Approved by SNRE Faculty

New Mobility Solutions for South Africa and India:

A Framework for Success

by

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Abstract

New Mobility seeks to create an integrated multi-modal transportation system through private sector investment. This enhanced system has the potential to provide significant social, human health, and environmental benefits through alleviation of congestion, increased efficiency, and better transportation access for all members of society. New Mobility Solutions for South Africa and India: A Framework for Success identifies the capabilities, strategies and management principles needed to ensure the success of New Mobility offerings and provides recommendations for initial entry into New Mobility markets. Drawing on secondary as well as in-country research in the previously identified cities of Bangalore, India and Cape Town, South Africa, specific recommendations were made with respect to the creation of a New Mobility business and industry. These recommendations provide Ford Motor Company with a solid base from which they may begin development of New Mobility through partnerships, alliances, and strategic experiments. The presented frameworks can guide the planning and implementation of New Mobility solutions throughout the world.

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Executive Summary

Background

Global megatrends such as climate change, population growth, and urbanization are straining our societies in ways never before imagined. Rapid urban growth in particular is making movement of people and goods within and around cities difficult, negatively affecting people, economies, and environments worldwide.

The concept of New Mobility seeks to promote sustainable urban transportation and industry development through improvements in moving people and goods in ways that are cleaner, greener, safer, faster, and more equitable. To that end, New Mobility works by implementing integrated, multi-modal hub networks throughout urban environments. Ford Motor Company has identified New Mobility as its "New Game" or "Blue Ocean" strategy and seeks to implement New Mobility solutions in several key cities around the world.

Objectives and Approach

Four M.S. students from the School of Natural Resources and Environment at the University of Michigan comprised our masters project team. The objective of our work was to: 1) Identify capabilities, strategies and management principles needed to ensure success of New Mobility offerings; and 2) Provide recommendations for initial entry into New Mobility markets. To formulate our recommendations, we used a combination of in-country research in Bangalore, India, and Cape Town, South Africa, interviews with the Ford New Mobility team, and secondary research on strategic innovation, alliance structures, New Mobility concepts, and urban transportation. We then synthesized findings and research utilizing a systems thinking approach. Finally, we developed a systems model which is included in Appendix E, to provide insights on the relationships between social and economic trends and New Mobility. Due to the distinct nature of these markets, we were able to develop overarching recommendations for Ford's use when developing New Mobility solutions in any city around the world.

Findings and Recommendations

New Mobility is a form of breakthrough innovation which differs greatly from other forms of growth and requires unique management structures, processes, and performance measures. By its nature it involves testing an unproven business model and a radical departure from Ford's existing business, while at the same time having high growth potential. Managing breakthrough innovation requires unique structures and processes that enable the venture to build needed competencies and encourage learning, which are key characteristics of ventures that have successfully implemented breakthrough innovation.

Ford should acquire the skills that will become the core competence for this new organization in-house, through strategic experiments and partnerships that promote innovation and learning.

Competencies for New Mobility include: Logistics, IT, marketing, innovation, urban planning, government relations, and systems thinking.

Strategic experiments are a low cost, low risk innovation strategy that will allow Ford to build competencies and to adapt over time. To maximize potential for success and to acquire the greatest range of market segments, strategic experiments should target both individuals with potential to own a personal vehicle in the future and those with high latent demand for mobility due to a lack of reliable, accessible, and affordable transportation. This dual market entry strategy reduces risk through testing a diverse portfolio of solutions. Addressing both markets simultaneously enables Ford to identify synergies between the offerings in terms of marketing, operations, and location. Finally, serving segments with high latent demand for mobility will generate goodwill with the government and provide the knowledge of city infrastructure and key socioeconomic issues, which will enable Ford to engage in a dialog with businesses, government, and non-governmental organizations regarding how to provide sustainable, New Mobility solutions for all.

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New Mobility: Ford's Blue Ocean Strategy

New Mobility Solutions for South Africa and India: A Framework for Success is the most recent in a series of collaborations between Ford Motor Company and the University of Michigan's School of Natural Resources and Environment, Ross School of Business, and the Sustainable Mobility, Accessibility and Research Transformation (SMART) project. In previous work, Chris Guenther, Marshall Chase, and Rina Horiuchi noted the opportunity for Ford Motor Company to implement a Blue Ocean strategy for growth by becoming an integrator of New Mobility, thereby serving underserved populations and creating significant business value. In 2007, Ford engaged a master's project team (John Gearen, Sarah Hines, David Hobstetter, Sathyanarayanan Jayagopi, Nikolaos Meissner, Josh Nothwang, Karen Putterman, and Mitsuyo Yamamoto) to develop an assessment of the market opportunity for New Mobility in major developing world markets. Based on the recommendations of these two teams, Ford Motor Company is beginning to execute this Blue Ocean Strategy. Building on the work of previous teams and Ford's ongoing partnership with the University of Michigan, our task was to identify the capabilities and strategies needed to ensure the success of this endeavor, develop management principles needed for developing and commercializing New Mobility offerings and to provide recommendations for initial entry into the Bangalore and Cape Town markets.

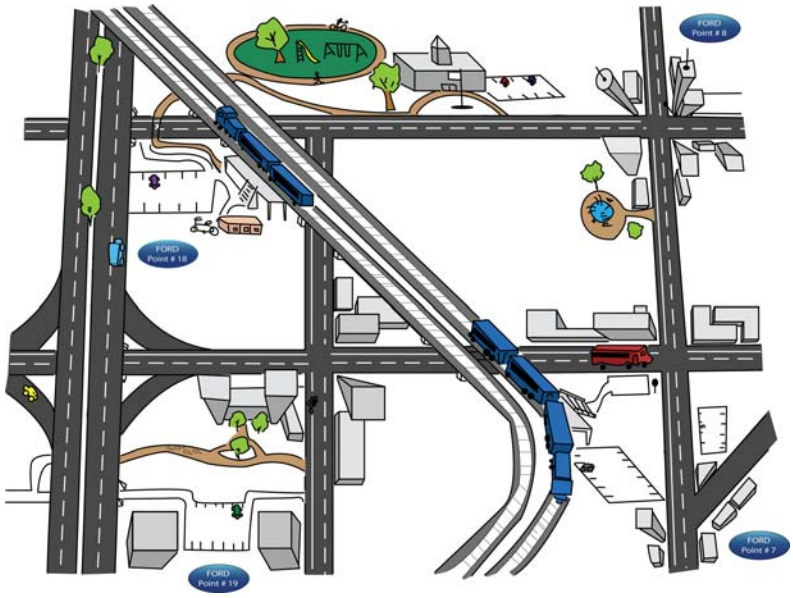
What is New Mobility?

Conceived in Europe and Canada in the late 1980's and early 1990s, New Mobility is an effort to create a more effective and efficient transportation system that results in economic vitality and opportunity while maintaining environmental integrity. The goal of New Mobility is to supply an integrated system of mobility and accessibility for moving people and goods and for moving less in urban regions. It is based on the premise that integrated modes, services, systems, and technologies can reduce congestion, increase user convenience, and increase accessibility for all members of society.[i]

The New Mobility Hub Network

One concept that is being explored to put New Mobility into practice is the New Mobility hub network. A New Mobility hub network provides seamless mobility services connected through an integrated payment system. Each hub provides access to multiple modes of transportation. Hubs are located throughout an urban geographic region, forming a network and enhancing accessibility, ease of use of the system, and adding resilience and redundancy throughout the system. This network of hubs, when developed in concert with urban planning, enables smart growth and mixed use around the hubs to further enhance accessibility and quality of life.

Figure 1: New Mobility Hubs in a City



The goal of the hub network is to embody many of the desired characteristics of the personal automobile, thus displacing its use. These characteristics include the following:

Accessibility: Accessibility both refers to what and how much people can accomplish within a given timeframe and budget and prioritizes accessibility features for elderly and handicapped citizens. This can be achieved through seamlessly integrated, multi-modal transportation systems and through innovative and progressive urban layout and design, smart land-use practices, and reliance on information technology. As a desirable characteristic, accessibility emphasizes social equity and environmental sustainability over speed and distance.

Reliability: Reliability describes transportation systems that can be trusted to arrive safely and on time. This can be achieved through the use of extensive information technologies that facilitate the interoperability of transportation modes.

Affordability: Affordability highlights the importance of providing mobility options that are affordable to 100 percent of the population of towns and cities.

Flexibility: Flexibility provides users with a range of transportation modes and options.

Integration: Integration refers to the integration of different transportation modes enabling the user to change between various modes or types of transportation seamlessly. [ii]

Coolness: Coolness refers to the importance of the New Mobility solution's ability to fulfill the aspirational qualities that have been associated with the automobile. To replace personal automobile use, New Mobility must not only be as good or better in terms of

convenience and cost, but it must also meet the emotional benefits attributed to the personal automobile.

A Day in the Life

The best way to conceptualize a New Mobility hub network is to describe it through the lens of an individual seeking mobility within a city.

Imagine Jennifer Martin, a young professional working in Detroit, MI. Jennifer lives in a two-bedroom house in Birmingham, MI, with her husband Mark. Mark and Jennifer both work away from home; Jennifer works in Detroit, while Mark works in Dearborn. The Martins have one car that they use to run errands on the weekend, although they are considering selling their car as a car share program has recently been established in their neighborhood. In many ways, using the car share program is both easier and more cost effective than owning a car. Each morning, Jennifer uses her cell phone or home computer to reserve her place on a taxi or mini-bus that drives her to the local bus rapid transit station in Birmingham. The bus travels to downtown Detroit in under 15 minutes, where it connects to one of the city's New Mobility hubs. Once at the hub, Jennifer can take the metro rail to the stop closest to her office, or she can use the car share service to pick up a client before a morning meeting. All of these transactions can be coordinated with her call phone and even paid for with her cell phone minutes. After work, Jennifer decides to meet some friends to play soccer in Grosse Point. She heads back to the downtown Detroit hub to grab clothes from her storage locker and jumps on the Bus Rapid Transit (BRT) to Gross Pointe. After soccer, Jennifer drives a car share vehicle home to meet her husband for dinner, returning the vehicle to the car share lot at the Birmingham BRT station the next morning before taking the bus into Detroit.

Figure 2: A New Mobility Hub

Through the course of the day, all trips were booked using her travel smart card, enabling seamless booking and no hassle in registration and payment—and thereby reduced transit time.

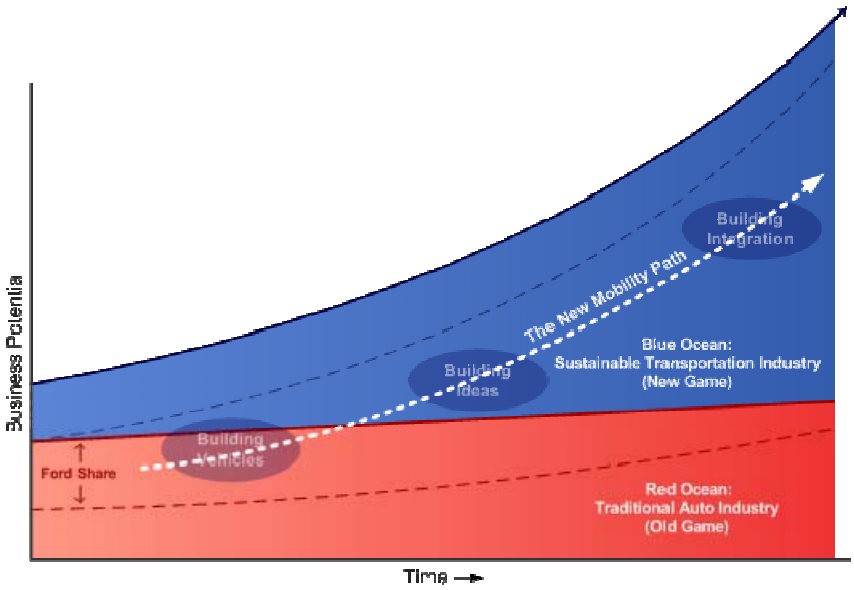
While this example demonstrates the efficiency of New Mobility for middle and upper class users, New Mobility is also applicable to underserved populations simply seeking quick and affordable mechanisms to get to work. In many parts of the world, the poor live on the outskirts of cities and transit time is a significant economic and time expense. Reducing travel time to work and other destinations required to meet basic needs can significantly reduce the financial burden associated with transportation and thus improve quality of life.

New Mobility as a Blue Ocean Strategy for an Automotive Company

New Mobility is Ford's Blue Ocean strategy,[iii] providing the opportunity to grow their business through breakthrough innovation by expanding into new geographies and building solutions to meet mobility needs.

Breakthrough innovation is a stretch mechanism for companies seeking to obtain real growth and to remain relevant as the needs of consumers and society at large evolve. This approach to new business growth involves a transition from offering a product to selling an experience and a corresponding shift from competencies in manufacturing to other areas of expertise. New competencies can be determined through a deep assessment and understanding of consumer needs and lifestyles, approached from a systems thinking perspective. Through innovation that utilizes this deep assessment of needs and aspirations as its foundation, customized, integrated mobility solutions can be developed.

Figure 3: Ford's Blue Ocean Strategy[iv]



There is significant opportunity for innovation and new business development utilizing the New Mobility hub network criteria outlined. This vision of New Mobility is an inspiring vision for the private sector. It can foster innovation for commercial offerings that have the potential to promote sustainable development. It also can serve as the basis for a broader dialog between government, NGOs, and industry in achieving sustainability.

That said, however, to date the New Mobility hub network concept has yet to be fully developed and operationalized by the private sector. And, while a New Mobility hub network can offer efficiencies due to economies of scope and scale compared to conventional transportation strategies, like any efficiency driven system, a percentage of the time and costs savings will be reinvested into mobility, thus negating some of these gains. This pattern is called the rebound effect and is essentially an extension of the law of demand. It is believed that the rebound effect is seen not only in transportation, but in all complex systems. In order to better understand the rebound effect and its consequences to a hub network, we built a computer model (see Appendix E). The model illustrates that, while the New Mobility hub network can offer real short term benefits with regard to easing congestion and increasing accessibility, without addressing the underlying root causes of urban growth and mobility patterns, the hub network will only increase time until mobility capacity of a city is reached.

With this in mind, the New Mobility hub network is discussed in this paper as a vision for Ford Motor Company's development of New Mobility solutions that can enhance the health of communities in the short term and promote continued innovation and dialog regarding progress toward reaching the ultimate goals of profitable, sustainable enterprise and a sustainable world.

Bangalore and Cape Town: Test Cases for New Mobility Solution Framework

To develop recommendations that can be utilized for the development of profitable New Mobility solutions, we assessed existing and proposed mobility infrastructure, usage patterns, and management structures in the Bangalore and Cape Town markets. The distinct nature of these two markets enabled the development of recommendations for Ford to use when implementing New Mobility solutions in cities around the world. The following is a brief description of these two markets highlighting the important characteristics of each locality and the subsequent identification of commonalities between the two cities. A more detailed assessment can be found in the Appendix B.

Bangalore

Figure 4: A Typical Scene in Bangalore

Bangalore, with an estimated population of 5,281,927[v] in 2007, is the third most populous city in India and the 27th most populous city in the world. The city is touted as one of the major economic powerhouses in India, considered the 7th most affluent city in the country.[vi] IT-savvy, Bangalore is home to the greatest number of broadband internet connections of any city in India[vii] and is considered one of the best places to do business in the wired world.[viii] Consequently, Bangalore is home to a large group of entrepreneurs who see opportunities for the integration of IT services and transportation. These are a few of the characteristics that make Bangalore an attractive market from the perspective of many industries, including New Mobility. This assertion is backed by the findings put forth in "*The Strategic Transformation of Ford Motor Company*," which assessed the Bangalore market for New Mobility to be $4.5 billion,[ix] based upon total population size, average GDP per capita, the average percent of income currently spent on transportation, and current car ownership data. The study also found that Bangalore had a great need for New Mobility solutions due to the widening gap between the city's current mobility solutions and its projected transportation needs.

Many of the social, economic and environmental problems that stem from the poor state of mobility infrastructure in Bangalore are further exacerbated by the present and forecasted impacts of several megatrends, including localized air pollution, social inequities, a growing young population, migration from rural villages to the city, rapid urbanization and severe congestion. Recent efforts to address Bangalore's mobility inadequacies have included the construction of bridges and flyovers in an effort to divert traffic from congested intersections, investment in road-widening projects, an increase in the size of the bus fleet and the development of dedicated lanes for 2-wheelers and rickshaws on busy roads.[x] In addition, the government is in the beginning stages of building a metro rail transit system, slated for Phase 1 completion in 2011.[xi] On aggregate, the projects have not produced positive results. The complex nature of transportation in Bangalore calls for a much more comprehensive mobility solution that is, innovative, accessible, affordable, as well as reliable and well-integrated into the existing and planned modes of transport, all of which can be addressed through the implementation of a New Mobility solution.

Cape Town

Figure 5: A View a Train in Cape Town

In 2010 South Africa will be the host of the FIFA Soccer World Cup, and the City of Cape Town is one of the cities hosting this worldwide event. The World Cup is expected to attract at least 500,000 visitors, and the city estimates a provisional income for 2007-2010 of $3 billion, plus investment in soccer development.[xii] City officials plan on using a significant portion of this income for transportation upgrades and believe, "The World Cup provides an opportunity to fast track and accelerate the improvement in the rail system in time with the rail framework."[xiii] To that end, city officials have developed both an Integrated Transportation Plan and a Public Transportation Plan to coordinate the improvements in infrastructure.

Cape Town is a prime candidate for the implementation of a New Mobility solution in the near-term because of the opportunity to leverage the World Cup for transportation and infrastructure

improvements given the short time frame of 2 years. Additionally, New Mobility has the opportunity to assist in alleviating health, economic development and social equity challenges facing Cape Town.

In addition to financing concerns, social and cultural issues have played a significant role in South Africa's history. The government's enforcement of apartheid from 1948 to 1994 has led to serious racial and social inequities within the country that are still being felt today. A large income gap between rich and poor and continued racial dissociation are direct affects attributable to the apartheid era; 38% of the population lives below the poverty line and 15.11% are unemployed.[xiv] To date, traditional transportation solutions are often not well positioned to meet the needs of varied socioeconomic groups.

In addition to issues related to social and economic inequity, the city of Cape Town and South Africa as a whole are additionally challenged by unusually high crime rates. According to a 2005 article in the *Economist*, "Some 19,000 murders were reported in South Africa last year--about nine times the American rate and 27 times the British one. Some 55,000 rapes were reported, one of the highest rates in the world."[xv] The presence of crime in cities like Cape Town has been a barrier to increasing rider-ship for mass transit and will present challenges for integrated New Mobility solutions.

To date, transportation solutions in Cape Town have not been adequately able to address the city population's safety or the affordability and accessibility needs that have spawned a reliance on personal automobiles. Such a gap has created serious transportation inequality issues for the significant number of urban inhabitants without personal transportation. While car ownership in Cape Town is relatively low compared with cities of comparable size (200 cars per 1,000 people[xvi] compared to 1 car per person in Chicago, a city of comparable size[xvii]), private transportation in Cape Town accounts for 52% of total transportation.[xviii] Additionally, traffic volumes have grown 3% per year over the last 10 years.[xix] This increasing reliance on the personal automobile poses challenges for any mobility solution developed for Cape Town.

