Research Report

Prepared for: Integrated Travel

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Integrated Travel Research and Development Team TransCAD Research Project

Title: Leveraging TransCAD Modeling for Sustainable Transportation: YYC (Calgary) – YEG (Edmonton)

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Executive Summary

This project research was planned with the broad objective to establish the value of TransCAD transportation models and make the case for its adoption in the cities of Calgary and Edmonton to help model a scenario in which high speed rail transit (HSRR) and express bus service is incorporated. It is focused on enhancing transportation systems in Calgary and Edmonton.

Project Scope: Incorporate high-speed rail and express bus services into existing transportation models to improve traffic flow, reduce maintenance costs, enhance safety, and minimize environmental impacts.

Anticipated Benefits: The incorporation of this scenario will determine but is not limited to the following reductions: traffic volumes, roadway maintenance costs, collisions, and fatalities, ghgs and other pollutants, and petroleum.

Abstract

This report presents a comprehensive examination of the application of TransCAD transportation models in the context of sustainable urban transportation planning within the cities of Calgary and Edmonton, Alberta. Employing a qualitative systematic review methodology, the study examined the significance of TransCAD modeling for promoting environmental sustainability, reviewed global studies on TransCAD usage, identified best practices from TransCAD models and advocates for enhanced knowledge sharing among major transit authorities in Alberta. Furthermore, this investigation evaluated the feasibility of integrating TransCAD models into the transportation infrastructure frameworks of Calgary and Edmonton, with particular emphasis on the seamless incorporation of high-speed rail transit (HSRR) and express bus services. Through an extensive analysis of scholarly works, case studies, and industry perspectives, the review explored the benefits of TransCAD modeling, including its capacity to facilitate informed decision-making processes, optimize transportation systems, and mitigate environmental impacts. Findings revealed the considerable potential of TransCAD models in advancing environmental sustainability, advocates for their widespread adoption and offers recommendations for enhancing TransCAD adoption in implementing high-speed rail transit (HSRR) and express bus service in Calgary and Edmonton.

Keywords: TransCAD, transportation modeling, sustainable development, environmental sustainability, high-speed rail transit, express bus service, Calgary, Edmonton, Alberta

Chapter One: Introduction

1.1 Background

Transportation plays a crucial role in in the global economy, facilitating the movement of people and goods across various regions. Worldwide, there are growing concerns over the challenges posed by rapid urbanization, population growth, traffic congestion and environmental degradation. In this regard, advanced transportation modeling tools such as TransCAD have gained prominence in urban planning practices as essential for addressing these challenges by enabling evidence-based decision-making and optimizing transportation systems and planning.

In today's interconnected world, efficient transportation systems are fundamental for economic growth, social connectivity, and environmental sustainability. TransCAD modeling stands out as a potent tool offering sophisticated analytical capabilities to address complex transportation challenges. TransCAD is a specialized Geographic Information System (GIS) software designed specifically for transportation planning, modeling, and analysis. Its versatility and adaptability makes it cornerstone in the development of sustainable transportation systems. It enables planners and policymakers to simulate, analyze, and optimize transportation networks. From urban transit planning to freight logistics optimization, TransCAD offers a versatile platform for tackling transportation challenges.

This report explores the use of TransCAD modeling in transportation worldwide, with a specific focus on its potential application in the cities of Calgary and Edmonton.

