, social media information, and transportation system records may all help us better analyze and enhance urban transportation networks, but they may also mistakenly disclose users' personal information. On the one hand, experts have focused on the privacy implications surrounding mobile signaling data. For example, Li Yuqin stated that in ride-hailing services, customers' trip data often includes sensitive information, and inappropriate management may result in privacy violations [30]. On the other side, although social media sites may supply more data for travel habit study, there is a danger of privacy violations. Ma Congcong et al. found that user interactions on social media exhibit a nuanced balance between availability and privacy [31]. The collecting and analysis of transportation system data and public service usage statistics raises privacy concerns. According to Gaoxun's study, managing personal data on ride-hailing services presents a serious privacy protection difficulty [32]. According to Zhou Liangjin's study, even in railway passenger services, privacy protection remains a critical problem that must be addressed. He advises employing blockchain and distributed database technologies to improve the security of passenger information [33]. With the advancement of technology, the challenge of maintaining personal privacy has become more apparent. Wu Xiao and Chen Yutong discovered that study on the coupling assessment of travel and service facilities using mobile signals and POI data may jeopardize users' location privacy [34]. Huang Yuting and Gong Weijie's research of urban public transportation mobile phone signaling data demonstrates that privacy must be addressed while processing this data [35]. While we love the ease and efficiency that big data provides, we must acknowledge that the subject of personal privacy protection is silently growing more difficult and critical. Scholars advocate for a more robust legislative and regulatory framework, technology tools, and active stakeholder involvement to guarantee that individual privacy rights are adequately respected while evaluating people' travel activity.

3.2. Difficult to Obtain Data

Although big data technology offers researchers with a wealth of data sources for assessing inhabitants' travel habits, data collecting remains a significant challenge. Despite ongoing advancements in technique, data collection is subject to a number of constraints that limit the scope and depth of study on citizens' travel. The data used to analyze residents' movement via mobile signals is often maintained by communication firms and is difficult to get owing to trade secrets and user privacy concerns. Jiang Yuzhou and colleagues conducted their study using mobile signaling data gathered via collaboration with operators, although this collaboration is difficult and not possible for other researchers [36]. Furthermore, while researching the travel characteristics of the Guangzhou metropolitan region, Li Jinpei and others emphasized the difficulties in gathering data and the necessity to deal with several legal and technological concerns throughout the collecting process [37]. Although data on social media sites seems to be simple to get, acquiring precise user travel data is difficult owing to platform policy limits and user privacy issues. According to Ping Lijun's study, although visual analysis of traffic data may be performed by merging social media, data privacy and security concerns are barriers to data collection [38]. To obtain transportation system trip information, particularly public transportation data, researchers often need permission from the government or appropriate institutions. Wang Kuang highlighted in his study the data identification of public transportation commuting groups, however acquiring official data often necessitates overcoming

significant administrative impediments [39]. Guo Bao's study included behavioral analysis and prediction of subway passenger journey, and obtaining this data often requires close collaboration with subway management departments [40]. Consumption records of public service facilities, such as shopping malls, are often private data, and each private firm has the freedom to choose whether and how to disclose their information. This demonstrates that getting such data requires not only the removal of legal and regulatory impediments, but also the negotiation of business interests in collaboration with firms. The difficulty in getting data is a significant restriction when investigating inhabitants' travel habits using big data technologies. Obtaining trustworthy data requires overcoming several difficulties such as business secrecy, privacy protection, laws, and regulations, all of which have a direct impact on the quality and efficacy of research.