All of the characteristics above are related to transportation through complex systems and urban transportation has traditionally fallen under the purview of the public sector. However, lack of government funding for transportation, the increased use of personal vehicles, and the continued lack of safe, accessible forms of public transportation will undoubtedly have negative economic and social implications for Cape Town. New Mobility has great potential to provide transportation solutions that satiate the needs of Cape Town's inhabitants and to seize the opportunity provided by the 2010 World Cup to spur meaningful economic development in the city.

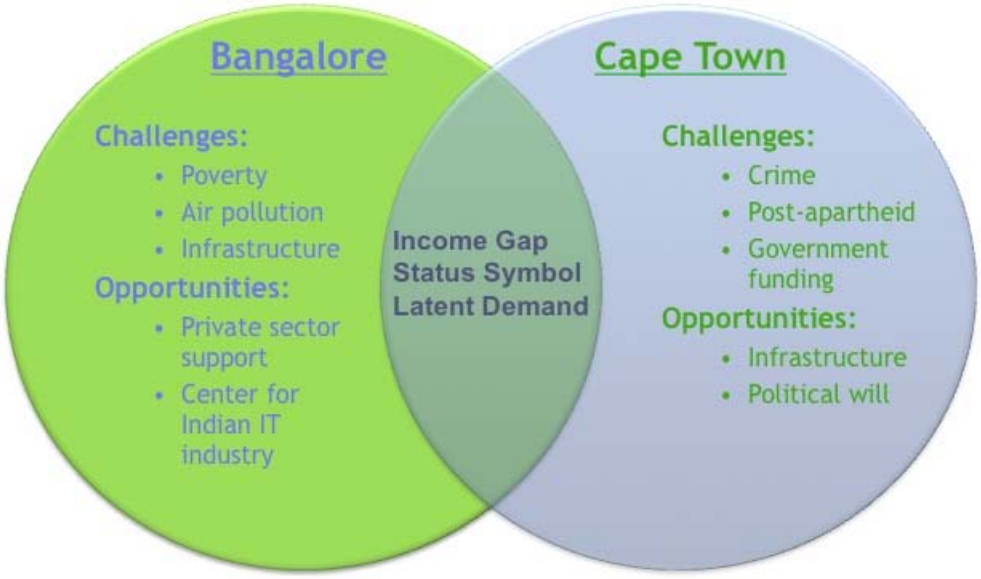
Summary of Insights into Local Markets: Challenges and Opportunities

Cape Town and Bangalore both exhibit distinct opportunities and challenges with regard to market entry and implementation of New Mobility solutions. In Bangalore, poverty, air pollution, and lack

of infrastructure are some of the most pressing issues facing the city. However, Bangalore has qualities that make it an attractive New Mobility market-namely support from entrepreneurs and large IT companies, both of which are instrumental for the successful implementation of a New Mobility solution. Conversely, Cape Town faces different challenges: high crime rates, post-apartheid social issues, and the lack of government funding. Nevertheless, the current state of mobility infrastructure and the political will behind transportation improvements make Cape Town an attractive market.

Despite the seemingly distinct characteristics of these two markets, Bangalore and Cape Town share several key commonalities, summarized in Figure 6 below. For instance, the socioeconomic landscape in both Cape Town and Bangalore is marked by a large and growing gap between rich and poor. Additionally, as in many places around the world, people in Cape Town and Bangalore aspire to own an automobile; car ownership is seen as a symbol of wealth and status. Finally, both markets exhibit a large latent demand for transportation. These similarities—all suggesting a need for New Mobility solutions combined with insights drawn from individual assessments of the challenges and opportunities in each market, prompted the generation of a list of essential competencies necessary the deployment of New Mobility solutions.

Figure 6: Opportunities, Challenges and Commonalities



Gap Analysis

New Mobility's execution requires numerous skills and capabilities that currently cannot be found in one firm. To inform Ford Motor Company on the best way to approach offering this new service and the potential partnerships and organizational structures needed, we outlined the key skills necessary for a hub network to be implemented in a city regardless of location. After describing the capabilities needed, we outlined our view of the existing capabilities of Ford Motor Company. Finally, we developed a set of questions for each capability area that will allow Ford to determine where their skills fall within the needs matrix. These questionnaires are listed in Appendix A[1].

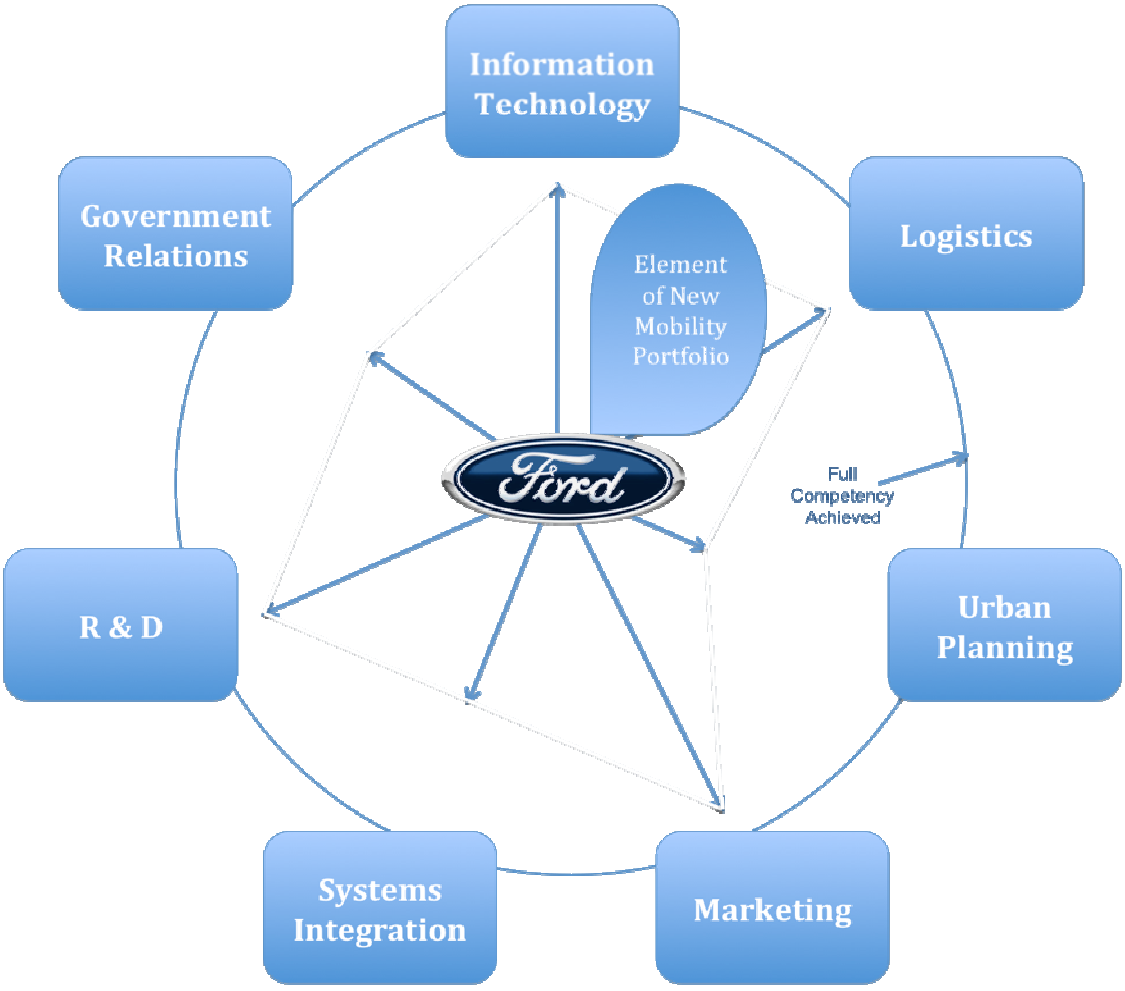
The key capabilities for supplying and operating a New Mobility hub network include:

- Logistics
- IT
- Urban planning
- Marketing
- Government relations
- Innovation/R&D management.
- Systems thinking and integration

Ford's competencies in each of the seven areas can be assessed and visually represented using the following diagram (Figure 7). The outer circle represents the complete set of competencies needed to provide 100% of the New Mobility hub network services for hub networks in all regions of the world. The *Element of New Mobility Portfolio* bubble illustrates the scalable nature of the hub network, indicating the competencies needed for a strategic experiment for a specific element of a New Mobility hub network. It is important to note that no one company is completely capable in all seven areas. Rather, we have developed a set of questions that can be used to assess Ford's current capabilities against what might be required for a fully integrated, fully functional hub network or the competencies needed for an element of a hub network.

[1] Please note that the questionnaires are Ford's confidential documents and will not appear in the document circulated to the general public.

Figure 7: Seven Key Competencies for New Mobility



Logistics

For individuals to use a New Mobility hub network rather than a personal vehicle, the service provided must be equally convenient when compared with alternative forms of transport and it must promise competitive travel times. Highly developed logistics, such as just-in-time management and delivery (JIT) of both passengers and goods throughout a New Mobility hub network, are essential for achieving these objectives.

Ford has extensive experience with JIT delivery of parts from their supply chain to their manufacturing facilities throughout the World. Nonetheless, the difficulty in offering high service levels for a hub network in a city with crumbling infrastructure and severe congestion, conditions common in the developing world, should not be underestimated. While Ford has years of

experience forecasting fluctuating demand for automobiles due to seasonality and other variables affecting demand, Ford does have expertise in forecasting demand for a service that experiences significant variability throughout the course of the day, week, and year. Simply put, the effect of linking the existing modes of transportation with newly introduced modes on the overall system dynamics is unknown—and increases the importance of flexible logistics services while at the same time making their successful execution more difficult.

Information Technology

Advanced Information technology (IT), often considered the backbone of the entire hub network system, is crucial to its efficient operation. IT capabilities enable the tracking and execution of the JIT logistics system. In addition, IT provides the means for an integrated cashless payment system and the interface for customers booking mobility services, which include both cell phones and the internet. IT also can be used to customize the experience for the user and to provide information regarding travel times and the arrival of the next bus. Similar to how Amazon recommends books based on previous purchases, a New Mobility offering could save individual preferences and recommend options thus enhancing the experience. Also, just as FedEx allows customers to track packages, a New Mobility system can provide real time information regarding wait and travel times. While some IT solutions such as cashless payment and route optimization will be transferable, other solutions are very location-specific and depend heavily on local variables.

An important and universal application of IT is metric creation and tracking through data collection. Data will aid in the establishment of a baseline and enable the benchmarking of goals for the New Mobility service. The ability to measure the performance of the New Mobility hub network will result in improved management of the system.

Ford has experience providing internal networking and enterprise solutions and developing custom applications for their business units. Ford has an established relationship with Microsoft and they jointly developed Microsoft Sync, an in-car communications and entertainment system.[xx] That said, each New Mobility market will provide its own unique IT challenges, ranging from state of the art IT solutions to nonexistent infrastructure. The uniqueness of each market makes IT learning and implementation an important New Mobility competency.[2]

[2] Please see Cemex case in Appendix C for the role IT played in assisting Cemex from solely offering product to providing a service.

Urban Planning

Efficient operations and achieving New Mobility's goal of accessibility for all depend upon urban planning and hub placement. Collaboration with local, regional, and national governments will enhance the efficiency and ultimate success of the New Mobility system. Government policies and actions that may enhance a New Mobility offering supplied by the private sector include assigning dedicated lanes, special zoning, and the installation of new infrastructure. Urban planning competencies depend on whether New Mobility offerings are sold to the government or whether this is solely a private venture. If it is supplied to the government, key lessons on successes and failures in this arena could be learned through the World Resources Institute's work on assisting cities with implementation of Bus Rapid Transit. This solution requires establishing air pollution baselines, establishing success measures and systems to monitor activity, and working with city planners to site stops and lanes for the city.

Ford does not have a specific urban planning or design service in house. Nonetheless, they have successfully partnered with the University of Michigan, Georgia Tech and other academic institutions in the past. Ford should continue to leverage these partnerships to generate the list of capabilities needed for the New Mobility hub network and to evaluate whether these skills should be developed by Ford or obtained through partnerships.

Marketing

Marketing is the fundamental lever for profitability and success. Marketing in this context must go beyond branding and advertising to include a deep knowledge of customer segments. This understanding will enable Ford to develop offerings that meet the customer's wide-ranging needs and aspirations.

Mobility and transportation patterns are linked to values, aspirations, needs, lifestyles, economics, patterns of behavior and living, and city design and structure. For these reasons, the design of the service, value proposition, pricing, and how it is promoted must be developed for each segment of the population in each region. Promotion and successful execution of a New Mobility hub network thus requires considerable knowledge of culture and market segments. In order to gain an understanding of these segments the following questions should be considered:

- When do people travel and why?
    - What are the customer's needs?
    - What are customer's usage occasions?
    - What are the customer's values and aspirations?
- How much do they currently spend on transportation? How much are they willing or able to spend?

- What are the key attributes of the service that the customer enjoys? If users could change or enhance one feature in the system, what would it be?
- Do customers use cell phones with internet capability?
- Is safety a major concern? How do customers perceive danger and safety? What attributes of transportation make customers feel safe?
- How long will customers wait in line for transit at a hub network?
- What market segments will be first adopters? How does information on new product offerings diffuse throughout the urban population?
- What are the multiple channels needed to reach customers?
    - What are the best channels to promote the new service? Internet? Movies? TV? Viral marketing? Other?

Marketing a new product or service is much more complicated than traditional marketing strategies employed by automotive companies. The automobile has become an established component of global culture and is something with which all people are familiar. Therefore, the key marketing strategies for automobile companies focus on retaining existing customers, stealing share from competitors, and encouraging the purchase of a car more frequently than a customer might otherwise without promotion and advertising from automotive companies.

The marketing skills required for a New Mobility hub network entail stimulating demand for a new service with which the public is not familiar. The best example for the marketing of a new service may in fact be the marketing of a new consumer product offering. For most consumer product goods, significant resources are invested in consumer research to identify behaviors and attitudes. Advertising campaigns and product positioning are constantly evolving to encourage use and customer retention. These types of strategies will also be needed to market New Mobility services. This requires a significantly higher investment in marketing as a proportion of the overall budget for the new venture compared to the traditional automotive business.

The difficulty in obtaining a deep understanding of the behaviors of target populations is compounded by the fact that the detailed market research data available for consumers in the US market is not available for most parts of the developing world. Given the diversity in economics and culture within both the Bangalore and Cape Town markets, significant research into the needs and aspirations of the diverse populations is needed. Because the New Mobility hub network is a new offering, partnering to mutually fund market research or partnering with individuals or organizations intimately familiar with the markets they will be serving may be useful.

Government Relations

Levels of corruption and the influence of government on business activities vary from country to country and affect how business is conducted and the ultimate profitability of the venture. The process of government approvals for New Mobility business activities may be even more complex than for other businesses given its interconnected linking of private businesses with public transit, city planning, economic development, and environmental management, all of which are typically the domain of city or regional governments.

A new entity seeking to implement and operate a New Mobility hub network will need to interface with the city or regional government in the following areas:

- Understanding city planning (zoning, planned infrastructure improvements)
- Lobbying for improved infrastructure, policies that promote the adoption of clean, safe modes of transit, and enforcement of existing policies
- Transactions for the purchase of real estate or permits for operating business or other legal matters

Ford's strong human rights code and corruption and bribery policies will assist them in developing solid relationships with governments. While Ford's government relations group has experience working with many governments and legal systems throughout the developing world, the company will need to develop (or leverage) political capital to effectively navigate and negotiate the political system in cities where New Mobility solutions are deployed. This is particularly true for New Mobility since transportation has traditionally been the domain of the public sector. For the New Mobility hub network concept to reach its potential, Ford must forge long term relationships with governments.

Innovation / R&D Management

Innovation is a key component in transitioning from offering a product to a service and it involves deep listening to fully understand needs and aspirations of target markets. Additionally, innovation involves the constant analysis of data provided by the IT systems to continually evolve and refine the offerings.

As the hub network concept has yet to be fully tested, we recommend that a number of strategic experiments be tested and managed as an R&D project, with similar expectations with respect to time frame for potential returns and probability of success. The pharmaceutical industry is particularly known for their R&D and product development capabilities. Implicit in the development of new drugs is the understanding that not all research endeavors lead to commercially viable solutions. R&D and commercialization efforts are managed through a stage-gate process, with appropriate success measures at each stage from research through product launch. In this system, risk is managed by investing in a portfolio of R&D efforts. While only a small proportion of research

activities lead to commercially viable products, the business as a whole is profitable due to a well-managed, structured R&D and commercialization process.

Ford has a similar process for the development of new cars and technologies that could be adapted for use by a New Mobility venture. R&D and commercialization lessons learned from automotive technologies and the pharmaceutical industry can be applied to a New Mobility hub network. Instead of investing in a one-size-fits-all solution, components of solutions can be tested in various markets to diversify risk and to enhance the probability of success. For example, instead of Ford commercializing a concept car where every component is new, often new components are incorporated into existing designs. Such a strategy enables Ford to isolate variables to measure its success and reduces risk if the component fails.

Systems Thinking and Integration

Systems thinking and integration are crucial to the successful creation of a New Mobility hub network. All of the capabilities above are interconnected. Logistics capabilities are strongly tied to IT, and R&D investment may be heavily dependent on marketing information. Traditional categorization of each capability in separate silos ignores their interrelatedness. Understanding their connectedness and coordinating their development will facilitate the identification of scalable solutions.

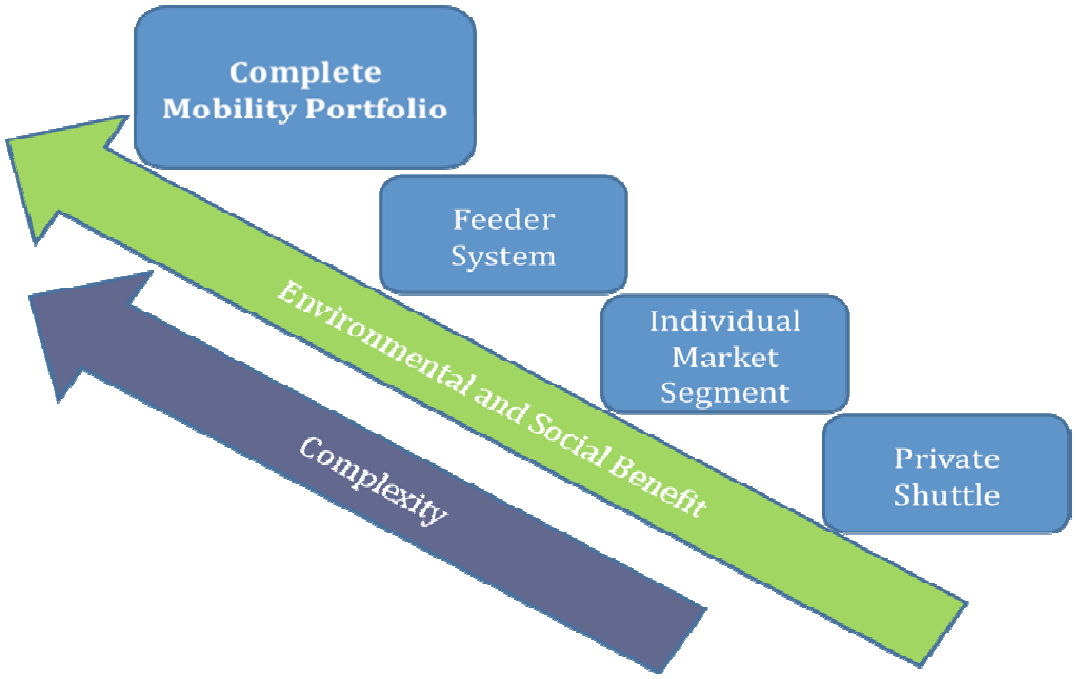
Ford is applying concepts of systems thinking throughout its organization to foster competitive advantage. Company managers are trained in systems thinking concepts through their Systems Thinking Program Management Office (STPMO), organized under their IT group, because much of the systems thinking work relies on computer-based modeling programs. [xxi] STPMO works in all areas of Ford's business including the international business units of Ford Europe and Volvo.