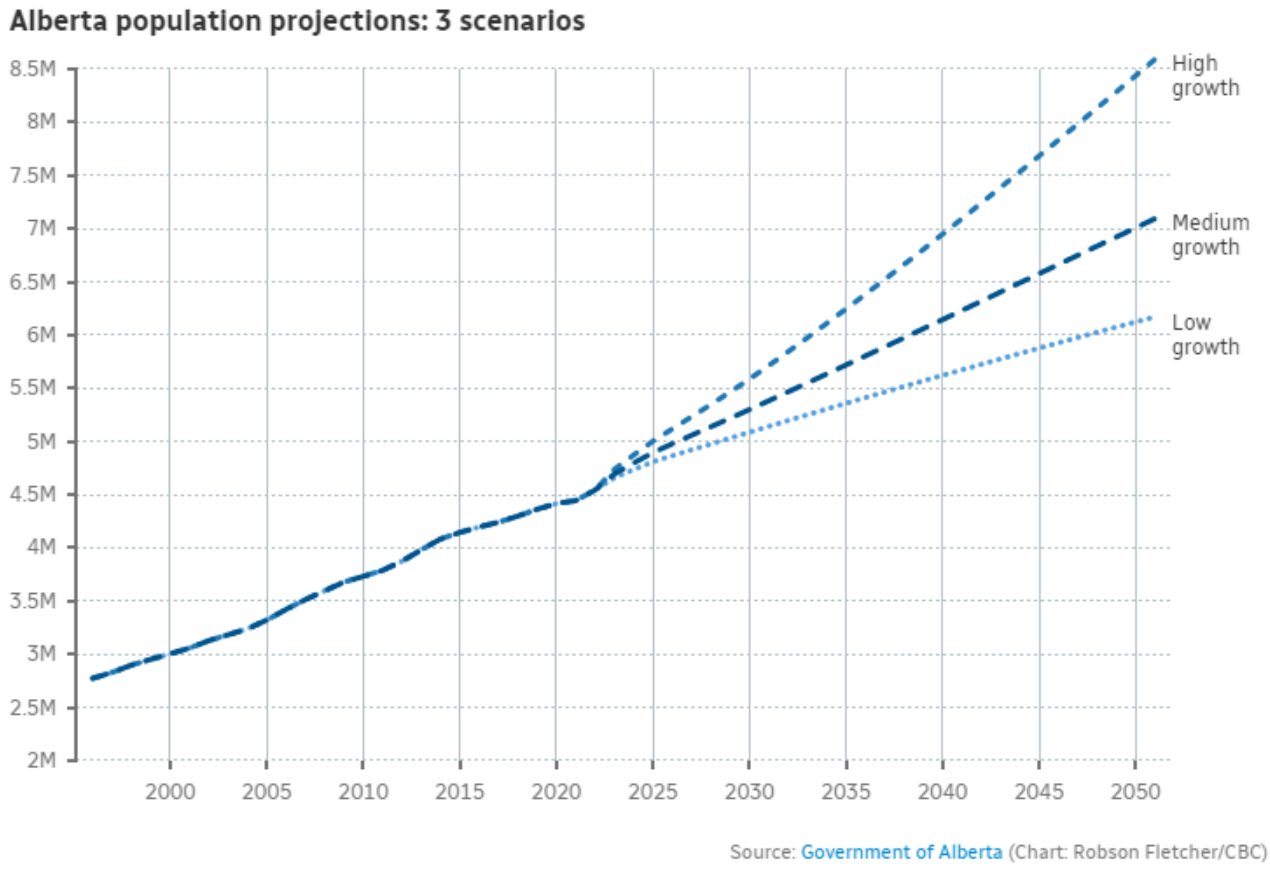
1.2 Problem Statement

Calgary and Edmonton, the two largest cities in Alberta, Canada, have experienced rapid population growth and urbanization in recent years. With populations of approximately 1.6 million and 1.2 million, respectively, these cities are facing significant challenges related to transportation and mobility. (Statistics Canada, 2021). The rapid population growth, coupled with increasing urbanization, has put pressure on existing transportation infrastructure and exacerbated issues such as traffic congestion, air pollution, carbon emissions and inefficient transportation systems.

Addressing these challenges requires innovative approaches to urban transportation planning that prioritize sustainability, efficiency, and resilience.

According to the Government of Alberta Population Projections, 2023-2051, the Edmonton-Calgary corridor accounts for six per cent of Alberta's land area, but is home to nearly 78 per cent of the population, making it "the most urbanized area of the province." By 2051, it's expected that 81 per cent of Albertans will live within the corridor.

In this context, there is a pressing need to leverage innovative tools like TransCAD to address these challenges and transition towards more sustainable transportation systems. Despite the potential benefits of TransCAD modeling in urban planning, its adoption in cities like Calgary and Edmonton remains limited.