3.3. The Data Quality Varies Greatly

Big data has provided plentiful resources for studying inhabitants' travel behavior, however variation in data quality has become a serious barrier. Inaccurate and incomplete data, as well as variances in data gathering procedures, may all have an influence on analysis outcomes, reducing the study's efficacy and accuracy. Although mobile signaling data may give a wealth of user trajectory information, it is impacted by a number of variables, including hardware devices, signal coverage, and user activity. In their study of the spatiotemporal features of small city inhabitants' travel, Zhao Pengjun and colleagues found that the coverage and quality of mobile signaling data had a direct impact on the accuracy of spatiotemporal feature analysis [41]. Tian Zhao and Zhang Qianzhong discovered that the data cleaning and processing steps had a substantial influence on the final findings when extracting the dynamic OD matrix of urban dwellers [42]. The validity of data used on social media is an inescapable concern. Chen Zishuai said in his examination of the significance of social media intelligence that, although data is simple to access, its reliability and accuracy are often influenced by user behavior, and the presence of misleading information cannot be overlooked [43]. Furthermore, Jinhua Hao and Cairang Zhuoma underlined in their investigation of the influence of user IP locale that the anonymity of social media and the complexity of user activity patterns result in inconsistent data quality [44]. Although transportation system data is official and looks to be credible, there are several difficulties with its quality. Wang Zheng discovered in his study on the variables influencing taxi and subway travel that variations in data sources influence the evaluation of competitive relationships [45]. Zhu Kangli discovered that time delays and inadequate data make identification techniques and behavior complexity analysis more challenging when analyzing urban rail transit group travel. The study's data sources are diverse, including mobile signals, social media, transit systems, and public service usage records; nonetheless, their unequal quality may restrict the research's usefulness. The inaccuracy, incompleteness, and discrepancies in data gathering techniques need careful processing prior to analysis, increasing the complexity and expense of study.

3.4. Limited Data Processing and Analysis Capabilities

Big data technology offers an abundance of data resources for examining inhabitants' travel habits. However, the capacity to handle and analyze data is limited, whether at the hardware or software level, or in terms of talent development. This has an impact not just on data processing speed, but also on the ability to conduct in-depth analyses. The capacity to handle and evaluate data has been tested in a variety of ways. Big data technology offers an abundance of data resources for researching inhabitants' travel habits. However, there are constraints on the capacity to handle and analyze data, whether at the hardware or software level, or in terms of talent development. This has an impact not just on data processing speed but also on the ability to conduct in-depth data analysis. The capacity to handle and evaluate data has been tested in a variety of ways. At the software level, Gao's research demonstrates that the study of developing transportation modes lacks mature and professional analytical tools, limiting the capacity to extract useful information from data [49]. Zhang Yimu and colleagues encountered the problem of data fusion and processing while building a multimodal public transportation journey chain [50]. The creation and optimization of professional software is critical to accomplishing successful data processing. Talent development is critical to the capacity to process and analyze data. According to Wu Jiaorong et al.'s paper in the Comprehensive Transportation

Journal, interpreting complicated data demands professional abilities with a combination of data science and transportation engineering skills [51]. Wang Xiao discovered that data analysis demands excellent abilities and professional knowledge when researching the supply and utilization of public service facilities for migrant workers in major cities [52]. Data processing and analysis skills are limited in terms of computer resources, software tools, and talent development, posing considerable difficulties to research on resident travel. As a result, despite the growing volume of data, successfully employing this data to derive meaningful insights into behavioral research is far from straightforward. Researchers must always strive at these three levels to improve their overall data processing and analysis skills.