STPMO has already facilitated a Ford-wide conference on New Mobility.[xxii] The development of systems thinking skills within Ford through STPMO and exercises such as the company-wide conference will assist Ford in becoming a leader in the emerging New Mobility industry.

Elements of a New Mobility Portfolio of Solutions

There are a range of options and services that Ford could provide as components of a New Mobility portfolio. These range from targeting individual market segments with transit offerings to selling a turn-key solution to a city government which essentially creates a new public transit system based on the hub network concept. These offerings could be components of a New Mobility hub network or offerings that meet New Mobility design criteria in a different fashion. The following is a diagram of the range of offerings and the relative complexity, social, and environmental benefits of each.

Figure 8: Elements of a New Mobility Portfolio of Solutions



The following table and subsequent text outlines the range of offerings and the skills, approaches, and partnerships needed for each. It emphasizes the key capabilities needed to offer each solution and evaluates the solution's ability to meet New Mobility design criteria. It also evaluates the solutions potential for reducing congestion, air pollution, and climate change impacts and relative positioning for future breakthrough innovation. A visual representation of the capabilities needed to supply each solution is included below.

Ford New Mobility Offering	Description	Marketing Strategy	Customer & Value Proposition	Key Competencies	Key Relationships / Partners
Servicing Individual Segment	- Provides transport to specific market segment - Ex.: Kab Shuttle in Cape Town	Stimulate latent demand for more trips	- Individual market segments - Increase accessibility of market segment while meeting segments aspirations	Marketing & R&D: Co-develop business offerings with customers	Community groups and on-the-ground NGOs to understand needs and promote service
Private Shuttles	- Through contract, provides transport to and from destination - Ex.: Hotel shuttles from the airport	Stimulate demand - Client: increased volume Consumer: decreased travel time	- Businesses, Clinics, Churches, Hotels - Increases number of trips to client's location	- IT: route optimization, booking software	Corporate and NGO clients
Feeder System	- Provides transport from door to public transportation access point - Ex.: Auto-rickshaws in India	Steal share from existing last mile services	- Public transit user - Cheaper, quicker, safer than current options	- Government Management - Logistics/IT	Government

Servicing an Individual Segment

The first option presented is a private New Mobility service offering which targets an individual market segment. This segment is defined by usage occasion, income bracket, and consumer aspirations.

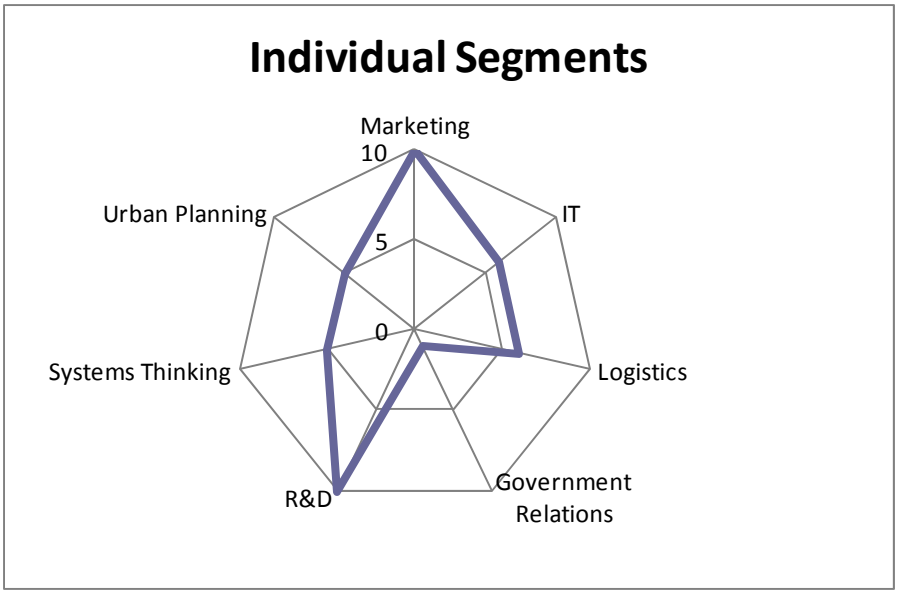
For example, in Bangalore, India, this service might target young, professional middle class men and women that currently drive a two-wheeler; live in certain neighborhoods; and frequent the same clubs, restaurants, and recreational areas.

This service stimulates latent demand for trips in an underserved population or can steal share from another mode of transit (e.g. bus, rickshaw, or two-wheeler). It targets a specific population, and while it initially may service only one usage occasion for a given market segment, it can expand to provide the service to more segments, or it can seek to fulfill the entire set of mobility needs for the target segment.

The key competencies needed to offer this service include:

- Marketing – A deep understanding of an individual's behaviors, lifestyles, etc. is needed to fully develop solutions that meet their needs and lifestyles.
- R&D and Innovation – The solutions and their marketing will need to constantly evolve over time.
- IT – While the level of IT requirements can vary depending on the solution developed, some solutions may include:
    - Route optimization software
    - Centralized dispatcher
    - GPS tracking of vehicles
    - Online and cell phone booking of trips
    - Cashless payment system
- Logistics – Route optimization, quick arrival and travel time will be critical for profitability and customer satisfaction.

Figure 9: Spider Chart for Servicing an Individual Segment Solution



There also are significant business benefits from pursuing this New Mobility offering, specifically:

- Low initial capital investment – While scaling the solution and achieving optimal efficiency and profitability may require investments in IT and marketing, the initial tests of these offerings could be very inexpensive. The initial investment could simply require a marketing investment, hiring a few drivers and purchasing a few vehicles.

- Gain experience– Provides an opportunity to gain experience offering a service instead of a product.

- Positioning for breakthrough innovation – This offering provides an opportunity to deeply understand the culture of target markets and to grow demand over time. Fully tapping the potential of the New Mobility market requires stimulation of latent demand rather than stealing share from transit modes. This solution provides an opportunity to deeply understand target populations—an understanding that could lead to new marketing strategies or even new solutions that will help displace personal cars. Pursuing the aforementioned strategy provides an opportunity for Ford to optimize its marketing skills at the outset to develop the New Mobility business.

The following matrix illustrates how this solution fits into the New Mobility criteria.

Accessibility	Yes (improves accessibility for the target population)
Reliability	Yes. With the use of IT systems, route optimization, and quality drivers and vehicles, the system can be more reliable than existing offerings.
Affordable	Yes. The solution can be designed to be affordable to the targeted population.
Flexible	Yes. It can be flexible in its ability to meet travel needs, supply a specific type or "quality" of vehicle, and can provide multiple forms of booking.
Integrated	No. It is not necessarily integrated with other modes of transit. But, this could be used as an initial step in the formation of a hub network.
Cool/Sexy	Yes. A key component of this solution is marketing. It can lend cache to shared, last mile, or public transit.
Congestion	Maybe. It may not alleviate congestion in the long run as it stimulates demand for underserved populations thereby increasing the number of trips.
Air pollution & Climate Change	Maybe. Vehicles can be operated that use renewable or cleaner energy sources and have better emissions controls than those currently in use.
Positioning for breakthrough innovation	Yes. By emphasizing marketing and key needs of individuals, synergies and opportunities for continued innovation can be discovered and consumer trust and government confidence gained for future growth and innovation.

Private Shuttles

This service offers transportation to a specific destination that would be sold to the client organization by the mobility provider. It would be a private service offering marketed to clients with the goal of stimulating demand from businesses or organizations for transportation of their employees, patients, customers or clientele. Such a system could serve a range of destinations and include corporate bussing, transport to and from stores, or transportation to health service organizations. Examples of this solution include airport or corporate shuttles. Examples of potential customers include businesses, hotels, airports, and health clinics.

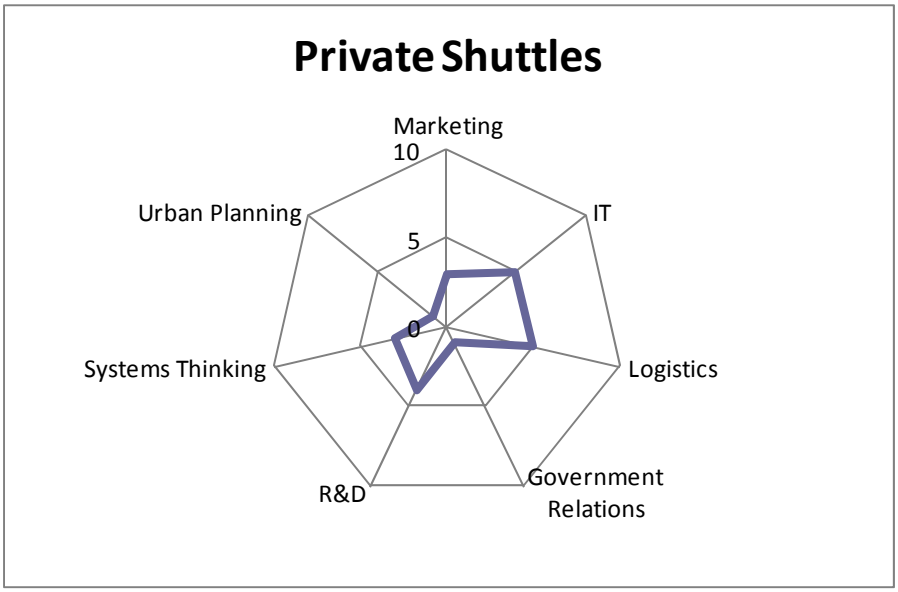
One potential use for this type of solution would be providing transportation to or from health clinics. Foundations and corporate social responsibility divisions of companies may be interested in implementing and funding this service. This solution would give Ford an opportunity to have a direct

impact on the health outcomes and livelihoods of the public. As a consequence, this offering most likely would generate goodwill and brand equity that Ford could leverage for future endeavors.

Some of the key competencies needed include:

- IT and logistics- Route optimization and booking software are the most important competencies within IT for this solution.

Figure 10: Spider Chart for Private Shuttle Solution



Some of the key benefits for this solution are:

- Lower IT investment- Compared to any of the other proposed solutions, this does not require much new IT infrastructure, other than route and load optimization, and what is needed can be easily purchased.
- Service experience - This is a small and easy step to test Ford's service capabilities and evaluate potential pitfalls of providing a service instead of a product.
- Demand stimulation in other markets- Successful operation should stimulate demand for this type of service throughout the market.

The following matrix illustrates how this solution fits into the New Mobility criteria.

Accessibility	Yes (for those traveling to targeted destinations). In many situations these users will not have access to personal transportation, so this solution will increase their accessibility to specific destinations.
Reliability	Yes. The limited scope of the solution allows efficiencies to be optimized, thereby increasing reliability.
Affordable	Yes. The company or organization is charged for the service rather than the user.
Flexible	No. While the client may be able to specify specific modes of transit, the user cannot.
Integrated	No. The destination is set. Integration with other locations is not included as part of the offering.
Cool/Sexy	No. This is a specific solution servicing a discrete mobility need. Very little advertising is required to actual users since they will be a captive market, so the need to make it cool/sexy is diminished.
Congestion	No. This solution will not significantly impact congestion.
Air pollution & Climate Change	No. The solution is on a smaller scale so changes in environmental impacts will be negligible.
Positioning for future breakthrough innovation	No. This solution is servicing a specific mobility need and does not give the provider much exposure to breakthrough innovations.

Feeder System

While many cities have existing public transportation modes like buses and light rail, last-mile transit to and from transportation hubs is often limited. Additionally, many perceive the existing transit services to be unsafe or lack transparent pricing systems. For example, auto-rickshaws in India are often open vehicles exposing riders to air pollution, thereby decreasing the experience of the trip as well as affecting health outcomes of drivers and frequent users of the service.

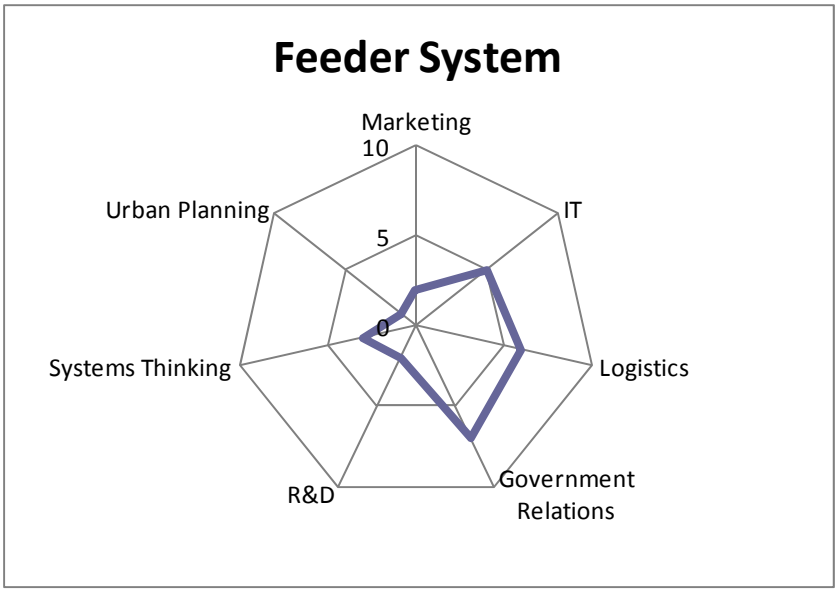
Ford could offer a feeder system service that is integrated with the existing public transit system through a cashless payment system and coordinated with public transit schedules and routes. This

strategy relies on stealing share from existing last mile services by offering a more convenient, reliable, safe, and affordable service.

The key competencies needed to offer this service are listed in order of priority below

- Government relations – This offering would require significant coordination with the government.
- Logistics – The efficiency of this offering is important to ensure profitability and customer satisfaction.
- IT – Route optimization software and GPS tracking and routing would increase the efficiency of the system. A centralized call center and dispatching service could also benefit the system depending on its makeup. For the simplicity of this solution, it is assumed that an integrated cashless payment system will either be supplied by the government or would not be immediately required so therefore it would not need to be provided by Ford or its partners.

Figure 11: Spider Chart for Feeder System Solution



Some of the benefits and considerations for pursuing this strategy include:

- Strong HR policies and hiring practices are needed as customer satisfaction and efficiency of the system are contingent upon the professionalism of the drivers.
- This solution may not stimulate demand for transport. It may only serve the current demand.

- Contracting with the government, if necessary, most likely will require that Ford commit to service the market for a minimum length of time. Compared to the previous option, this increases the risk and long-term investment level required.

- In some cities such as Cape Town, this offering may require that Ford compete within an already hyper competitive market in which disputes between service providers are commonly solved with violence. The government has been working hard to curb this violence, but it appears that they still have a long way to go.[xxiii]

- Ford can gain experience working with city governments and providing last mile delivery of people throughout a network by providing this service.

The following matrix illustrates how this solution fits into the New Mobility criteria.

Accessibility	Yes. The offering may decrease the amount of time it takes for individuals to get to their destination by offering new or more efficient last mile services.
Reliability	Yes. The service could be designed to be more reliable than existing last mile services.
Affordable	Yes. The service can be designed to be cheaper than, or at a minimum, compete with the current price of the existing service.
Flexible	No. Customers cannot choose vehicle modes.
Integrated	Yes. It should be integrated with the existing public transit offerings.
Cool/Sexy	No. Marketing would be the same as the existing public transit service so it is unlikely to have a cool image.
Congestion	No. It is assumed that the demand level, hence number of vehicles on the road, would remain constant or even go up if an improved service is offered.
Air Pollution & Climate Change	Yes. If renewable energy, cleaner fuels, or stronger emissions controls are employed, there could be a net benefit with respect to air pollution and climate change.
Positioning for Future Breakthrough Innovation	Assuming that Ford decides to compete with existing providers, this is a steal share versus a stimulate demand strategy so it does not lead to significant growth.

The Role of Systems Thinking

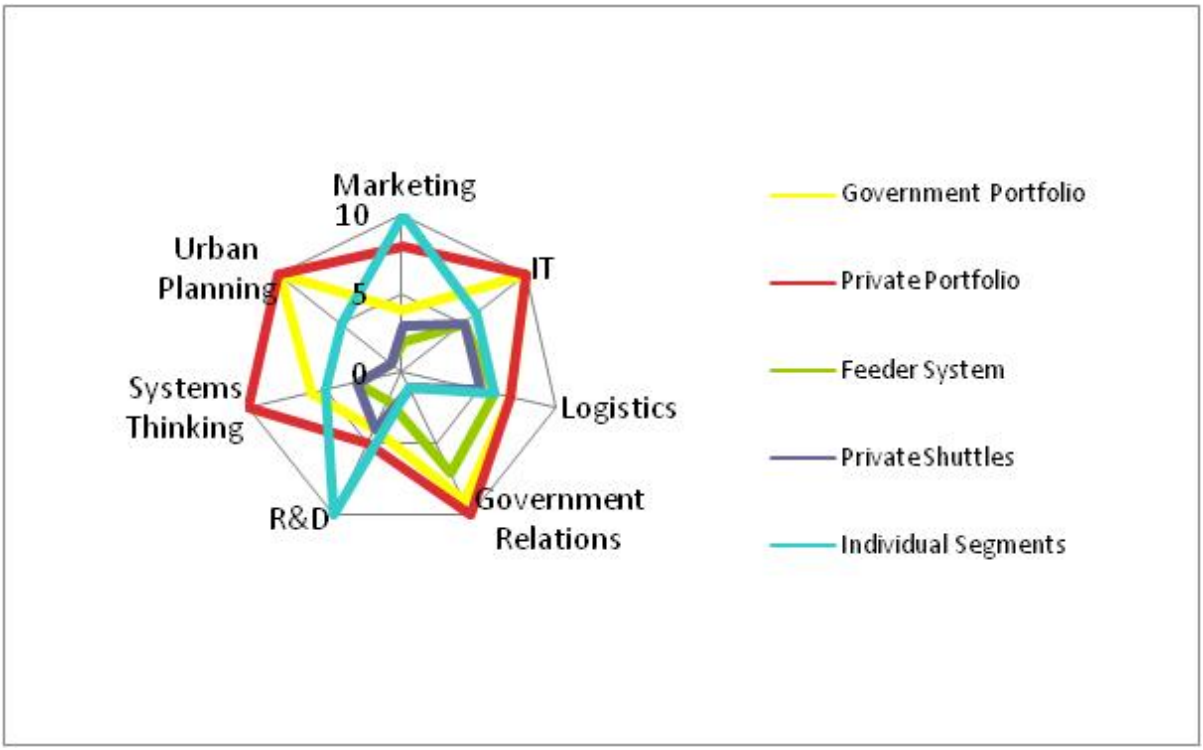
Systems thinking and innovation is a key component to any New Mobility hub network. For the solutions ranked above, we considered the systems thinking component of each individual solution on a standalone basis. For example, developing a single, incremental mobility solution that moves people from one place to another does not require in-depth systems thinking capabilities. Nonetheless, systems thinking becomes essential when operating the hub network as a whole due to the integration of several different solutions.