1.3 Research Objectives

This research project aims to achieve the following specific objectives:

1. Explore the importance of TransCAD modeling and its benefits for environmental sustainability in urban transportation planning.
2. Review existing research studies on TransCAD usage globally to identify trends, challenges, and opportunities.
3. Identify best practices based on existing TransCAD models implemented in different urban settings worldwide.
4. Advocate for better information sharing among major transit authorities in Alberta to facilitate knowledge exchange and collaborative transportation planning efforts.
5. Provide recommendations for incorporating high-speed rail transit (HSRR) and express bus service into the transportation networks of Calgary and Edmonton using TransCAD.

Chapter Two: Methodology

2.1 Qualitative Systematic Review

A qualitative systematic review methodology was employed to achieve the research objectives. This involved the systematic selection, collection, and analysis of relevant literature on TransCAD modeling and urban transportation planning, and synthesizing the findings from relevant studies and reports.

2.2 Selection Criteria

The selection criteria for identifying relevant studies included publication year, geographic scope, research methodology, and relevance to the research objectives. Studies meeting these criteria were included in the review.

2.3 Data Collection

Comprehensive searches were conducted across academic databases, journals, conference proceedings, and grey literature repositories to identify relevant studies and reports on TransCAD usage and urban transportation planning. Primary data was collected through a systematic search of electronic databases, including but not limited to Research Gate, Academia.edu, Web of Science, and Google Scholar. Keywords such as "TransCAD," "transportation modeling," "urban planning," and "sustainability" was used to identify relevant articles and reports.

2.4 Data Analysis

The collected data were systematically analyzed to extract key insights, trends, and findings related to TransCAD modeling, best practices, and opportunities in urban transportation planning. This involved synthesizing the information from diverse sources to develop a comprehensive understanding of the research landscape and identify actionable recommendations. The collected data was analyzed using thematic analysis techniques to identify recurring themes, patterns, and insights related to TransCAD modeling and its relevance in urban planning. The findings were synthesized to address the specific objectives of the study and draw meaningful conclusions.

Chapter Three: Literature Review

The literature review explored the role of TransCAD modeling in urban transportation planning. It reviewed global studies on TransCAD usage to identify successful applications, challenges, and emerging trends. Additionally, it delved into the significance of TransCAD modeling for promoting environmental sustainability by facilitating informed decision-making, optimizing transportation systems, and reducing greenhouse gas emissions. Finally, the impacts and benefits from existing TransCAD models worldwide were analyzed, providing valuable insights.

3.1 Global Adoption of TransCAD Modeling

TransCAD has gained widespread adoption across the globe, with several countries leveraging its capabilities to address their unique transportation challenges. Key countries leading global innovations in TransCAD modeling include:

3.1.1 North America

As the birthplace of TransCAD, the United States boasts widespread adoption. Agencies like the Federal Highway Administration (FHWA), in collaboration with state departments of transportation (DOTs), metropolitan planning organizations (MPOs), consulting firms and academic institutions, drive advancements in TransCAD modeling techniques and applications. Cities like New York, Los Angeles, and Chicago rely on TransCAD to analyze traffic flows, optimize transit routes, and evaluate infrastructure investments. Leading research institutions like the Massachusetts Institute of Technology (MIT) and University of California, Berkeley, also contribute to advancing TransCAD modeling techniques.

Case Study: California Department of Transportation (Caltrans) - Caltrans employs TransCAD to conduct corridor studies, assess environmental impacts, and forecast future travel demand, aiding in the prioritization of transportation projects statewide.

However, O'Toole (2021) argues that high speed rail is a costly, inefficient, and outdated transportation solution for the United States, and pursuing such projects may lead to economic burdens and corruption without delivering the promised benefits.

In Canada, TransCAD is widely used by municipal, provincial, and federal agencies to address transportation challenges across vast and diverse regions. Cities such as Toronto, Vancouver, and Montreal leverage TransCAD for transit planning, traffic management, and land use integration.

TransCAD's ability to model multi-modal networks and analyze transit ridership has been particularly beneficial in Canadian metropolitan areas.