3.5. Lack of Policies and Technical Standards

Although big data technology has great potential in promoting research on residents' travel behavior, its practical application is often constrained by the lack of policies, regulations, and technical standards. On the one hand, this is reflected in the lack of standardization in data collection, storage, and sharing, and on the other hand, the lack of unified standards for technological applications has constrained the promotion and application of big data technology. The formulation of policies and regulations often lags behind the speed of technological development. Ni Lu's research shows that although public service facility data is of great significance for travel and planning, the collection and use of relevant data often lack clear policy guidance [53]. This latency not only reduces data quality and reliability, but it may also result in legal conflicts over privacy protection. The absence of technological standards will reduce data interoperability and comparability. Liu Ye et al.'s research on the spatiotemporal features of residents' mobility in smart city application scenarios found that the absence of a uniform data processing and analysis framework impedes the capacity to extract useful information from mobile signaling data [54]. When examining the travel characteristics of major comprehensive retail malls in Changchun, Guo Chuang and colleagues discovered that without a consistent data standard, it is impossible to properly combine data from various sources and kinds [55]. Due to a lack of defined technological standards, solutions established by various academics and organizations are sometimes difficult to generalize. When examining the activity travel characteristics of urban public transportation passengers, Zhou Hang must utilize data from many sources, but owing to the absence of a consistent data sharing method, he has data gathering challenges [56]. The absence of rules and technological standards not only restricts the range and depth of big data applications, but also adds complexity to data processing, impeding the advancement of research on residents' travel behavior. It is critical to develop industry standards, boost data exchange, and increase policy openness. On this premise, research into people' mobility patterns may better exploit the potential of big data technology and propel the development of smart city building to new heights.

Big data technology has transformed the study of inhabitants' travel behavior, increasing the depth and breadth of research, but its use is also fraught with substantial limits. First, the subject of personal privacy protection has gained prominence. Big data research requires a great quantity of sensitive information and misusing it may lead to privacy breaches. Second, there are several barriers to data collection, including trade secrets, user privacy protection, and collaboration channels, which make it difficult for researchers to get in-depth access to critical data sources. Third, data quality varies widely, and errors, incompleteness, and variances in collecting techniques may all contribute to erroneous analytic conclusions, creating extra cleaning and processing issues for researchers. Fourth, restricted data processing and analysis skills, which include constraints in computer resources, software tools, and talent development, limit the capacity to extract useful information from enormous volumes of complicated data. Finally, the lack of regulations and technological standards restricts the range and depth of big data applications, while the absence of a single data processing framework and sharing mechanism complicates data processing. These issues impose major limits on residents' travel research and must be addressed via the creation of legal and regulatory frameworks, technical improvements, and cross-border collaboration methods. The accuracy and efficacy of monitoring inhabitants' travel behavior can be ensured, and the potential of big data technology can be fully realized to encourage the development of smart cities.

4. Analysis of the Advantages of Video Capture Methods for Residents' Travel Behavior in Public Areas

In the course of researching the development of smart cities, the technique of collecting inhabitants' travel behavior via public area video has attracted considerable attention as an essential means of data collection. This approach has become an essential component of urban planning and management owing to its major benefits in privacy protection, data accuracy, economics, time efficiency, monitoring range, and flexibility. Researchers can effectively capture and analyze residents' travel habits and behavior patterns by installing camera systems in public spaces and combining them with advanced video analysis technology, providing solid data support for developing more reasonable transportation policies and optimizing urban public services. Next, we will go over each of the five primary benefits of this strategy in detail, gaining a complete understanding of its importance in present and future urban development.

4.1. Not Infringing on Citizens' Personal Privacy

With the advancement of intelligent monitoring technologies, video surveillance in public places has become an essential tool for researching inhabitants' travel habits. A crucial benefit is its extraordinary validity in preserving residents' personal privacy. According to the GB 37300-2018 standard, the collecting of video image information in critical public spaces must conform with applicable national laws and regulations to guarantee that people' personal privacy is not violated [57].

He Jianxin's study found that while constructing public area video surveillance platforms, it is important to consider addressing public safety demands, preventing the gathering and analysis of personal identity information, and assuring the legality of monitoring operations. Meanwhile, Zhou Mingzheng et al.'s study proposes that the design of motion target tracking systems should prioritize public safety while adequately constraining data usage [59].

Liu Yupeng emphasized in her research on the recognition technology of dangerous behaviors in monitoring areas that by processing monitoring videos with efficient algorithms, targeted behavior features can be extracted without infringing on personal privacy, providing a scientific basis for the prudent use of monitoring technology [60]. Li Yuqin's research on the travel behavior of ride hailing customers based on the privacy paradox stressed the necessity of personal privacy protection, making a compelling argument for balancing reasonable surveillance and personal privacy protection [61].