Summary

As depicted in the diagram below (Figure 12), each offering requires a different set of skills and competencies, with the Complete Mobility Portfolio representing the full suite of New Mobility offerings in the form of a New Mobility hub network. For example, the individual market segment requires a stronger marketing skill set while the private shuttle is a relatively easier service to perform.[3] By testing different offerings, Ford can acquire competencies over time for the complete New Mobility portfolio.

[3] The competencies needed for the Complete Mobility Portfolio were outlined in the Gap Analysis section of the paper.

Figure 12: Competencies Requires for Each Offering



While all solutions have benefits, the individual market segment offering is most likely to stimulate demand for transportation and thus should strongly be considered for trials as a means to grow a New Mobility market and business.

One private sector offering that has yet to be mentioned is supplying and/or operating New Mobility hub solutions combined with existing public transit for a city. It is believed that if this solution is undertaken at an early stage, the focus of the business will be on operations and meeting existing public transit service levels rather than on innovation and stimulating demand for mass transportation or New Mobility. For these reasons, initially pursuing the other elements described above is our recommended strategy.

Building Competencies through Strategic Experiments and Alliances

In our research we evaluated two key ways for Ford to gain competencies to provide a suite of New Mobility offerings: alliances and strategic experiments.

During our research it became clear that New Mobility is a form of breakthrough innovation and that when seeking to build competencies for breakthrough innovation, strategic experiments along with learning alliances are the preferred method. Some of the key characteristics of breakthrough innovation are that it is a radical departure from the existing business, the innovation has high growth potential, and it requires testing an unproven business model.

New Mobility is a radical departure from Ford's existing business requiring them to transition from offering a product to service. While the New Mobility concept has been implemented in cities around the world, private sector integration of transit modes into a hub network and profitably serving underserved markets has yet to be achieved. For these reasons, it is an unproven business model.[xxiv]

When pursuing breakthrough innovation, the objective is to acquire skills that will comprise the core competencies of the offering. Ford can obtain the needed experience and capabilities prior to competitors entering the market space by testing and adapting these solutions and through engaging in learning alliances.[xxv,4]

Dual Market Entry Approach to Strategic Experiments

Through synthesizing case cities of Bangalore and Cape Town and breakthrough innovation best practices, we developed the following dual market approach for Ford's New Mobility strategic experiments.

In each city identified by Ford as a potential New Mobility market, Ford can simultaneously tests offerings for *potential new vehicle buyers* and *individuals with high latent demand for mobility*. By simultaneously testing offerings for market segments at each end of New Mobility market spectrum, Ford can identify synergies facilitate servicing the middle segments of the spectrum. In essence this approach illustrates the scalable implementation of the model described in "servicing individual segments."

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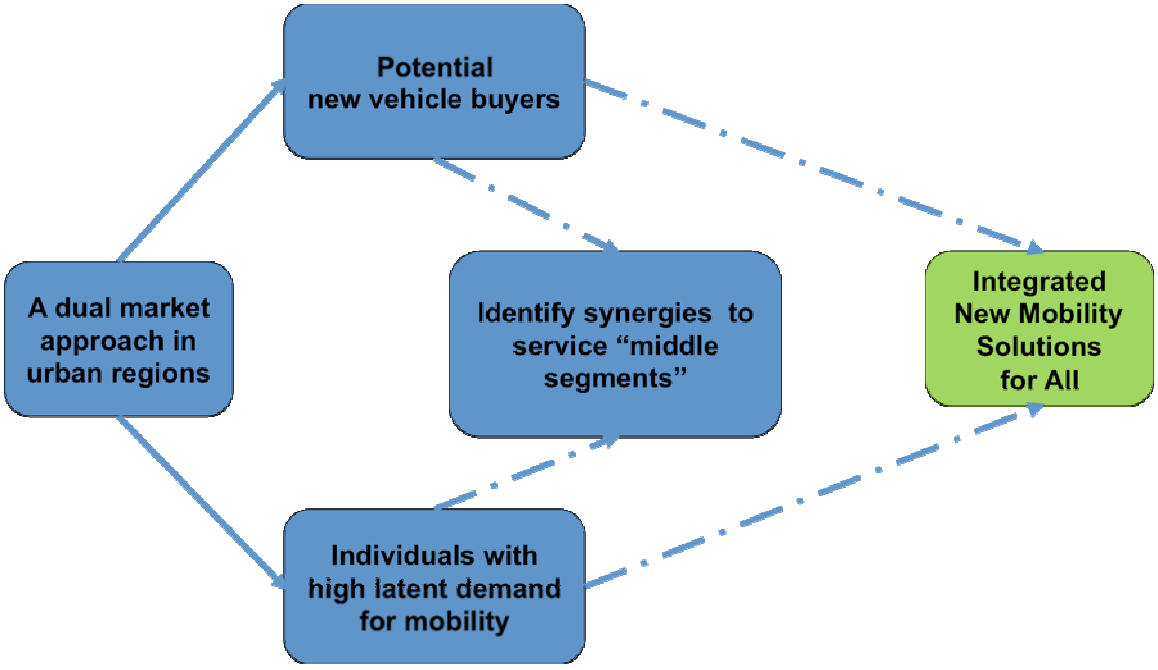
[4] Please see the 10 Rules of Strategic Innovation and managing breakthrough innovation sections of Appendix D to gain a deeper understanding of some of the unique characteristics of breakthrough innovation.

'Middle' segments may be defined as in the middle of the two markets, spatially, economically, through usage patterns, or from a cultural or aspirational perspective. For example, in Cape Town there is significant physical separation between rich and poor, so the convergence to middle segments could very well be a spatial convergence. In other cities or for other markets, the convergence may be related to brand. Through continued innovation, evolution, and expansion, Ford can offer integrated New Mobility solutions for all.

Figure 13: Dual Market Approach



Target Market: Potential New Vehicle Buyers

The first target market *is potential new vehicle buyers*, or those on the cusp of vehicle ownership. The key attributes of this service are that it is cool and hip, evoking many of the aspirational qualities that a vehicle provides while being just as convenient as a car, if not more convenient. One example of a New Mobility solution that has successfully targeted the middle to upper middle class market in the United States is the Zipcar. It has proven to be a quick, easy way to have transportation and its marketing evokes status, claiming that owning a car is more hassle than belonging to Zipcar. Concepts that address similar aspirations and needs for middle and upper middle class segments could be developed for similar segments in the developing world. In Cape Town, the *potential new vehicle buyers* market segment represents approximately 24% of

households. The estimate is based on the percentage of households in the income bracket just under that associated with owning a car, combined with those in the income bracket who currently do not own a car.[5] [xxvi]

Bangalore also is believed to have a significant market segment that meets this profile. While exact numbers are not available for Bangalore, we do know that 65% of population is under 30 years of age and 62% are employed or go to school, which suggests that the market size for this segment is significant.[xxvii] [xxviii]

Target Market: Individuals with High Latent Demand for Mobility

Figure 14: Walking as Primary Mode of Transit

Individuals with high latent demand for mobility comprise the other target market for the dual market approach. This target market can best be described as the population whose primary modes of transit are the bus and walking. This population may restrict the number of trips taken due to the actual or perceived travel time, or the cost of travel. Key attributes of a service for this market are accessibility and reliability of travel, and as with all markets, a price point that is affordable for this market segment.

In Cape Town, an estimate based on the percentage of households earning less than R1600/mo and do not have access to a car suggests that 35% of households have latent demand for mobility.[6] [xxix]

This *high latent demand* market also is significant in Bangalore. In Bangalore, 65% of households do not have access to a car or scooter, and 15% of the population in India as a whole is living in extreme poverty.[xxx,xxxi,xxxii]

There are numerous ways to target this offering through the elements of a New Mobility portfolio. One possibility for targeting a population with high latent demand is to partner with a service organization seeking a private shuttle to and from care options. Through this arrangement Ford would be paid by the service organization rather than collecting payment from individuals. Additionally, the service organization could assist with marketing the New Mobility solution.

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[5] 30% of households make R1001 – 3000/mo. R3,000/mo per household associated with car ownership. ~80% of households in R1,001 – 3,000/mo income bracket do not have access to a car in the Western Cape.

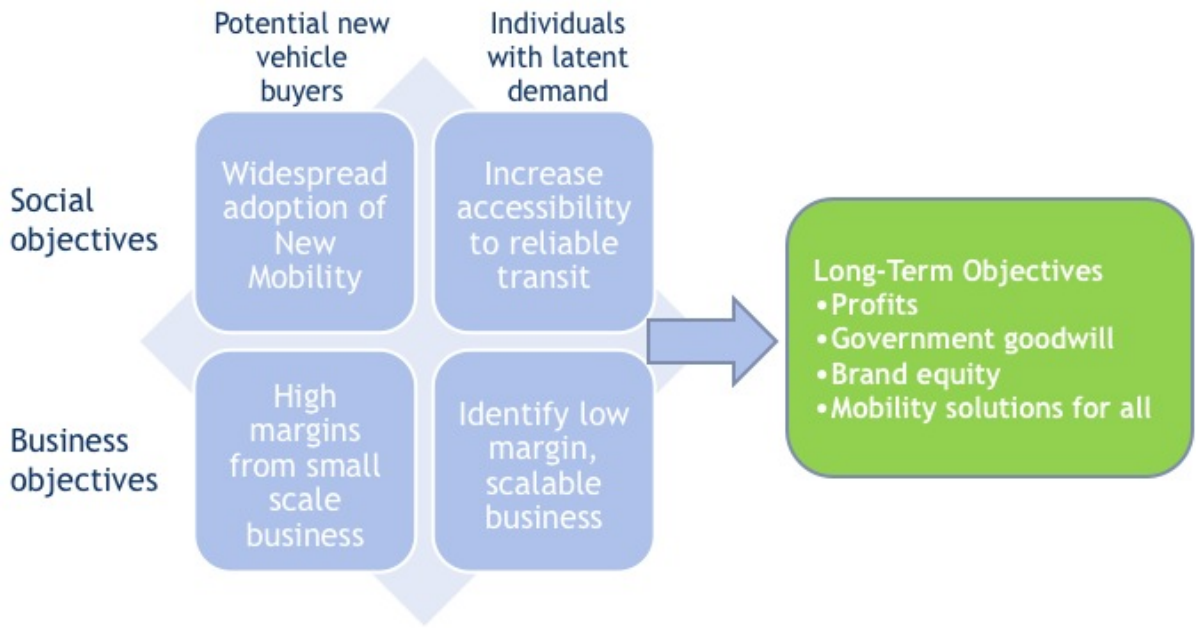
[6] >90% of households making less than R1000/mo do not have access to a car and 39% of households earn <R1,600/mo.

Target Market Comparison		
	Potential New Vehicle Buyers	**Individuals with High Latent Demand for Mobility**
Market Description	On the cusp of vehicle ownership	Bus/walking primary mode of transit Restrict trips due to travel time or cost
Key Attributes of Service	Cool/Hip Convenient	Accessible Reliable
Cape Town Market	24% of households	35% of households
Bangalore Market	65% under age 30% 62% employed/attending school	65% of households without vehicles 15% of India in extreme poverty

Diversified Portfolio Supports Long-Term Objectives

Pursuing this diversified portfolio approach will enable Ford to meet its long term objectives of creating a profitable business, brand equity and generating government goodwill that can be leveraged for future endeavors to support the ultimate goal of mobility solutions for all.

Figure 15: Diversified Portfolio Supports Long-Term Objectives



The following is a description of how the social and business objectives of both offerings combine to support long-term business objectives.

Synergies between social objectives

Providing mobility to *individuals with high latent demand* increases accessibility, has the potential to increase social equity, and assists with the upward economic mobility of these individuals.

The social objective of targeting *potential new vehicle buyers* is to facilitate widespread adoption of New Mobility. One of the reasons automobiles have been so successful throughout the world is because in addition to offering mobility, they also reflect an individual's aspirations and social status. A car communicates the socioeconomic status of the owner, and it represents the feelings and values of freedom, autonomy, and independence.

For a mobility solution to be effective, it must satiate an individual's aspirational desires. To achieve a long-term shift in culture, middle and upper middle class segments must adopt the use of New Mobility transit so that it symbolizes the status currently associated with the automobile. To achieve this cultural shift, Ford can target populations who have the potential to own a car in the future but have not yet achieved the income level to do so. By targeting this segment with an offering that is considered hip and cool, consumer mindsets will shift and New Mobility can begin to displace the personal automobile for the next generation.

This strategy is similar to marketing campaigns that target young and first time buyers of automobiles. Many car companies develop an entry-level car to attract first time buyers to their brand in the hopes of retaining them as a consumer of their products throughout their lifetime,

even as their needs and income levels change. A similar philosophy can be used to justify targeting populations on the cusp of buying cars as potential users of New Mobility solutions.

By targeting these two segments together, Ford can promote a cultural transformation that shifts aspirations and behaviors to align with a more sustainable form of mobility, and enhance social equity and upward economic mobility for impoverished populations. In addition to supporting social goals, these social objectives increase demand for New Mobility solutions.

Synergies between business objectives

The short-term business objective for the *potential new vehicle buyers'* market is to generate high margins while the short-term business objective for *individuals with high latent demand for mobility* target market is to identify a low margin, scalable business. While the high latent demand segment will most likely generate lower margins initially, it will serve a higher volume of users, potentially making it the more profitable business in the long-term.

Robust Design

Targeting the ends of the New Mobility spectrum allows for a holistic design process and creates a more robust design of an integrated offering by considering the range of users' needs and aspirations. Additionally, testing a diverse suite of offerings reduces risk and increases the likelihood of identifying a profitable solution.

Building Competencies through Alliances

What are Alliances?

There are a number of ways organizations can work together to pursue value creation; these can be thought of as a continuum, ranging from equal partnership to individual ownership as illustrated in the figure below (See Figure 14). Alliances are part of this continuum, typically employed to overcome the barriers faced by single entities, including legal and financial hurdles. In addition, alliances must enable both parties to pursue economic benefits more efficiently than either could individually in order to be successful.

The following illustration outlines the spectrum of relations between two or more organizations:

Figure 16: Spectrum of Relations Between Organizations

Key Characteristics of Alliances

Alliances are formed to derive benefits that would be more difficult to obtain by acting independently. Alliances and partnerships typically seek to resolve some form of need or market failure. Types of need can broadly be categorized as those related to human resources, capital, or a product or service offering.[xxxiii]

Relevant Alliances for Sustainable Mobility

In the context of New Mobility, alliances are instrumental in two ways. First, alliances can be used for learning purposes as evidenced by the benefits realized by members of the USCAR and WBCSD examples below. Second, alliances can also add tremendous value during the implementation of New Mobility solutions, as they are able to help companies overcome many of the barriers and challenges faced by an individual entity looking to enter a new market with a breakthrough innovation.

Alliances for Learning

USCAR[xxxiv]: Research & Development

The United States Council for Automotive Research (USCAR) was initially founded in 1992 as a way for US automakers to accelerate technology development in their products through collaborative R&D. The founding members are Ford, Chrysler, and General Motors, but the partnership has evolved to include the federal government (DOE) and several players in the energy industry. It provides an example of a horizontal alliance between companies who typically view each other as competitors yet see strategic opportunity in coordination at a certain point in the value chain. Their partnership focuses on researching innovative, futuristic technologies that could give competitive advantage to the alliance members in the future. Examples of research areas include low emissions technologies, hydrogen fuel cells, and energy storage.

Such a partnership relates to a New Mobility alliance because the consortium focuses on mutually beneficial technologies that are futuristic and not yet proven but could provide significant breakthroughs and strengthen the industry. Also, such an alliance will help to unify and focus New Mobility efforts of companies that may initially have different views on the direction of the industry. Partnerships here could include big players such as Ford, energy providers, and IT providers.

World Business Council for Sustainable Development: Supporting Innovation

The World Business Council for Sustainable Development (WBCSD) is a member-driven, member-led coalition of companies. Its mission is to "Provide business leadership as a catalyst for sustainable development and to support the business license to operate, innovate and grow in a world increasingly shaped by sustainable development issues."[xxxv] While its mission is as described above, one of the key roles it plays is problem definition, to define the issues that need to be addressed

regarding challenges for sustainable development. For example, in the case of mobility, the WBCSD was integral in defining the key trends and issues that companies can use to identify solutions.

Similar partnerships can continue to be used for long-term understanding of macro-level problems. This could be particularly useful for understanding systems relationships and society related changes affecting habits. For example, an alliance could seek to address questions about how urban populations will change over time or the linkage between key socioeconomic issues and mobility.

Alliances for Implementation

Bangalore Airport: Capital Intensive

Capital Intensive projects also often result in public private partnerships. A key to getting massive projects off the drawing boards is the formation of public-private partnerships where the government and companies share costs, risks, and rewards. In 2005, India passed a groundbreaking law permitting officials to tap such partnerships for infrastructure initiatives. Developers ante up most of the money, collect tolls or other usage fees, and eventually hand the facilities back to the government. Bangalore's new airport is one of the first projects to take advantage of India's new law.[xxxvi] The $430 million dollar airport, slated to open in the next year, is designed to handle 11.5 million passengers per year--nearly double the capacity of the existing airport. What is truly unique about this project is not its price tag or capacity, but its financing structure.

In order to leverage India's new incentives for infrastructure development, the Airport Authority of India will be corporatized, and as a next step, airports in Bangalore, Delhi and Mumbai will be corporatized as well.[xxxvii] The airport will be owned by a private company and turned over to the Karnataka state government after 60 years of operation. The global engineering and equipment giant Siemens is helping to build the facility, and Switzerland's Unique Ltd. is tasked with the management of the facility. These companies are also equity investors in the project. Thus, the state of Karnataka had to contribute just 18% of the project's total cost. This financing arrangement has largely enabled the realization of Bangalore's dream of a new airport. If the airport is a success it will proves the viability of public-private partnerships, and more such ventures could begin to take root in Bangalore as well as throughout the country.[xxxviii]

Ford/BP Alliance: Eliminating Uncertainty at the Product Interface

Ford Motor and BP have recently partnered in order to work together coordinating development of vehicle engine technology and their fuels, specifically related to hydrogen fuel cells. [xxxix] This relationship allows them to synergistically develop these technologies and tap market that would otherwise be very difficult penetrate alone. Their partnership is an example of a vertical alliance between non-competing industries to innovate around a product or a service. Instead of working on

technologies that are in the distant future, this alliance focuses on demonstration projects and commercializing currently available, cutting-edge technology.

This type of alliance would be very useful for the development and continued innovation of a New Mobility industry. Consider, for instance, the partnership between Ford and a telecom company in Bangalore, India. On its own, Ford would have a difficult time developing innovative solutions that integrate the New Mobility hub network with cellular telephones and the internet for scheduling and paying for transit. Through collaboration with a company specializing in telecom, however, Ford would gain knowledge about current and near-term technologies related to the industry, which would allow the company to develop technologically advanced, cell phone based hub network solutions not otherwise possible.