Canadian researchers contribute to advancing TransCAD's capabilities through academic collaborations and applied research projects. According to High Speed Rail Canada, "since 1985, there have been 8 completed high-speed rail studies conducted as partnerships proposing a high-speed rail corridor between Calgary and Edmonton. Yet, the longer they wait to implement HSR the more difficult and expensive it has become."

TransPod Inc., in collaboration with the European Union and the United States transportation departments, has designed a high speed electric train called TransPod that utilizes aerospace engineering for enhanced safety and efficiency and is proposed to run on the Edmonton Calgary corridor with a stop at Red Deer. With a cost of approximately $90 per trip between cities, it would take people from Calgary to Edmonton in 45 minutes. The train project is privately funded and estimated at $18 billion US or $22 billion in Canadian dollars. (Transpod, 2021)

3.1.2 Asia-Pacific

Rapid urbanization and burgeoning populations in Asian cities have spurred the adoption of TransCAD modeling for mega-city transportation planning, high-speed rail network optimization, and last-mile connectivity solutions. Asian cities face unique challenges such as traffic congestion and air pollution, which TransCAD helps address through data-driven decision-making. Government agencies, urban planners, and engineering firms in countries like China, India, Japan and Singapore rely on TransCAD to forecast travel demand, design transit-oriented developments, and optimize freight distribution networks. Mega-cities like Tokyo and Shanghai utilize TransCAD to optimize public transit systems, mitigate traffic congestion, and improve air quality.

Case Study: Singapore Land Transport Authority (LTA) - LTA utilizes TransCAD to support the planning and development of Singapore's integrated transportation system, including the planning of new metro lines, optimization of bus routes, and analysis of congestion pricing schemes to manage urban traffic flows efficiently.

According to Nunno (2018), Japan is a global leader in high-speed rail transportation and its high-speed rail network, known as the Shinkansen or "bullet train", remains one of the most

extensive and advanced in the world. The network consists of multiple lines connecting 22 major cities across the country's main islands of Honshu, Kyushu, and Hokkaido. Renowned as the busiest high-speed rail service globally, it accommodates over 420,000 passengers on an average weekday. Operating at speeds of up to 320 km/h (200 mph), the Shinkansen has maintained an impeccable safety record over its 50-year history, with no passenger fatalities or injuries resulting from accidents.

As China undergoes rapid urbanization and transportation modernization, TransCAD has gained prominence in urban planning and transit system design. Chinese cities like Beijing, Shanghai, and Guangzhou utilize TransCAD for traffic management, public transit planning, and land use integration, contributing to the development of sustainable urban environments.

3.1.3 Europe

European transportation agencies and research institutions utilize TransCAD to analyze modal shifts, improve intermodal connectivity, and enhance the resilience of transportation systems. Countries like Germany, the United Kingdom, and France have integrated TransCAD into their transportation planning frameworks. European cities leverage TransCAD for multimodal transportation planning, including public transit scheduling, bicycle network design, and pedestrian safety analysis. The European Union's emphasis on sustainable mobility aligns well with TransCAD's capabilities in promoting eco-friendly transportation solutions.

Case Study: Transport for London (TFL) - TFL utilizes TransCAD to support strategic planning initiatives, optimize bus routes, and enhance the accessibility of public transit services across the Greater London area, contributing to the efficiency of one of the world's largest urban transportation networks.

Local authorities across England, Scotland, Wales, and Northern Ireland employ TransCAD for strategic transport planning and congestion management.

Germany is renowned for its robust transportation infrastructure and engineering expertise and German cities like Berlin, Munich, and Hamburg extensively use TransCAD for transportation planning at regional and national levels.

3.1.4 Latin America

Latin American countries are increasingly turning to TransCAD for addressing urban mobility challenges. Cities like São Paulo, Mexico City, and Bogotá that grapple with issues such as traffic congestion, inadequate public transit, and urban sprawl use TransCAD to develop integrated transportation systems, optimize bus rapid transit (BRT) corridors, and mitigate traffic congestion.

Brazilian cities such as São Paulo, Rio de Janeiro, and Brasília utilize TransCAD for addressing traffic congestion, optimizing bus routes, and planning integrated transit systems. The software's capabilities in demand modeling and spatial analysis have been crucial in supporting Brazil's efforts to enhance urban mobility and accessibility.