During the discussion about the design and research of a public area video surveillance sharing platform, Zhu Yue and Jiang Ling proposed the design principle of respecting residents' privacy, emphasizing the importance of secure information sharing between monitoring units while strictly controlling access permissions to prevent privacy leakage [62]. In his study on the preservation of personal privacy rights under public video surveillance, Zhang Zexin found that the collection and processing of monitoring data linked to personal privacy rights must adhere to legal laws and address privacy concerns sensitively [63].

The benefits of video capturing residents' travel behavior in public areas include the guarantee of legality without infringing on citizens' personal privacy rights; the design principle of technology respects privacy; and the monitoring platform's standardized management measures ensure the security of personal data. These features, taken together, guarantee that the video capturing technique in public spaces not only provides successful urban management, but also respects residents' private rights, representing the notion of merging current surveillance technology with ethical principles.

4.2. Accurate and Objective Data

The technology of video recording people' travel behavior in public places has become an essential instrument in urban planning and traffic management research because it delivers extremely accurate and impartial information. This technology uses a camera system to continually monitor and record the circumstances of public spaces around the clock, resulting in a vast quantity of useful data.

As Ding Shuozhi said, video data gathering may be utilized to analyze the behavior patterns of public green spaces and landscapes, precisely portraying crowd behaviors at various times and spatial layouts [64]. Yongjian said in his study that video footage acquired by public welfare cameras may

supply a big quantity of reliable data for urban safety and resident behavior while protecting personal rights, allowing urban management agencies to make more scientific judgments [65].

Sun Xuexue stated that video surveillance, as a data source, can accurately represent inhabitants' use behavior and network demands, driving wireless network optimization and implementation [66]. When addressing the design of a public area safety video surveillance system, Chen Suhong emphasized the need of reliable data in enhancing the monitoring system. The dynamic data produced by the surveillance system may help to avoid and manage a variety of security threats [67].

Zhang Quan and others have validated the objectivity of video data. In the course of analyzing target tracking in public area surveillance video data, they discovered that video data may better represent dynamic changes in the surveillance scene than manually collected data [68]. In his study, Lin Yao also underlined the need of striking a balance between data objectivity and privacy protection in public video surveillance, stating that a solid privacy protection system must be established while maintaining data objectivity [69].

This method collects data without requiring individual participation, reduces the interference of individual bias, and can capture details that individual data collection cannot, such as behavior patterns in densely populated areas and travel characteristics over specific time periods. This technology offers significant data support for scientific and improved city administration and planning, both in theory and practice. With the advent of smart cities, the technology of video capture in public places will become more frequently used to study residents' daily travel behavior, consequently boosting the development of different elements such as urban safety, convenience, and comfort.

4.3. Low Demand for Funding

Because of its cheap cost, video capturing in public locations is commonly used in urban management and resident mobility research. This strategy provides considerable cost benefits over other ways of data collecting.

It lowers the cost of infrastructure building and maintenance. Unlike data gathering techniques that need costly equipment such as high-altitude cranes, video capture methods in public spaces often simply involve the deployment of cameras at important places, resulting in significant resource savings. For example, Chen Lu said in her study that complicated behavior monitoring may be accomplished with conventional security cameras without the need for extra costly equipment support [70].

Furthermore, the video surveillance system is simple to setup and use. When addressing privacy difficulties under private video monitoring, Gao Zhongshao not only focused on privacy protection measures, but also implicitly highlighted the relative ease of implementing public surveillance systems [71]. According to Gaoxun's study on privacy data management of ride hailing services, camera systems have cheaper deployment and operating costs than other pricey data gathering technologies [72].