Biodegradable Products Institute and the Dairy & Pork Association: Marketing Strategies

When a new industry emerges, competitors often bind and join forces to promote the differentiating feature of their products. The theory behind this is that selling more of a product or service is contingent upon raising awareness regarding why the new category is better. One current example of this trend is the biodegradable products institute, an association of companies that work together to deal with issues related to their product with the hopes of growing the market for all. Additionally, the premise also can be seen in the promotion of new existing products in the food category to increase consumption. Examples include the 'got milk' campaign by the Dairy association, or 'pork, the other white meat' by the pork association.

If a consortium of companies is formed to launch New Mobility solutions in a city, they could jointly fund marketing campaign to support the use public of transit similar to the campaigns described above.

Wal-Mart Bharti: New Territory

Many alliances are formed to enter new territories or regions—sometimes for legal reasons but most often to obtain local knowledge and to build trust with the community regarding the new product or service. The benefits of the local knowledge range from marketing to human resources. For example, local knowledge assists in understanding the best way to market the product or service for the local culture, including identifying promotions to enhance sales, identifying the appropriate sales and promotional channels, and providing knowledge of how to adapt the product to ensure it meets needs and is successful.

In order to enter the Indian retail market, U.S. retail giant Wal-Mart recently forged an alliance with Bharti, India's largest telecommunications company.[xl] Indian law states that unless foreign retail businesses operating in India are single-product retailers, the foreign entity must enter into a joint venture with a local company who will have at least a 50% equity stake in the partnership.[xli] Since Wal-Mart has built its brand on selling thousands of different products, legally they were required to find a partner in order to do business in India.

That said, however, the alliance with Bharti is much more than just a tactic to appease Indian law; both companies realized the strategic benefits of the partnership. The alliance between Bharti and Wal-Mart provides significant advantages to each company. Wal-Mart will run the back-end of the partnership and deal with the supply chain as well as logistics. A separate company owned by Bharti will run the front-end retail aspects of the partnership. It has been rumored that some stores in the chain will carry the Bharti brand name while others may be the Wal-Mart brand US consumers would recognize.

Wal-Mart chose Bharti for their knowledge of the Indian consumer as well as the company's dominant market share and brand visibility within the telecom industry. Bharti will also operate the retail end of the business where they have local bargaining and negotiation skills critical to the success of foreign company such as Wal-Mart. Through the partnership, Bharti intends to become another one of India's large horizontally integrated conglomerates. From Wal-Mart they will gain retail industry experience in supply chain and logistics management, and the knowledge gained from the partnership allows Bharti to become a major player in the retail market. Due to similar legal and cultural considerations in India, South Africa and other potential target markets, Ford should consider similar alliances for the implementation of New Mobility solutions.

Alliances for New Mobility: A Summary

The world is changing at a rapid rate, and mobility is interconnected with a range of socioeconomic factors. To better understand human migration patterns, urbanization trends, and socioeconomic factors that influence mobility patterns such as crime, social inequality, Ford should engage in partnerships with leading institutions to understand the trends that will inform the sitting of New Mobility solutions and the types of offerings that will meet society's needs today and in the future.

While there are limitless types of alliances and reasons for them, the two types of alliances that are most applicable to New Mobility are alliances for learning and alliances for implementation. Two areas within these alliances that would be particularly useful include:

- Understanding megatrend relationships
- Future technology

Information technology is continually evolving and has many synergies with mobility. Partnering with IT companies to understand the technologies of the future will enable Ford to continually evolve New Mobility offerings and design for this changing landscape. For implementation, Ford should seek partnerships for non-core activities and to meet legal requirements for partnerships with local entities in the country in which New Mobility solutions are deployed.

Conclusions/Recommendations

New Mobility is an exciting opportunity for Ford Motor Company as New Mobility represents a business with high growth potential while supplying a solution that is predicted improve environmental and social outcomes.

Innovative, yet-to-be-tested, business concepts with high growth potential require structures, processes, and management approaches that promote adaptation, learning, and building needed competencies.

Ford can realize the potential of this Blue Ocean strategy through undertaking strategic experiments and engaging in alliances to build competencies and facilitate ongoing learning. Through the use of these strategies, Ford will be well positioned to identify trends, opportunities, and changes in the technical, social, and cultural landscapes which shape the New Mobility market.

New Mobility Solutions for South Africa and India: A Framework for Success is part of an ongoing collaboration between the University of Michigan and Ford Motor Company. Potential areas for future research and collaboration include the refinement of the elements of a New Mobility portfolio and modeling the complex interactions of socioeconomic characteristics of targeted urban areas and mobility patterns in cities targeted for New Mobility solutions.

Appendix A: Gap Analysis Questionnaire

This section has intentionally been left blank because it is Ford Confidential.

Appendix B: Market Case Studies

Target City: BANGALORE, INDIA

Bangalore's rapidly growing population and booming economy have both contributed to the city's rising income gap, increased air pollution and traffic congestions. While these challenges pose formidable barriers for the successful implementation of effective transportation infrastructure, the presence of private sector innovation and interest in the application of IT to the transportation sector, nevertheless make this city an attractive market for New Mobility.

Current State of Mobility: Key Issues and Trends

In order to generate the best solutions for Bangalore, an assessment of the current and proposed transportation modes and their governance structures must be examined.

Existing Modal Split and Infrastructure

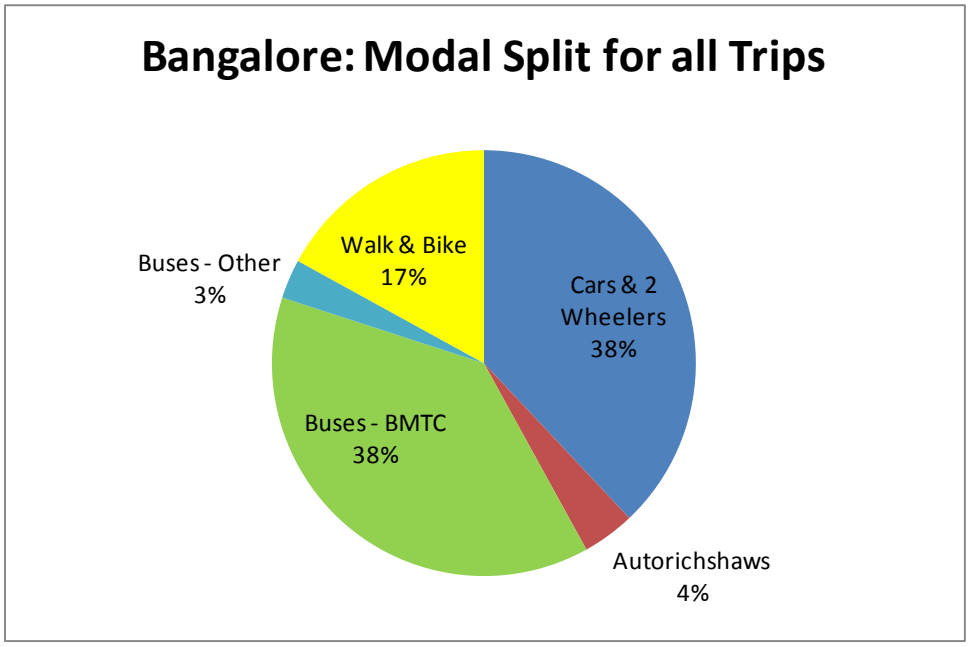
The current modal split by trips in Bangalore includes:

- Walking;
- Biking;
- Public and private buses;
- Cars;
- Two-wheelers; and
- Autorickshaws.

The following chart illustrates the modal split and accompanying text discusses the issues and trends associated with each mode of transportation.[7] [xlii]

[7] *Demand estimates are weak due to no large-scale household travel surveys conducted in Bangalore in many years.*

Figure 17: Graph of Bangalore's Modal Split



Two-Wheelers

Two-wheelers and rickshaws dominate traffic in Bangalore. Of a total of 1,499,000 private vehicles in Bangalore, 81% or 1,220,000 are two-wheelers.[xliii] They are preferred for their convenience and affordability. The average two-wheeler sells for about Rs 50,000 ($1,260USD[xliv]), which is about one-third the price of an entry-level small car.[xlv] While two-wheelers are a popular mode of transportation, they are often blamed for congested and chaotic traffic patterns.

Figure 18: 2-Wheelers in Bangalore

Bangalore is currently experimenting with dedicated lanes for rickshaws and two-wheelers to encourage a more orderly flow of traffic and alleviate congestion. This traffic control tool has been used on main thoroughfares and has had some positive impact on overall traffic flow but has created a negative externality in the form of highly concentrated exhaust. Less efficient two-wheeler and rickshaw engines generate pollution with high particulate matter (PM).[xlvi] Passengers and drivers alike are exposed to this concentrated pollution, which poses a threat to human respiratory health.

Rickshaws

In India, rickshaws are another popular mode of transportation. This type of last-mile transportation has emerged in the absence of convenient, reliable formalized public transportation (i.e. busses).[xlvii] While last mile transit increases mobility for those without personal modes of transportation, it does have external costs, including contributing in large part to traffic congestion as well as air pollution. The lack of regulation over this transit mode results in reckless and unsafe operation of the vehicles by drivers and often deters women from using this form of transit altogether. Regardless of the dangers and negative externalities associated with last mile transportation, the entrepreneurs and drivers that cumulatively provide this service need to be part of any long-term sustainable mobility solution.[xlviii]

Figure 19: Rickshaws in Pilot Dedicated Rickshaw Lane

Cars

Cars are not the predominant mode of transportation in Bangalore, but rather a rapidly growing mode of choice. In 2003 there were roughly 300,000 cars on the streets in Bangalore, a number that is expected to double by 2011.[xlix] Car ownership is appealing both for its perceived convenience and for the status it confers upon its owner. Increased affinity for car ownership and the growing availability of affordable cars in the Indian market[l] will only drive the growth of private cars and further stress aging roads and bridges. While further investment in highway projects may serve as a temporary solution, they will continue to encourage private car ownership and make little headway little toward reducing congestion, noise, air pollution and traffic accidents, all of which have increased with car ownership.[li]

By 2011 it is estimated that 4.2 million vehicles, 2.9 million 2-wheelers and 600,000 cars, will populate Bangalore.[lii] While motorized vehicles will continue to play an important role in an integrated transport system, they should not continue to be thought of as the primary and most efficient mode of transport in the city. This behavior change will be enabled through the creation of transportation alternatives that not only meet the needs currently satiated by cars, rickshaws and two-wheelers, but that also relieve congestion, decrease average trip times and result in improved air quality in the city of Bangalore.

Buses

Bangalore Metropolitan Transport Corporation (BMTC)

The Bangalore Metropolitan Transport Corporation is an independent company fully owned by the state of Karnataka. The BMTC is responsible for operating all conventional, street-based, scheduled

bus services on 1,212 routes with a fleet of 2,200 buses, a staff of 13,830, and a passenger list of 2.6 million daily. [liii]

The BMTC has its roots in the under-funded, overburdened Karnataka State Road Transport Corporation from which it was formed in 1997. Upon its inception, the BMTC conducted a full-scale internal restructuring program. This included the application of IT solutions in every area of the business, from ticketing to accounting and scheduling.

Importantly, the BMTC entered into contracts with the private sector with a "kilometer scheme" that enables private operators to compete on a gross cost basis to serve specific routes. In 2001-2002, 300 private buses were in operation. This constituted about 13% of BMTC's total fleet.

BMTC has reaped great financial benefits from its decisions to implement IT and engagement with the private sector. In 1998-1999 BMTC turned its first profit, reporting a surplus of Rs 39.6 million (<$1 million), which grew to Rs 267 million ($5.6 million) in 2001-2002. In addition to BMTC's strong financial track record, the transport provider is considered among the top two to three urban transport companies in India based on its technical performance indicators.

2002-2003 Statistics[liv]	
Fleet Utilization	96%
Breakdowns	19 breakdowns per 10,000km
Fuel consumption	740.1

Private Buses

A growing trend in Bangalore is the use of private busses and shuttles to transport employees to and from work, busses that are hired by large employees (Infosys, Cisco, etc.) located in and around Bangalore. While private bussing is expensive, it is considered a necessity as public transit does not service these routes, and there is a need to ensure employees have reliable transportation to and from work. According to the article, "The Trouble with India", Infosys spends $5M/yr to transport 18,000 employees to and from work in Bangalore, not including the loss of productivity due to employees spending up to four hours a day in traffic.[lv]

Proposed Infrastructure

Bangalore Airport (2009)

A $430 million dollar airport is slated to open this year in Bangalore. The facility is designed to handle 11.5 million passengers per year--nearly double the capacity of the existing airport. The new airport will be erected 35 km from the city centre. Its opening will result in the closing of the present HAL (Hindustan Aircraft Ltd) airport, which will be dedicated to defense and government

use. To take advantage of the new law, the Airport Authority of India will be corporatized, followed by the corporatization of airports in Bangalore, Delhi and Mumbai.[lvi] The airport will be owned by a private company and turned over to the Karnataka state government after 60 years. The global engineering and equipment giant, Siemens is helping to build the facility, and Switzerland's Unique Ltd. will manage it. These companies are also equity investors. The state had to contribute just 18% of the cost. Without this financial arrangement, the state of Karnataka would likely not be getting a new airport.

Links to Transport

The civic authorities are planning to build seven underpasses on Bellary Road, one of the busiest roads between the city centre and the periphery and leading to Devanahalli airport.[lvii] Additionally,state-run Bangalore Metropolitan Transport Corporation (BMTC) is planning to introduce brand new Volvo buses to ferry passengers to and from the airport as many travelers may find taxi fares exorbitant. One-way taxi fare to the new airport at Devanahalli is likely to be around Rs 1,000 as it is outside the city limits. The BMTC is also planning a luxury cab service.

Despite proposed improvements, road connectivity to the new airport is still a major problem. A 'trumpet' expressway interchange that passes over National Highway No 7 (Kanyakumari-Bangalore-Hyderabad up to Agra) to facilitate smooth traffic flow from the city to the airport is yet to be built. Land acquisition for the expressway is caught in legal wrangles. The presence of significant investments in transportation infrastructure provides an ideal location for the deployment of New Mobility solutions that have the ability to integrate established as well as new modes of transport, obviating many of the connectivity issues highlighted around the development of the new airport.

Opportunities

A key to getting massive projects off the drawing boards is forming public-private partnerships where the government and companies share costs, risks, and rewards. In 2005, India passed a groundbreaking law permitting officials to tap such partnerships for infrastructure initiatives. Developers ante up most of the money, collect tolls or other usage fees, and eventually hand the facilities back to the government. The airport is one of the first projects to take advantage of the new law.[lviii]

A lot of India's hopes rest on the airport deal's success. If it proves the viability of public-private partnerships, more such ventures could come pouring in.[lix]

Bangalore Metro (2011)

The metro is expected to carry 15% of traffic at full utilization. By 2011 they anticipate ridership of about 10.2 million passengers per day, increasing to 16.10 million by 2021. The metro has required acquisition of private, state and federal land, totaling 228.61 acres. A sensitivity analysis revealed that with a 10% increase in cost and a 10% reduction in ridership, the project’s internal rate of return (IRR) would be 7.54% and 7%, respectively, as compared to the base case IRR of 8.20%. Peak

electric power demand, both normal and emergency scenario) is expected to nearly double by 2021 as a result of the activation of the metro.[lx]

Plans for Integration

The Bangalore Metro will integrate its stations with current national rail and city bus routes as well as the planned light rail to the airport. The construction plans include public parking at all major metro stations and provides for feeder bus services to all metro stations. There are also plans to create a common ticketing system for feeder buses and metro. An in-depth assessment of the current and proposed transportation infrastructure must be considered within a broader context of national transportation policies and projects in order to obtain an accurate assessment of the current climate for investments and opportunities in the area of integrated sustainable transportation systems. This assessment should inform the implementation of New Mobility solutions with a focus on integration.

Transportation Initiatives at the National Level: The Indian Transportation Landscape

In early 2005, the Ministry of Urban Development issued a draft of the *National Urban Transport Policy*, which emphasizes the need to increase the efficiency of road space through increased utilization of public transit and the implementation of traffic management tools, including restricting the growth of private vehicular traffic. These efforts will be complemented by a strategy to reduce vehicle emissions via technological improvements in both vehicles and fuels.

The organization and structure of government agencies in the transportation space has posed a major barrier to realizing these goals. Transportation is an inherently unwieldy area to manage as it falls under the purview of and significantly impacts multiple government bodies, as evidenced in the diagram below.

Government Structure as it relates to Transport

While BMLTA is considered the current authority, the central issues restraining this body are clarity of purpose and enforceable influence. There is no clear separation of the planning and operational roles assigned to the BMLTA; (semi-colon, not comma) thus it is presently viewed as a committee of the BMRDA, until it is granted the power to work full-time on traffic issues. Observers suggest that BMLTA is in need of an independent secretariat with officials drawn from traffic, transport, BBMP, BDA, KSPCB and BMRDA, in order for the government body to be taken seriously by stakeholders. In an ideal scenario, BMLTA (or other agency) would make sure that all the components of the transportation system mesh together; coordinating schedules, fares and services like sanitation, information, and help for elderly/handicapped, etc.[lxi]

The implications for private sector opportunities were articulated by one Bangalore resident, "[t]he best I can think is an integrated transportation setup, with a government body like BMTC to monitor it, and smaller pieces of this integrated setup thrown open to private players."[lxii] Specific examples of the division of services between public and private players include:

- Long-haul city routes would be serviced by: metro, Indian railway and bus
- Short-haul bus routes would represent a separate set of bus operators from those mentioned above
- Short, local routes would be serviced by: car rental/car share providers, taxis, and last mile transportation services.[lxiii]
-

According to O.P. Agarwal, the former head of the Urban Transport Division of the Ministry of Urban Development,[lxiv] there is very little coordination or holistic planning between the departments at the state level. What is needed, in the eyes of the former government official, is an agency (or entity) to undertake coordination and an improved management system for transport from a national perspective. There has been some response to the need for coordination at the municipality level, for example, Bangalore's BMLTA (Bangalore Metropolitan Land Transport Authority), although efforts to coordinate various forms of transportation have been unsuccessful to date. There have been a number of solutions proposed, ranging from disaggregating responsibility and service among different players/providers to a more cohesive approach that is overseen by one central government body. The need to integrate various government agencies for the management of transportation services, highlights the importance of government relations as a competence for the integrator of New Mobility solutions.

Target City: Cape Town, South Africa

To various degrees, Cape Town suffers from all of the problems typically seen in burgeoning cities in the developing world. Traffic volumes have grown 3% per year over the last 10 years[lxv] and lead to congestion, decreasing air quality, degradation of public transportation, and unsafe road conditions. These problems most negatively impact the majority of the population who don't own personal automobiles—which in Cape Town is a significant portion of the population. Car ownership there is roughly 200 cars per 1,000 people.[lxvi] Conversely, in Chicago, a city of comparable size, the ratio is roughly 1000 cars per 1000 people.[lxvii] Despite the smaller per capita distribution of cars in Cape Town, private transportation accounts for 52% of the split with public transport.[lxviii] These mobility needs combined with the opportunity to leverage the World Cup for transportation and infrastructure improvements make Cape Town a prime candidate for the implementation of New Mobility.

Current State of Mobility: Key Issues and Trends

Building upon previous New Mobility work and through detailed, site-specific research and analysis, we have generated a list of 6 key issues in Cape Town that significantly impact urban transportation. These issues will help form the basis for determining relevant New Mobility solutions in Cape Town.