Case Study: Mexico City, one of the largest urban centers in the world, relies on TransCAD for transit planning, congestion management, and infrastructure development. The software's integration with GIS data allows transportation planners in Mexico to visualize and analyze complex urban environments, leading to more informed decision-making.

3.1.5 Australia

In Australia, TransCAD plays a vital role in addressing the transportation needs of rapidly growing cities and remote regions. With its vast geographical expanse and diverse urban environments, municipalities such as Sydney, Melbourne, and Brisbane use TransCAD to forecast travel demand, analyze modal split, and develop integrated transport strategies. Australian transport agencies leverage TransCAD for freight planning, public transport optimization, and environmental impact assessment.

3.2 Key Innovations of TransCAD Modeling for Environmental Sustainability

TransCAD modeling promotes sustainability by facilitating informed decision-making, reducing greenhouse gas emissions, mitigating traffic congestion, and enhancing the efficiency of transportation systems. The global landscape of TransCAD modeling continues to evolve with ongoing innovations and emerging trends. Some notable developments include:

3.2.1 Integration of Big Data

Transportation planners increasingly harness big data sources, such as GPS traces, mobile phone data, and social media feeds, to enrich TransCAD models with real-time insights on travel patterns and behavior. Advanced analytics techniques, including machine learning and predictive modeling, enhance the accuracy and reliability of transportation forecasts.

3.2.2 Resilience and Climate Adaptation

Transportation planners are increasingly incorporating resilience and climate adaptation considerations into TransCAD models to address the impacts of extreme weather events, sea-level rise, and other climate-related challenges. Scenario-based modeling helps assess the vulnerability of transportation networks and identify adaptive strategies to enhance system robustness and sustainability

3.2.3 Multimodal Transportation Planning

TransCAD enables multimodal transportation planning by integrating various modes of transportation, including roadways, railways, waterways, and air transport. This holistic approach allows planners to assess the impact of transportation policies on different modes, promoting efficient resource allocation, seamless connectivity, and intermodal transfers.

3.2.4 Dynamic Traffic Assignment

Dynamic traffic assignment (DTA) is a critical feature of TransCAD that simulates real-time traffic flows and congestion patterns. By modeling traveler behavior and network dynamics, DTA helps optimize traffic signal timing, manage incident response, and improve travel time reliability. This capability is invaluable for addressing congestion hotspots and enhancing the overall performance of transportation networks.

3.2.5 Environmental Impact Assessment

TransCAD's GIS capabilities enable spatial analysis and visualization of transportation data. TransCAD can assess the environmental impact of transportation projects by modeling vehicle emissions, energy consumption, and pollutant levels. This capability supports sustainability initiatives by identifying opportunities to reduce carbon emissions, mitigate air pollution, and promote eco-friendly transportation solutions.

3.2.6 Transit Accessibility Analysis

There is a growing emphasis on accessibility-based planning approaches that prioritize equitable access to essential services, employment opportunities, and recreational facilities. TransCAD facilitates accessibility analysis by evaluating the spatial distribution of transit stops, service frequencies, and travel times across different geographic areas. This analysis aids in identifying underserved communities, optimizing transit routes, and improving overall accessibility for passengers.

3.3 Impacts and Benefits from Existing TransCAD Models

The widespread adoption of TransCAD modeling has yielded numerous benefits for transportation systems worldwide:

3.3.1 Improved Efficiency

By optimizing routes, schedules, and infrastructure investments, TransCAD helps improve the overall efficiency of transportation networks, reducing travel times and costs.

3.3.2 Data-Driven Decision Making

TransCAD provides decision-makers with valuable insights through data visualization and scenario analysis, enabling informed policy decisions and strategic planning.

3.3.3 Sustainability and Resilience

With its ability to analyze environmental impacts and promote sustainable transportation options, TransCAD supports efforts to reduce carbon emissions and promote eco-friendly mobility. Integration of environmental and social factors into transportation planning promotes sustainable development goals, resilience to climate change impacts, and equitable access to transportation services.