The video surveillance system is very simple to set up and use. In addition to paying attention to privacy protection measures, Gao Zhongshao subtly brought up the relative ease of implementing public surveillance systems while talking about privacy concerns under private video monitoring [71]. In his study on ride-hailing services' privacy data management, Gaoxun noted that camera systems are less expensive to implement and operate than other costly data gathering technologies [72].

In the "Evaluation Indicators for National New Smart Cities (2016 Edition)", it is also emphasized that public safety video surveillance plays an important role as an indicator, and its implementation cost is more controllable compared to other technologies, thus occupying an advantage in the construction of smart cities [75]. When discussing how public safety video surveillance can assist in the construction of smart cities, Yu Wei and Ma Jingyu also pointed out the economic benefits brought by networked applications [76].

Due to its high cost-effectiveness and minimal financing needs, the technique of filming in public spaces has shown considerable promise in the development of smart cities and the study of citizens' movement patterns. Because of the single point camera and easy installation procedure, this approach

not only successfully lowers the project's original expenditure but also lowers ongoing operating and maintenance expenses. Because of this, public area video surveillance is a crucial tool for raising the standard of living for locals and increasing the effectiveness of urban administration.

4.4. Short Consumption Time

There are many time-saving benefits to installing video recording devices in public spaces to gather information on locals' travel habits. Relevant study indicates that whereas conventional manual surveys or questionnaire surveys are inefficient and time-consuming, video surveillance systems are able to record a significant quantity of trip information in real time.

In contrast to traditional data collection methods, Jiang Yuanyi noted in her research on the collection and application of big data on the travel behavior of urban residents in China that video collection can monitor travel behavior continuously and in real time, meaning that this technology can collect more dimensions of data simultaneously [77]. In addition to eliminating the need for lengthy field research projects, video collection may concentrate on gathering data at certain times, such on a particular day. This significantly increases the efficiency of data collection. According to Zhang Xiaojia's study, a significant quantity of real-time data support is often needed for simulation-based passenger flow distribution status prediction in urban rail transportation. This need may be satisfied and the study cycle shortened by using the high-frequency data that video capture provides [78]. Urban traffic conditions may be predicted more rapidly thanks to video capture, which makes it possible to swiftly enter the data into the model for analysis.

In their study on visually impaired people's journey, Li Junhua and Wu Hongxia noted that video recording not only reduces the amount of time needed to gather data, but it also precisely captures the unique behavioral traits of the group in question [79]. In travel behavior research, this benefit illustrates the double benefits of time efficiency and data accuracy in video capturing for certain populations.

Video surveillance systems are not only quick but also seamlessly connected, offering continuous data for public transportation analysis without data breakpoints that may occur with manual methods, according to Wu Xiangguo's article on the derivation and application of residents' public transportation OD matrix based on public transportation IC cards and GPS data [80].

Traditional human resource surveys, on the other hand, take a substantial amount of time to create questionnaires, train survey people, perform on-site investigations, and enter data, while video capture eliminates these time-consuming procedures and allows for the simple and direct collection of necessary information. As a result, using public area cams to capture inhabitants' travel activity provides considerable time efficiency benefits.

The time-saving benefits of video capture of residents' travel behavior in public spaces are represented in real-time and high-frequency data collecting capabilities, as well as accuracy and continuity in particular demographic studies. These features are crucial for immediately assessing and adjusting to urban traffic dynamics.

4.5. Wide Monitoring Range and Strong Flexibility

Public area video capture has exhibited unique benefits in the field of studying people' travel behavior, particularly in terms of extensive monitoring range and flexible deployment, making it a significant means of information collection. Here are some researchers' perspectives and research findings to support this advantage in this field.

Chen Tingzhao et al.'s study, based on Wi Fi probe data analysis of traffic behavior characteristics, demonstrates the flexibility of video surveillance in changing urban contexts. This indicates that video surveillance equipment may be used effectively to gather data in a variety of public settings [81].