Preparation for FIFA 2010 Soccer World Cup

In 2010 South Africa will be the host of the FIFA Soccer World Cup. The World Cup is a worldwide event, and the City of Cape Town is one of the host cities with a total of 9 matches. This event is expected to attract at least 500,000 visitors and they estimate a provisional income for 2007-2010 of $3 billion, plus investment in soccer development.[lxix] City officials plan on using a significant portion of this income for transportation upgrades and they believe, "The World Cup provides an opportunity to fast track and accelerate the improvement in the rail system in time with the rail framework."[lxx] The City has developed an Integrated Transportation Plan as well as Public Transportation Plan to coordinate the improvements in infrastructure.

Racial and Social Inequities

Social and cultural issues have played a significant role in South Africa's history. The government's enforcement of apartheid from 1948 to 1994 has led to serious racial and social inequities within the country that are still being felt today. A large income gap between rich and poor as well as continued racial dissociation are direct affects attributable to the apartheid era. These issues are directly related to many of the challenges faced by the transportation industry. Income inequities have led to inadequate public transportation in the poorer neighborhoods of Cape Town. Also, racial inequities have spilled over to public transportation, attaching a stigma of social separation to the public transport industry. In that vein, public transport is used largely by lower income populations: 26% of population falls into "special needs" transport category, including both life-cycle and impaired passengers.[lxxi] These passengers require more transport investment by the government and can strain an already tight budget.

Crime

Crime is one of the most serious concerns in Cape Town public transportation. In the city's Public Transport Plan, authors note "Cape Town is faced with a high crime level, especially in the marginalized areas where the use of public transport is highest. The dangers are exacerbated by poor infrastructure, inadequate lighting, and lack of surveillance."[lxxii] These problems act as a barrier for social integration in Cape Town's public transport system. The incidences of crime keep many potential users away from the trains and busses and in their personal vehicles.

Human Health

Human health issues, particularly HIV/AIDS infection rates, are also a significant concern in Cape Town. With a total population of 3.3 million[lxxiii] people and an infection rate of approximately 15.7%, over half a million Cape Town residents are infected with HIV/AIDS.[lxxiv] The current lack of adequate public transportation means that many of those infected citizens do not have access to health care. This provides a space for New Mobility to have a significant impact on social welfare.

Economic Issues

Cape Town is one of the more developed cities in Southern Africa but still faces economic challenges associated with developing countries. For instance, 38% of the population lives below the poverty line, and 15.11% are unemployed.[lxxv] Improving economic conditions is always at the forefront of political issues, so leveraging New Mobility as economic development is key to its implementation. The creation of a New Mobility industry will address this area in a direct way: by creating new jobs and by increasing access to current jobs for the unemployed.

Environmental Quality

While Cape Town experiences poor air quality due to particulate matter from diesel engines, it is not a top priority for city officials. That said, urban air quality is a concern for many residents, and transportation in Cape Town contributes to just over 50% of total air emissions.[lxxvi] Even though it may not be of utmost concern to officials and residents, improvements in air quality can be leveraged as another "side" benefit of New Mobility. Optimization of the transportation system through New Mobility implementation can reduce vehicle use and total number of trips.

Governance/ownership of Transport Systems

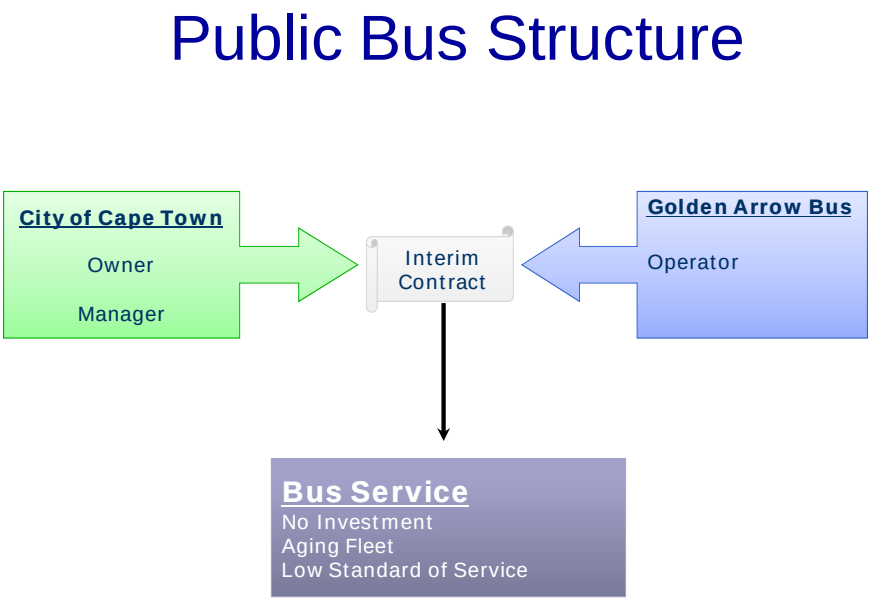
For New Mobility to adequately address the key issues facing Cape Town listed above, there also must be an understanding of the current structures of transportation systems and the relationship between these structures and the overall state of mobility in Cape Town.

Bus Service

Golden Arrow Bus Service operates the public bus system in Cape Town. However, the City of Cape Town is the owner and managing agency. This ownership/operational division and short term focus of operation has led to an interim, short term contract between Golden Arrow and the City of Cape

Town. The lack of a long term contract and management plan has resulted in multiple negative outcomes associated with the bus system. The City of Cape Town recognizes that the current system causes uncertainty and "precludes investment to the operator and has led to an aging fleet and low standard of service quality."[lxxvii]

Figure 20: Cape Town Bus Service Structure

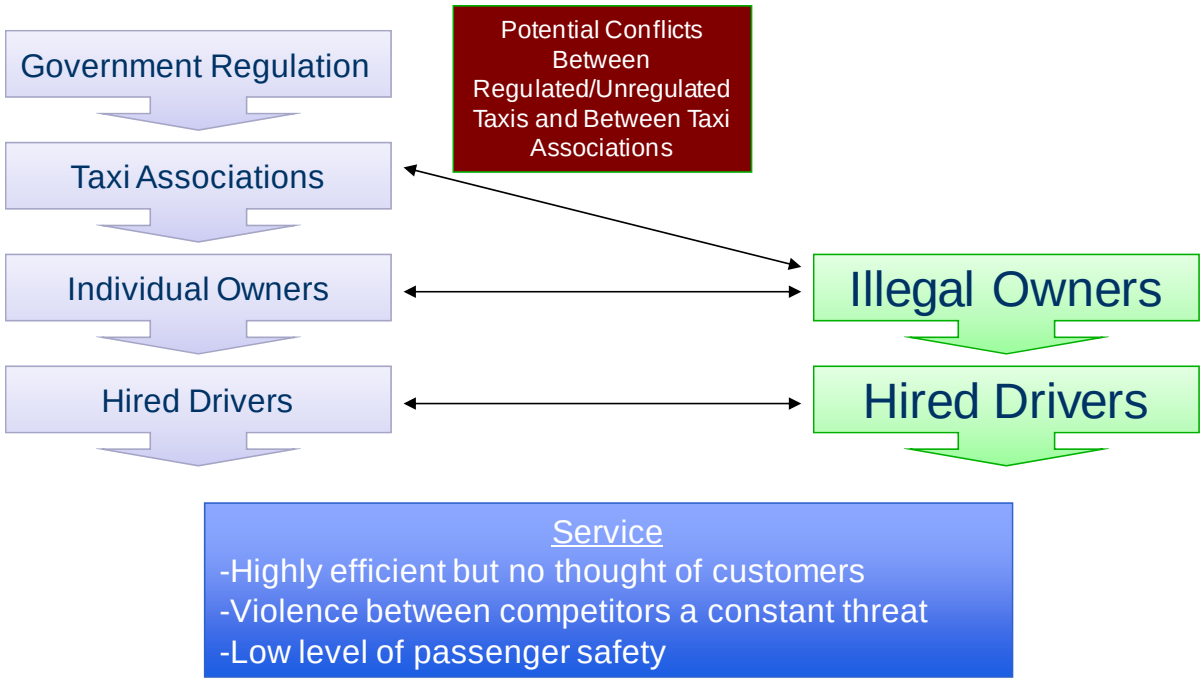


Minibus Taxis

Minibus taxis are the most important form of public transportation in South Africa, and they play a significant role in the Cape Town transportation system. The taxis are primarily used by township residents to commute from outside the city to their jobs within Cape Town. Minibus taxis have an estimated fleet size of about 7,500 vehicles (registered and unregistered), and carry about 332,00 passengers daily.[lxxviii] Minibus taxis are low-cost and incredibly efficient, with a peak frequency every 1-2 minutes during peak hours.

Despite management efforts by the government, the minibus taxi system is highly unregulated. The government issues permits to individual owners, but lack of a permit does not dissuade owners from illegal operation. Taxi owners may have only one vehicle, but most own small fleets operated by hired drivers. Each owner belongs to a local taxi association that manages routes, times, and fares. When one association undercuts another or infringes on another association's turf, violence is usually the chosen enforcement mechanism. This has led to violent altercations in certain places and makes the minibus taxis the most dangerous form of public transport. Also, due to a significant emphasis on profit maximization, the owners have little incentive to maintain safety standards in their taxis and encourage drivers to overload them to maximize passenger fares.

Figure 21: Diagram of South African Taxi Market



Rail

Additionally, the rail system in Cape Town plays a significant role in the daily commute. It carries about 620,000 passengers per day, which accounts for just over 50% of public transportation trips.[lxxix] Unlike other rail systems in South Africa, the Cape Town system services upper class neighborhoods as well as the poorer townships. This means the rail system is uniquely positioned to serve a wide range of transportation users.

The South African Rail Commuter Corporation (SARCC) owns the rail assets and is responsible for planning and funding. The SARCC is a unit of the Department of Transport. A private company, Metrorail, operates the system under an operating agreement and contract with the SARCC. However, the system is currently being restructured to move operating responsibilities over to the SARCC, which would make it wholly owned and operated by the public sector. A lack of funding in the recent past has led to some problems within the system. The infrastructure is deteriorating due to a lack of investment. Personal safety and overcrowding are the biggest concerns for users of the rail system.[lxxx] Lack of adequate crime enforcement has led to an increasing number of events and only solidifies users' perception of an unsafe system. Of related concern, significant overcrowding occurs during peak hours due to the inefficiency of the system, and the current lack of government funding makes addressing these issues difficult.

Private Car Use

The last and fastest growing form of transportation in Cape Town is private car use.[lxxxi] When combined with the lack of non-motorized infrastructure in the city, considerable problems arise

including increasing congestion, commuting times, and accident rates involving pedestrians. During our on-site visit we experienced firsthand the “walkability” of the city and determined that currently non-motorized transportation is not a viable option.

Appendix C: CEMEX Case Study

Transitioning from Offering a Product to Becoming a Full Service Provider

The transition from offering a product to providing a service necessitates a strong company commitment as well as several strategic elements discussed above. The innovations of Monterrey, Mexico based cement company CEMEX provide some key examples of what is required to make this successful transition within a large multi-national company.

Background

CEMEX is the second largest cement manufacturer in the United States and third largest in the world. The company has operations in four continents and has recorded global revenues of $6.54B in 2002, with a gross margin of 44.1%.[lxxxii] CEMEX manufactures and sells raw cement, ready-mix concrete, aggregates, and clinker (used to make cement) under different brand names. As the largest cement company in Mexico, they operated in a highly protected legal environment with little competition until the 1990s. During the 1990s, however, the legal barriers in Mexico broke down, paving the way for international competition. As a consequence, CEMEX then found itself operating in a highly competitive environment, and in 1994-95 they experienced a huge drop in domestic sales. In the formal construction segment alone, sales dropped by as much as 50%, whereas sales in the informal/self-construction segment dropped by only 10-20%[lxxxiii] As a result, CEMEX then conducted an assessment and realized that the do-it-yourself segment accounted for 40% of the cement market in Mexico and had a market potential of $500-600M annually.[lxxxiv] Accessing this new market required key strategic changes within the company and required transition from a large-scale bulk cement manufacturer to an integrated provider of products and services, some previously unrelated to CEMEX's core business.

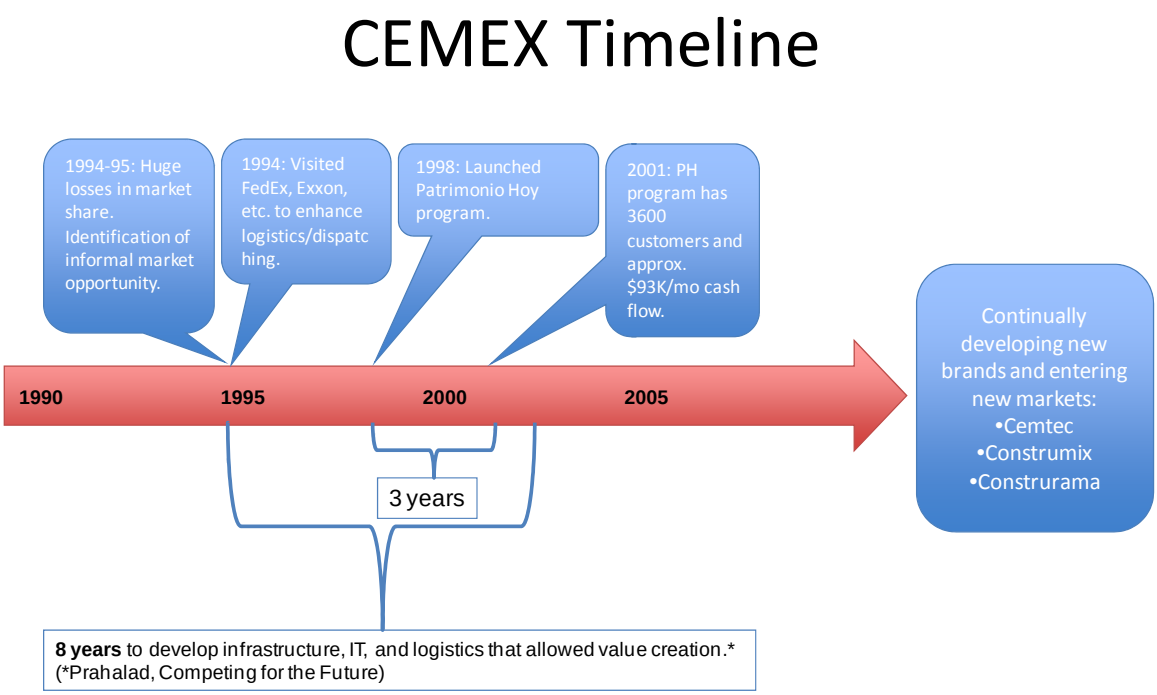
Innovation

Before launching a new program that targeted the self-construction market segment, CEMEX conducted a three month marketing assessment to study the social, religious, political, and financial characteristics of the informal cement segment in Mexico. Through this study the CEMEX team identified three key areas of improvement/change:

- Identify ways to provide access to credit for the poor before selling cement
- Improve the brand perception of CEMEX as a socially responsive company to earn trust from the people, especially the poor
- Change/improve distribution methods and construction practices to make it cost effective for CEMEX, its distributors, and the low income customers

Then, in 1998 CEMEX rolled out their new program called Patrimonio Hoy (Personal Property Today). The goal was to organize low-income consumers into self-financing cells and give them access to low-cost building materials, technical expertise, and building services.[lxxxvlxxxvi]

Figure 22: A Timeline for the CEMEX Case Study



After 3 years of the program, CEMEX had 3,600 customers and was adding about 1,500 more per month. In a similar vein, positive cash flows from operation increased to approximately 1,000,000 pesos per month (roughly $93,000). More importantly, CEMEX took about eight years to build its current infrastructure, starting with the communications network and the IT infrastructure and followed by the logistics infrastructure that enabled its customers to participate in creating value.[lxxxvii] This helps demonstrate that such a transition takes time and cannot be expected overnight.

Key Factors for Success

Several important factors contributed to the success of the Patrimonio Hoy program. These factors are very high level and relevant to Ford's goal of transition from an automobile manufacturer to a mobility service provider:

- Relationships with Distributors/Contractors
    - CEMEX implemented a rigorous standard for distributors interested in participating in Patrimonio Hoy. Only 10% of their past distribution companies qualified under the new, more stringent standard.[lxxxviii]

- Relationships with Consumers
    - Focusing on excellent customer service and good treatment, CEMEX was able to build brand image and loyalty for a commodity. Ultimately this was accomplished through provision of new services previously unavailable to the informal construction market (credit, architecture consulting, etc).
- Systems Analysis
    - Using information from visits to leading companies in other fields such as Exxon and FedEx, CEMEX was able to enhance internal capabilities through incorporation of best practices from the other industry leaders.
- IT
    - CEMEX created an innovative service offering by adapting IT strategies developed for other applications in the business. Research and customer engagement drove the innovation without relying on extreme cutting-edge technologies. Key aspects of the IT system includes delivery trucks equipped with computers and GPS system and connected to a central dispatching system to reduce delivery time, e-commerce site to support online ordering of cement and for customer to specify cement characteristics requested, an online portal that allows customers, distributors, and suppliers to track status of orders and to make changes to existing orders.[8,lxxxix,xc] IT and logistics capabilities enabled CEMEX to achieve a 97.63% on-time delivery rate.[xci]

[8] CEMEX reduced delivery time from three hours to 30 minutes in Mexico City.

Appendix D: Ten Characteristics of Strategic Experiments

Ten Characteristics of Strategic Experiments[xcii]

1. High Growth Potential
2. Focus on emerging or fuzzy industries
3. Test an unproven business model
4. Radical departure from existing business
5. Use of some existing assets and competencies
6. Development of new knowledge and capabilities
7. Discontinuous rather than incremental value creation
8. Great uncertainty across multiple functions
9. Unprofitable for several quarters or more
10. No clear picture of performance early on

Appendix E: Rebound Effect Model

This section was written as a stand-alone document fulfilling an assignment for a systems thinking class at the University of Michigan. It explores more deeply the rebound effect on New Mobility, but may repeat some general information stated in our project paper.

Purpose of the Model

The goal of this model is to evaluate the potential rebound effects caused by the reduced motorized transportation costs and travel time through implementation of an integrated multimodal transportation, often referred to as a New Mobility hub network.

While the previously described hypothesized benefits of a New Mobility hub network are promising, there is potential for cost savings resulting from hub network implementation to be reinvested into travel, thereby returning congestion to its original state. This is often referred to as a rebound effect. A rebound effect is an extension of the law of demand which assumes that a certain percentage of savings will be reinvested into the task at hand, thereby increasing consumption. This trend has been specifically noted in the field of energy efficiency and transportation. For example, increased vehicle fuel economy often leads to an increase in vehicle miles traveled. Roadway expansion also has been shown to induce vehicle travel, quickly eliminating the short term benefits of reduced congestion.[xciii] For this model, we applied the concept of the rebound effect to the application of a mobility hub network in an urban environment in the developing world. We modeled a 30-year time period assuming that the hub network was implemented today. We use data for Bangalore, India as the basis for the model: Bangalore is a city facing serious congestion issues with many roads currently with a congestion index greater than 1 during peak travel times as well as a large latent demand for transportation due to a large portion of the population living in poverty. The main question we seek to answer is how a New Mobility hub network will impact congestion in the short and long-run given potential rebound effects.