3.3.4 Optimization of Resources

Efficient allocation of transportation resources, including infrastructure investments, operational budgets, and maintenance activities, leads to cost savings and improved service quality.

Chapter Four: Findings

The key findings revealed that TransCAD modeling offers numerous benefits for urban transportation planning, including improved decision-making, enhanced efficiency, and reduced environmental impacts. Despite its benefits, TransCAD implementation faces challenges such as data availability, technical expertise, and cost implications. Addressing these challenges requires investment in data collection, staff training, and stakeholder engagement to ensure the effective use of TransCAD in urban transportation planning. By optimizing transportation systems and reducing environmental impacts, TransCAD can contribute to long-term cost savings and improve the overall quality of life in urban areas.

4.1 Finding 1: Importance of TransCAD Modeling for Environmental Sustainability

Key Finding: TransCAD modeling offers robust capabilities for assessing the environmental impacts of transportation systems, including carbon emissions, air pollution, and land use. TransCAD modeling offers significant benefits for urban transportation planning, including improved efficiency, cost-effectiveness, and environmental sustainability.

Benefits: By integrating environmental factors into transportation planning decisions, TransCAD helps minimize ecological footprint, promote modal shift to sustainable modes, and enhance overall urban livability.

Implications: Incorporating TransCAD modeling in urban transportation planning processes can lead to more environmentally sustainable infrastructure investments and policy decisions.

4.2 Finding 2: Review of Global TransCAD Usage: Trends, Challenges, and Opportunities

Key Finding: Existing research studies on TransCAD usage globally reveal a growing trend towards multimodal transportation planning, dynamic traffic assignment, and spatial analysis. It demonstrates the utility of TransCAD in optimizing transportation networks, reducing emissions, and improving accessibility.

Trends: TransCAD is widely used in North America, Europe, Asia-Pacific, and Latin America for transportation planning and management. Key trends include the adoption of multimodal transportation planning, dynamic traffic assignment, and spatial analysis capabilities.

Challenges: Common challenges include data availability, model calibration/validation, data integration issues, technical complexities, resource constraints and stakeholder coordination.

Additionally, there is a need for improved interoperability with other transportation modeling tools and systems.

Opportunities: Opportunities for enhancing TransCAD usage include leveraging emerging technologies such as artificial intelligence (AI), machine learning (ML), and big data analytics to improve model accuracy, scalability, and predictive capabilities.

4.3 Finding 3: Best Practices from TransCAD Models Implemented Worldwide

Key Findings: Successful TransCAD implementations in urban settings worldwide emphasize the importance of stakeholder engagement, data quality assurance, and scenario analysis in decision-making processes. Best practices derived from international case studies offer valuable insights for the effective utilization of TransCAD in transportation planning processes.

Best practices include iterative model refinement based on feedback from transportation agencies, community stakeholders, and environmental advocates.

Cities like Singapore, New York, and London Amsterdam have leveraged TransCAD for optimizing public transit networks, designing pedestrian-friendly streetscapes, and promoting active transportation.

Lessons Learned: Flexibility, scalability, and adaptability are essential attributes of effective TransCAD models, enabling cities to respond to evolving transportation needs and priorities.

4.4 Finding 4: Advocating for Better Information Sharing among Transit Authorities in Alberta

Key Finding: Limited information sharing among major transit authorities in Alberta hinders knowledge exchange and collaborative transportation planning efforts. There is a need for better information sharing by major transit authorities and stakeholders, to enhance collaboration and coordination among stakeholders.

To facilitate knowledge exchange and collaborative transportation planning efforts among major transit authorities in Alberta, the following strategies are recommended:

Establishing a centralized platform: Create a centralized platform or database where transit authorities, municipalities, and research institutions can share data, models, and best practices related to TransCAD modeling and urban transportation planning.

Encouraging collaboration: Encourage collaboration among transit authorities through workshops, seminars, and working groups focused on TransCAD usage and application. Foster a culture of knowledge sharing and mutual support to address common challenges and achieve shared goals.

Promoting interoperability: Promote interoperability between TransCAD and other transportation modeling tools and systems used by transit authorities in Alberta. Develop standardized data formats and exchange protocols to facilitate seamless data integration and sharing.