Rapid deployment and information acquisition. In his study on predicting public transportation commuting behavior using individual travel graphs, Liang Quan stated that video surveillance systems can be quickly deployed and provide real-time information, emphasizing the importance of quickly obtaining and updating information in dynamic urban environments. This is especially evident in the area of video surveillance, where cameras may be very simple to install and relocate to fulfill varying monitoring requirements [82].

Zhang Jing's study on the administration of video security monitoring systems in public libraries

reveals the benefits of video surveillance in terms of monitoring range, since it can cover both interior and outdoor areas. This is not just true for outdoor places; video surveillance systems may also improve safety and service quality in inside public locations [83].

Strengthening security through collaborative monitoring, Zhang Xiaoyuan's research on algorithms for detecting and recognizing abnormal human behavior in public areas emphasizes the use of video surveillance in security, which can be used to prevent and respond to potentially dangerous situations in public areas, thus protecting public safety [84].

Luo Chen and coworkers developed an integrated system for smart cities that used video surveillance data as one of the analytical tools for assessing citizens' mobility decisions during public health crises. This method's flexible deployment performance, when paired with other smart city components, has made it part of a larger smart city solution [85].

Video capture in public spaces not only covers a broad range of monitoring locations, but it also exhibits great adaptability in a variety of circumstances, successfully reacting to complex and evolving urban demands. The quick deployment, effective operation, and strong monitoring capabilities of video surveillance technology have significantly enhanced the quality and efficiency of public area management, resulting in positive changes and growth in contemporary urban life.

Video capture technology in public spaces has shown considerable benefits in the research of residents' travel behavior, as indicated in the following aspects:

For starters, it outperforms other systems in terms of privacy protection. Compared to data collecting using personal devices, public video surveillance systems are regarded lawful in most countries, concentrating on public safety and management while decreasing the chance of personal privacy violations. Being able to do behavior analysis without gathering any personal data while adhering to laws, regulations, and technological safeguards.

Second, video data's exceptional precision and neutrality make it an excellent basis for analysis. The monitoring system can continually and in real time capture the dynamics of public spaces, delivering a huge quantity of accurate and timely data for assessing crowd flow, movement patterns, and emergency evacuation behaviors.

Third, video monitoring in public places provides huge cost benefits. When compared to other data gathering technologies, it has a cheaper initial facility investment, reduced installation and maintenance costs, and clear economic advantages in long-term maintenance and data processing.

Fourth, video capture systems provide time efficiency benefits because they can efficiently gather huge volumes of data while reducing the time required for data preparation and analysis. This improves the speed of data processing, making research more efficient and real-time.

Finally, video surveillance systems have a vast coverage area, allowing them to continually monitor residents' movement behavior in huge regions while also dynamically adjusting and responding to particular times and events, giving comprehensive and thorough data analysis assistance.

Video recording of citizens' travel behavior in public spaces is an efficient, low-cost, accurate, and adaptable way of data collecting for urban management and transportation planning. Its non-invasive nature and broad application make it an essential component in the creation of "smart cities".

5. Conclusion

The selection and optimization of methodologies for studying people' travel behavior is critical for the scientific development of transportation planning, urban management, and even socioeconomic policy. Although conventional approaches have played an essential role throughout history, their limits have become more evident. Big data technology has broken past the breadth and depth bottlenecks of old methodologies, generating new concepts for travel behavior research. However, the limitations of privacy protection, data collecting, and processing capacities urgently need improvement. The technique of video capture in public places, with its distinct benefits in terms of privacy protection, data quality, economy, and flexibility, has emerged as an essential adjunct to the research of travel behavior in smart cities. In the future, researchers will need to integrate the benefits of old and new technology to create a complete and multidimensional data collecting and analysis

system. Simultaneously, by improving laws and regulations and unifying technological standards, greater assurances will be offered for data applications, boosting the long-term growth of urban transportation and service systems.

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