Model Definition and Key Variables

Our model is made up for four major sections:

- Cost per passenger trip – The sum of the cost per trip to the individual plus transportation subsidies provided by the government.
- Time per passenger trips – The average time per trip in minutes.
- System capacity – the maximum number of passenger trips per year given the current transportation infrastructure.
- Number of passenger trips - number of passenger trips per year.

Additionally, we have two key modifiers within the system to test the concept of the hub network efficiencies and the potential rebound effect as a result of the increased efficiencies.

- Hub network efficiencies

- Hub network cost efficiencies – Percent passenger trip cost reduction due to hub network efficiencies
- Hub network time efficiencies – Percent passenger trip time reduction due to hub network efficiencies

- Rebound Effect
  - Percent cost savings reinvested – Percent cost savings reinvested based on a review of empirical findings on transportation related rebound effects
  - Percent time reinvested – Percent of time reinvested not to exceed time threshold for travel per day

The following table outlines the model's variables and their relationships.

Cost per Trip				
Key Variable (include units)	**Description**	**Endogenous/ Exogenous**	**Stock/Flow/ Converter**	**Policy Lever**
Average Income (USD)	The average income of a user in the system. This is modified by the Growth in Income variable		Stock	
Income Growth (%)	The flow that modifies Average Income.	Endogenous	Flow	
Growth in Income (%)	The percent that the Average Income grows per year.	Exogenous	Converter	
Government Subsidies (%)	The amount of money the government subsidizes the transportation network on a per trip basis. This is driven by a ratio of cost per trip to average income that is then compared to society's willingness to pay. The specific size of the subsidy is determined by the Percent Government Subsidy variable.	Endogenous	Converter	X
Fractional Income Spent on Transport (%)	The maximum amount of an average person's income that can acceptably be spent on transportation. The assumption is that if they have to spend more than this amount they will	Exogenous	Converter	

	force the government to subsidize transportation.			
Percent Government Subsidy (%)	The size of the government subsidy as a percentage of the cost per trip.	Exogenous	Converter	X
Hub Network Cost Efficiencies (%)	This is the amount of cost savings a New Mobility hub network can give a transportation system. It is a variable that is expressed as a percentage of cost per trip.	Endogenous	Converter	X
Cost (USD)	Cost per trip in the transportation system. This is modified by Inflation, Congestion Factor, Government Subsidies and Hub Network Cot Efficiencies.	Endogenous	Stock	X
Increases in Cost (USD)	The amount in one unit time that the cost increases. This is modified by Inflation and the Congestion Factor.	Endogenous	Flow	
Decreases in Cost (USD)	The amount in one unit time that the cost decreases. This is modified by Government Subsidies and Hub Network Cost Efficiencies.	Endogenous	Flow	
Cost Savings Reinvested (USD)	This is the amount of the cost that is saved in the year to year changes in cost that is used to purchase additional trips in the system. This is modified by Increases in Cost, Decreases in Cost and Percent Cost Reinvested.	Endogenous	Converter	
Percent Cost Reinvested (%)	This is the fraction of the cost savings that is spent on additional trips in the system.	Exogenous	Converter	

Time per Trip				
Key Variable	**Description**	**Endogenous/ Exogenous**	**Stock/Flow/ Converter**	**Policy Lever**
Time per Trip (min)	This is the average amount of time that it takes to complete an average trip in the system. This is modified by Hub Network Time Efficiencies, and the Congestion Factor.	Endogenous	Stock	
Increase in Time (min)	This is the increase in the amount of time an average trip in the system takes. This is modified by the Congestion Factor.	Endogenous	Flow	
Decrease in Time (min)	This is the increase in the amount of time an average trip in the system takes. This is modified by the Congestion Factor and Hub Network Time Efficiencies.	Endogenous	Flow	
Hub Network Time Efficiencies (%)	This is the amount of time savings a New Mobility hub network can give a transportation system. It is a variable that is expressed as a percentage of time per trip.	Endogenous	Converter	X
Time Savings Reinvested (min)	This is the amount of the time that is saved in the year to year changes in cost that is used to purchase additional trips in the system. This is modified by Increases in Time, Decreases in Time and Percent Time Reinvested.	Endogenous	Converter	
Percent Time Reinvested (%)	This is the fraction of the time savings that is spent on additional trips in the system.	Exogenous	Converter	

System Capacity				
Key Variable	**Description**	**Endogenous/ Exogenous**	**Stock/Flow/ Converter**	**Policy Lever**

System Capacity (trips)	This is the optimal number of trips that a system can handle without any increases in time or cost.	Endogenous	Stock	
Planned Increase in Capacity (%)	The amount of transportation infrastructure that is being added to the system to deal with increased demand for trips. This is modified by Maximum Capacity, Time to Add Capacity, and Infrastructure Improvements.	Endogenous	Flow	
Congestion Factor (dimensionless)	This is the ratio of the number of trip taken in a system to the system capacity.	Endogenous	Converter	
Room for Capacity Improvement (dimensionless)	This is the ratio of the maximum capacity to the initial capacity. This is basically the room there is for the capacity to grow.	Exogenous	Converter	
Infrastructure Improvements (dimensionless)	The amount of capacity that is to be added when additional capacity is added to the system. This is modified by the Congestion Factor, Threshold for Action, and Percent Infrastructure Improvement.	Endogenous	Converter	X
Percent Infrastructure Improvement (%)	The percentage of the current capacity that is added every time there is additional capacity added to the system.	Exogenous	Converter	X
Threshold for Action (dimensionless)	This is the trigger for the adding of additional infrastructure based on the congestion of the current system.	Exogenous	Converter	X
Time to Add Capacity (years)	This is lag for the construction (addition) of additional infrastructure.	Exogenous	Converter	

Maximum Capacity (dimensionless)	This is the maximum optimal, assuming that all possible improvements are made, capacity of the transportation system.	Exogenous	Converter	

Trips				
Key Variable (Unit)	**Description**	**Endogenous/ Exogenous**	**Stock/Flow/ Converter**	**Policy Lever**
Trips (trips)	The number of trips made in the system for a given year. This is modified by Time Savings Reinvested, Cost Savings Reinvested, Increase in Trips, Decrease in Trips, Cost Threshold, Time Threshold, and Present Decrease Due to Threshold.	Endogenous	Stock	
Increase in Trips (trips)	This is the additional number of trips taken/required in the system. This is modified by Population Growth Rate, Time Savings Reinvested, Cost Savings Reinvested, Time per Trip, and Cost per Trip.	Endogenous	Flow	
Decrease in Trips (trips)	This is the decrease in the number of trips taken in the system. This is modified by Cost Threshold, Time Threshold, Percent Decrease Due to Threshold, Time per Trip, and Cost per Trip.	Endogenous	Flow	
Time Threshold (min)	This is the limit to the amount of time that a person is willing accept for a trip.	Exogenous	Converter	
Cost Threshold (USD)	This is the limit to the amount of money that a person is willing to accept for a trip.	Exogenous	Converter	
Percent Decrease Due to Threshold (%)	This is the fraction of trips that decrease due to exceeding either the Cost Threshold or the Time Threshold.	Exogenous	Converter	

Population (people)	This is the population of the city/region using the transportation system.	Endogenous	Stock	

Reference Behavior Pattern

Our model is a hypothesized model based on the implementation of a New Mobility hub network that incorporates a rebound effect. The model assumes that a hub network is implemented today in Bangalore, India, and the results are modeled over a 30-year time period. This model is compared to a base case where no hub network is implemented.

Basic Mechanisms and Organizing Principles

If a hub network is not implemented, we anticipate that time per trip and cost per trip will continue to rise and the number of trips will eventually revert to the bare minimum of trips necessary for society to function. This is because the trip time and cost will surpass the time and cost thresholds due to congestion.

We anticipate that the implementation of the New Mobility hub network will postpone this impact and increase the potential number of trips per year; however, system capacity and time per trip will eventually reach the threshold due to continued population growth, a latent demand for travel, the rebound effect, and limits to infrastructure expansion.

Our dynamic hypothesis is that installing and using mobility hub networks will lead to cost and time savings which can actually lead to more trips, and perhaps unexpected congestion, due to rebound effects.

Hub Network Time and Cost Efficiencies

Hub networks are believed to provide both time and cost efficiencies by reducing congestion through encouraging use of mass transit (reduction in vehicle miles traveled), urban design that increases accessibility and decreases the need for motorized travel, and reduced travel time through route optimization and timing of trips. While the exact sources of benefits and percentages cannot be known precisely without a specific design, it is assumed that the new system will decrease the travel time and costs. However, there are limits to time and cost efficiencies that a hub network can provide. In our model, we have assumed that additional improvement to the hub network will be zero by year fifteen. Figure 23 and Figure 24 show the model for efficiencies included in our model.

Figure 23 Assumed Hub Network Time Efficiencies

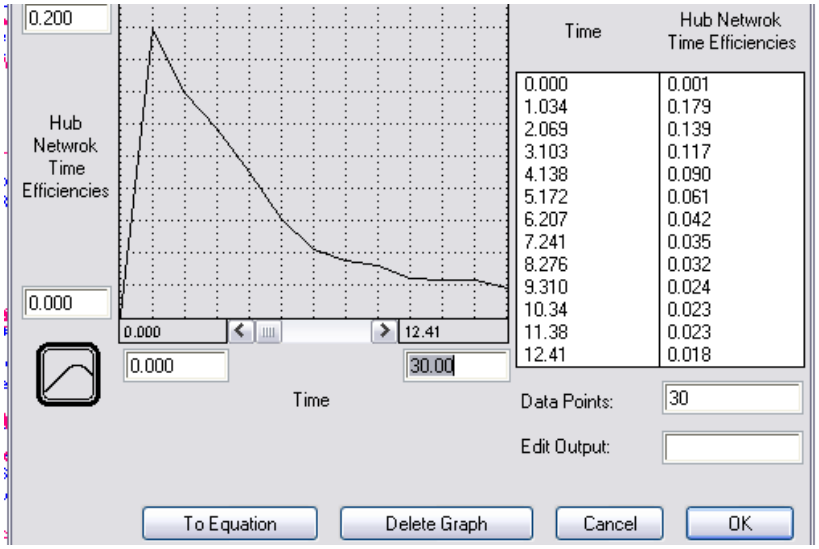
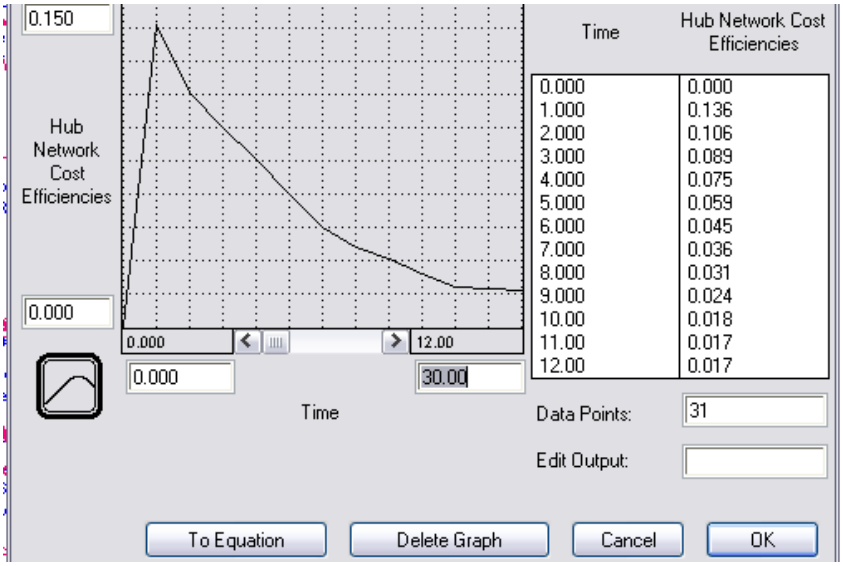


Figure 24 Assumed Hub Network Cost Efficiencies



Rebound Effect

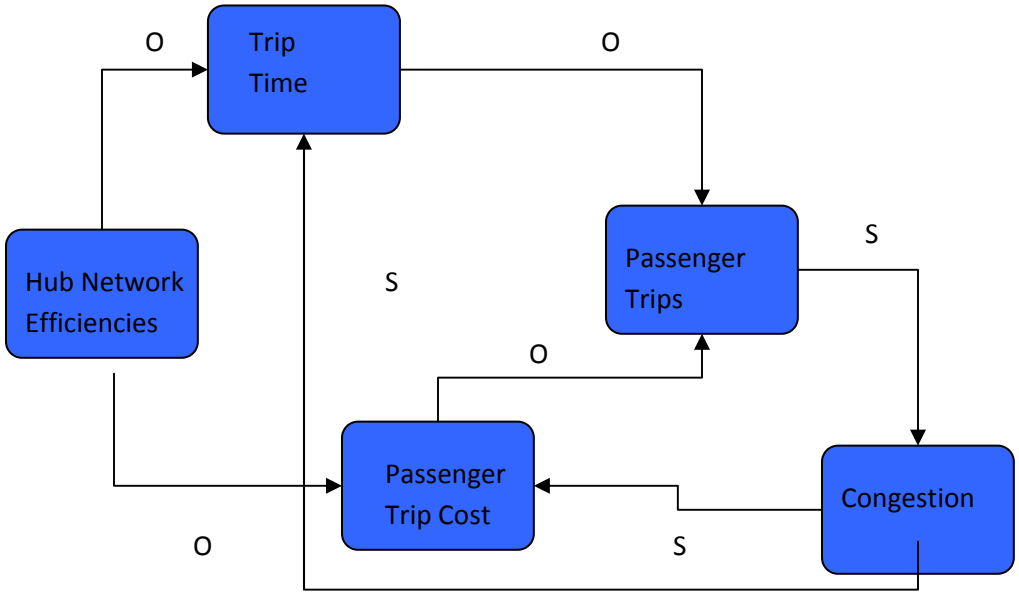
According to M. Binswanger's review of empirical studies of the rebound effect with respect to energy efficient technology, 5-50% of energy savings is invested in additional consumption of the good or service (Binswanger, 2001, p. 123). Studies reviewed related to vehicle miles traveled with respect to fuel economy experienced rebound effects ranging from 9%-22%.[xciv] For this paper, we

ran three scenarios of cost savings reinvested in transportation, 5%, 25%, and 50%, to study the sensitivity of the rebound effect on time traveled, number of trips, and cost per trip.[9]

Causal Loop Diagram

The causal loop diagram below illustrates the basic cause and effect elements of our model.

Figure 25 Causal Loop Diagram



The passenger trips to congestion, to passenger trip cost is a balancing loop. The trip time to passenger trips to congestion, to trip time also is a balancing loop. It is hypothesized that there is a limit to the capacity of the system and the hub network provides a short term fix but addresses symptomatic issues of congestion rather than fundamental problems of accessibility for all. Additionally, it is predicted that congestion will oscillate over time as changes in trip time and trip cost influence the number of passenger trips per year.

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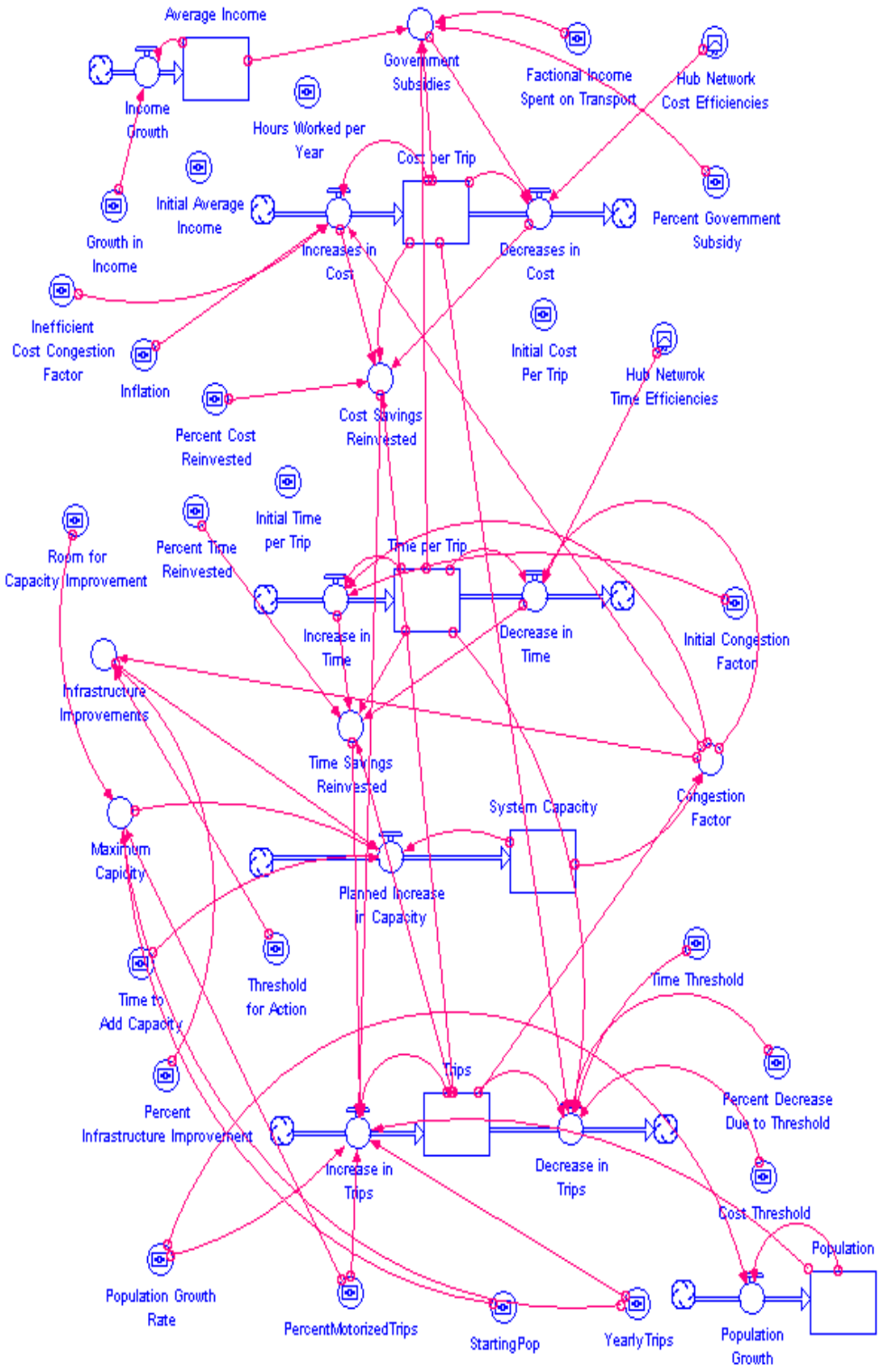
[9] There are two other key variables that must be taken into account when considering the rebound effect: Substitutability between services and the income effect. Substitutability is substituting one mode of transportation for another (non-motorized vs. motorized) and income effect is investing the money saved into the purchase of other goods and services rather than investing it back into transportation. A lower rebound effect would assume a greater income effect and substitutability whereas a higher rebound effect assumes a lower income effect and substitutability.

Stella Model Diagram



Parameter Values

In setting our base variable values, we used Bangalore, India as a reference point. For the variables that do not have hard data, especially the effect that hub networks can have on the cost and time required for transportation, we use graphs that clearly show our assumptions.