Benefits: Enhanced collaboration can lead to more integrated and efficient transportation solutions, benefiting residents, businesses, and the environment.

4.5 Finding 5: Recommendations for Incorporating HSRR and Express Bus Service

Key Finding: High-speed rail transit (HSRR) and express bus service present viable options for improving intercity connectivity and reducing reliance on single-occupancy vehicles

To incorporate high-speed rail transit (HSRR) and express bus service into the transportation networks of Calgary and Edmonton using TransCAD models, the following recommendations are proposed:

Conduct feasibility studies: Evaluate the feasibility of HSRR and express bus service based on factors such as ridership demand, travel time savings, cost-benefit analysis, and environmental impact assessment. Use TransCAD modeling to simulate different scenarios and identify optimal routes, station locations, and service frequencies.

Stakeholder engagement: Engage stakeholders, including government agencies, transit authorities, business communities, and the public, in the planning process for HSRR and express bus service. Solicit input and feedback to ensure that transportation plans align with the needs and preferences of the community.

Integration with existing infrastructure: Integrating with existing transit hubs, rail corridors, and road networks. Coordinate planning efforts with ongoing transportation projects.

Considerations: Factors such as travel time, cost-effectiveness, environmental impacts, and land use implications should be carefully evaluated in the planning process.

Chapter Five: Recommendations

Incorporating high-speed rail transit and express bus service into the transportation networks of Calgary and Edmonton requires careful planning and analysis. TransCAD models can be used to evaluate the feasibility and impacts of these transportation interventions.

The following recommendations emerged from the key findings of this study:

1. Calgary and Edmonton should prioritize the adoption of TransCAD models in their transportation planning processes to enhance sustainability and efficiency.
2. Transit authorities in Alberta should establish mechanisms for improved data sharing and collaboration with stakeholders to support evidence-based decision-making.
3. Capacity-building initiatives and training programs should be implemented to enhance the technical proficiency of transportation planners in utilizing TransCAD effectively.
4. Integration of high-speed rail transit and express bus service into the transportation networks of Calgary and Edmonton using TransCAD models could be facilitated through scenario analysis and feasibility assessment.
5. Cost allocation strategies, such as public-private partnerships and grant funding, could be explored to optimize resource utilization and maximize return on investment in TransCAD implementation.
6. Further research is needed to explore the specific applications of TransCAD modeling in the context of integrating HSRR and express bus services in Calgary and Edmonton.

Chapter Six: Conclusion

This research highlights the significance of TransCAD modeling in shaping sustainable urban transportation solutions. By leveraging TransCAD, cities like Calgary and Edmonton can effectively plan and optimize transportation systems to accommodate the integration of high-speed rail transit and express bus service.

However, realizing the full potential of TransCAD requires concerted efforts to promote information sharing, capacity building, and stakeholder collaboration within the domain of transportation planning.

Moving forward, it is imperative for Alberta transit authorities to embrace TransCAD as a cornerstone of their decision-making processes for more resilient, equitable, and sustainable urban transportation systems that enhance the quality of life for Canadians and future generations.

6.1 Recommendations for Future Research

- **Community Engagement Strategies:** Explore innovative strategies to involve stakeholders and foster greater public participation and support. (surveys)
- **Economic Cost-Benefit Analysis:** Conduct comprehensive analyses of TransCAD implementation in urban transportation planning. This would involve quantifying the direct and indirect economic benefits of TransCAD modeling, including cost savings, improved efficiency, and potential improvements in the quality of life for residents.
- **Integration with Emerging Technologies:** Explore opportunities for integrating TransCAD models with emerging transportation technologies, such as autonomous vehicles, electric mobility solutions, and alternative energy sources.
- **Social Equity and Accessibility Analysis:** Explore the implications of TransCAD-based transportation planning interventions particularly with underserved communities and marginalized populations, access to essential services, and transportation affordability.
- **Policy and Regulatory Implications:** Assess the legal and institutional frameworks governing the use of TransCAD models, propose recommendations for policy reforms, explore incentives for municipalities to invest, standardize data-sharing protocols, and address privacy and security concerns associated with transportation data.

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