Cost per Trip	
Variable	**Assumption/Base Case**
Initial Average Income	$2,200 USD for Bangalore. Source: Gearen et al 2006. Strategic Transformation of Ford Motor Company.
Growth in Income	Assumed to be 8.7%. Based on the general economic growth of Bangalore from 2005-06. Source: http://www.hinduonnet.com/2006/03/21/stories/2006032109900400.htm
Hours Worked per Year	2080. Assuming a standard 40 hour and 5 day work week.
Average Income	Assumed to grow at a steady rate (Growth in Income). For simplicity, average income never decreases.
Fractional Income Spent on Transportation	22%. Assuming that a person in Bangalore uses transportation at the same rate of a person with similar income in the US. Source: http://www.bts.gov/publications/issue_briefs/number_01/html/commuting_expenses_disparity_for_the_working_poor.html
Percent Government Subsidy	2%. This assumption is based on a rough average of the yearly change (ranges from 0 to 5%) in the Indian government's subsidy of the public bus service in Mumbai. Source: http://siteresources.worldbank.org/INTTRANSPORT/Resources/336291-1171658979314/3465102-1175712481687/Mumbai_Transit_SHORT_REV.pdf
Initial Cost per Trip	$1.53. Based on an exchange rate of 42Rs per $1. Source: Sudhir Gota & Prashant Mutalik. Congestion to Demotorisation - A Paradigm Shift for Bangalore By Sudhir Gota and Prashant Mutalik http://www.cleanairnet.org/caiasia/1412/articles-72398_resource_1.pdf. Accessed on March 7, 2008.
Cost per Trip	See Initial Cost per Trip for the basis of the initial value. Future values are calculated based on the input of Increases in Cost and Decreases in Cost.
Inflation	5.3%. Assuming that the current inflation rate will be steady over the course of the simulation. Source: http://www.indexmundi.com/India/inflation_rate_(consumer_prices).html

Increases in Cost	Assumed to increase with inflation and as the congestion factor exceeds the Inefficient Cost Congestion Factor.
Inefficient Cost Congestion Factor	1.5. This is the level of congestion that will lead to cost inefficiencies. This value is a pure assumption.
Decreases in Cost	Assumed to decrease with government subsidies and the benefits of a hub network.
Percent Cost Reinvested	25%. Based on an average of expert opinions. Source:
Cost Savings Reinvested	Assumed to be the fraction of cost that is saved per trip that is reinvested to create new trips.
Hub Network Cost Efficiencies	This is the assumed cost efficiencies of the hub network system. In the model this is a graph so that we can properly estimate is effect throughout the life of the model. This assumption is based only on our collective opinions.

Time per Trip	
Variable	**Assumption/Base Case**
Initial Time per Trip	42 minutes for Bangalore. Based on an average trip length of 10.57 km at an average speed of 15 km/h. Source: Sudhir Gota & Prashant Mutalik. Congestion to Demotorisation - A Paradigm Shift for Bangalore By Sudhir Gota and Prashant Mutalik http://www.cleanairnet.org/caiasia/1412/articles-72398_resource_1.pdf. Accessed on March 7, 2008.
Time per Trip	See Initial Time per Trip for the basis of the initial value. Future values are calculated based on the input of Increase in Time and Decrease in Time.
Increase in Time	Assumed to increase if the congestion of the system increases.
Decrease in Time	Assumed to decrease if the congestion of the system decreases or if the hub network improves the efficiency of the system.
Hub Network Time Efficiencies	This is the assumed time efficiencies of the hub network system. In the model this is a graph so that we can properly estimate is effect throughout the life of the model. This assumption is based only on our collective opinions.
Percent Time	100%. According to World Business Council on Sustainable Development, the time spent traveling per person per day remains at an average of 1 hr throughout the

Reinvested	world. While distant traveled changes, the amount of time remains relatively constant. For this reason, percent of time reinvested in travel is 100%.
Time Savings Reinvested	Assumed to be the fraction of time that is saved per trip that is reinvested to create new trips.

System Capacity	
Variable	**Assumption/Base Case**
Room for Capacity Improvement	4. This number is an assumption because they have very poor infrastructure. We tried to compare the length of roads and subways (741 km for Bangalore) to the overall footprint of the city (4300 km^2) and then compare that to a city that has good infrastructure like New York City to see if the ratio would be much higher (the ratio for NYC is 6.13 for Bangalore it is 5.8), but we feel this difference is too small to totally grasp the scope of possible improvements. Source: http://en.wikipedia.org/wiki/Bangalore and http://en.wikipedia.org/wiki/New_York_City
Infrastructure Improvements	Assumed to increase by the Percent Infrastructure Improvement only after the Congestion Factor is greater than the Threshold for Action.
Maximum Capacity	Assumed to be the existing optimal capacity multiplied by the Room for Capacity Improvement.
Time to Add Capacity	2 years. Rough estimate as time to add capacity because the time will vary depending on the type of capacity added.
Percent Infrastructure Improvement	15%. This is an assumption.
Threshold for Action	This threshold is an assumption based on level of congestion. Current average congestion during peak periods for major roads throughout the city is 1.4. Source: Karnataka Road Development Corp., Ltd. Flyovers and Grade Separators. http://www.krdcl.com/projects/roads/flyover.htm. Accessed on March 7, 2008.
Planned Increase in Capacity	Assumed to be a time lagged amount of capacity that is added to the system that will not allow the System Capacity become greater than the Maximum Capacity.
System Capacity	The initial optimal capacity of the system. It is assumed to be the product of the StartingPop, YearlyTrips, PercentMotorizedTrips divided by the Initial Congestion

	Factor. It increases with Planned Increase in Capacity.
Congestion Factor	Assumed to be the ratio of Trips to System Capacity.
Initial Congestion Factor	1.4. Source: Karnataka Road Development Corp., Ltd. Flyovers and Grade Separators. http://www.krdcl.com/projects/roads/flyover.htm. Accessed on March 7, 2008.

Trips	
Variable	**Assumption/Base Case**
Time Threshold	90 minutes. According to World Business Council on Sustainable Development, the time spent traveling per person per day remains at an average of 1 hr throughout the world. While distant traveled changes, the amount of time remains relatively constant. For this reason, the maximum time allotted time to travel is set at 90 min. Source: World Business Council for Sustainable Development (WBCSD). 2001. Mobility 2001: World Mobility at the End of the Twentieth Century.
Percent Decrease Due to Threshold	10%. This is an assumption.
Cost Threshold	$3. This is an assumption based on the fact that this cost would be about 50% of the average income.
Population	Assumed to grow and never decrease. Its initial value is StartingPop. It will increase with Population Growth.
Population Growth	The fractional increase to population based on the Population Growth Rate.
Population Growth Rate	2.8%. Source: The world's largest cities and urban areas in 2006, City Mayors, 26 Nov 2006 <http://www.citymayors.com/statistics/urban_2006_1.html>.
StartingPop	5.7 million People. Source: Census of India http://www.censusindia.gov.in/Population_Finder/Population_Finder.aspx?Name=Bangalore&Criteria=U
YearlyTrips	365. We assume that each person using the system would take on average one trip a day.
PercentMotorize	85%. Based on the number of people currently using motorized transport in

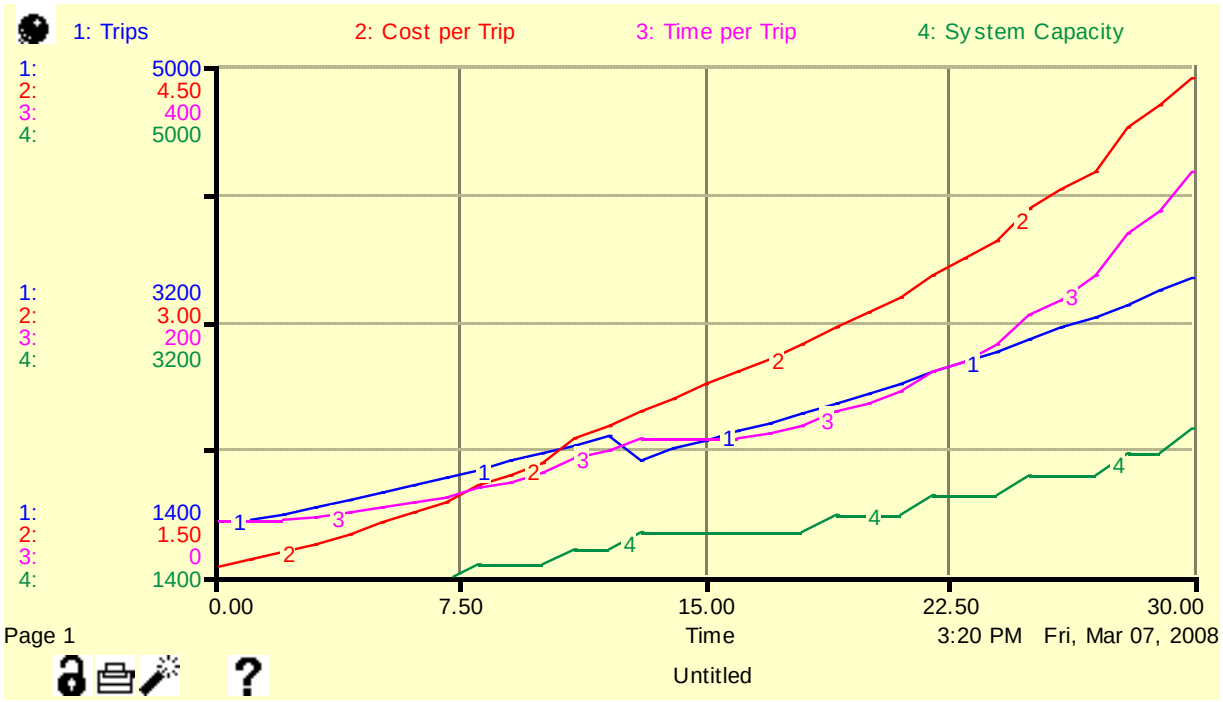
dTrips	Bangalore. Source: Bangalore Mass Rapid Transit Ltd, presentation to the World Bank, November 2003.
Trips	Initial number of trips assumed to be the product of StartingPop, YearlyTrips, PercentMotorizedTrips. The number of trips is then increased or decreased by Increase in Trips and Decrease in Trips.
Increase in Trips	Assumed to minimally increase at the Population Growth Rate. It could also grow with the input from Cost Savings Reinvested and Time Savings Reinvested.
Decrease in Trips	Assumed to decrease if the cost or time thresholds are exceeded.

Test Dynamic Hypothesis

Base Case

As mentioned above, we first used the model to examine the base case. For our base case, all variables are at their given values in the table above, but there is no hub network installed. Therefore, both Hub Network Cost Efficiencies and Hub Network Time Efficiencies give no benefits to the transportation system. Figure 26 is an output graph from the model. Note the drop in number of trips around year 13, due to the fact that the Time per Trip is greater than the Time Threshold. The only reason that the number of trips does not continue to go down after year 14 is the latent demand of the population for minimal transportation. As you can see this high demand coupled with lower than necessary System Capacity leads to high Cost per Trip due to great inefficiencies.

Figure 26 Base Case Output Graph



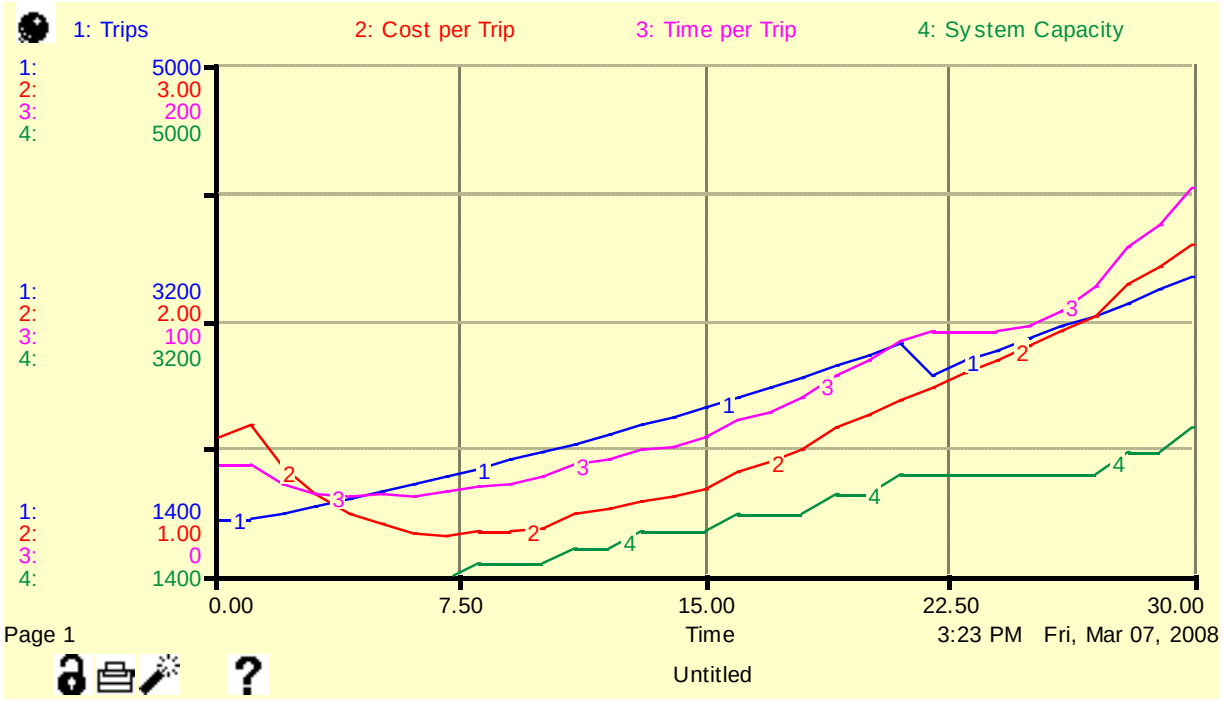
Hub Network Effects

Next, we examined the effects that a New Mobility hub network could have on our transportation system.[10] Figure 27 is the output graph from the model to demonstrate the hub network effect. Note that here the costs for the system remain much lower than the base case. It is also important to note that the hub network was able to delay a drop in Trips due to the Time per Trip being greater than the Time Threshold until year 20. This is a 7 year improvement. Since the slope of the Trips line in

[10] We assumed that the hub network would have a positive effect on the system for at least 15 years, but after that we are assuming that it adds no additional benefit.

Figure 27 is greater than the slope of the Trips line in Figure 26, the hub network drives an increased demand for Trips. The increased demand is most likely caused by a rebound effect due to the cost and time savings.

Figure 27 Hub Network Effect on Transportation System Output Graph



Sensitivities and Policy Levers

Next we were interested in checking how sensitive our model was to changes in a select number of variables. We tried to focus on the variables that will help prove our dynamic hypothesis that there is a rebound effect in transportation. We also wanted to look at the variables that the government, the transportation policy makers, can control. The variables are:

1. Percent Cost Savings Reinvested
2. Percent Time Savings Reinvested
3. Percent Government Subsidy
4. Percent Infrastructure Improvement

For Percent Cost Savings Reinvested, we looked at varying the value from 5% to 25% to 50%.

Figure 27Figure 27 shows the output of the model with 25% Cost Savings Reinvested. When we ran the model with Percent Cost Savings Reinvested at 5% and 50% we got very similar graphs. Upon further inspection, since the actual cost savings taking place is a small fraction of the Cost per Trip, even if 100% of it is reinvested it leads to a small number of increased trips. In order to see if there would be a rebound effect due to a greater constant cost savings, giving more funds for reinvestment, the Hub Network Cost Efficiencies was set to 15% for the entire 30-year run of the model. Figure 28 is the output when Percent Cost Savings Reinvested is set to 5%. Figure 29 is the output when Cost Savings Reinvested set to 25%. Figure 30 is the output when Percent Cost Savings Reinvested is set to 50%.

It is interesting to note that in each of these figures you can see a rebound effect. More trips are taken when money is saved, and it becomes more pronounced as the amount of reinvestment increases. The drop in Trips in each of the figures is due to the congestion in the system growing, driving the Time per Trip up to a point that it is no longer tolerable for the user. Therefore, our model under normal operating conditions is not sensitive to Cost Savings Reinvested, but it is sensitive when there is a constant cost savings throughout the life of the model.

Figure 28 Output for Constant 15% Cost Savings and a Reinvestment Rate of 5%

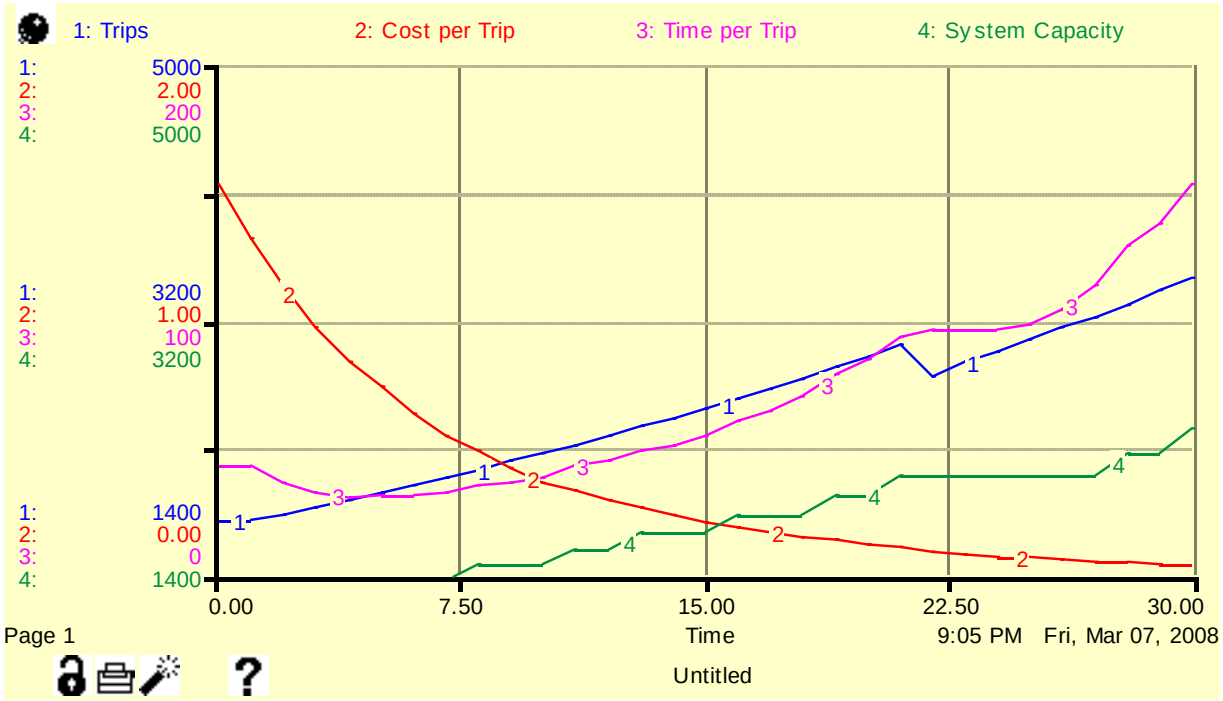


Figure 29 Output for Constant 15% Cost Savings and a Reinvestment Rate of 25%

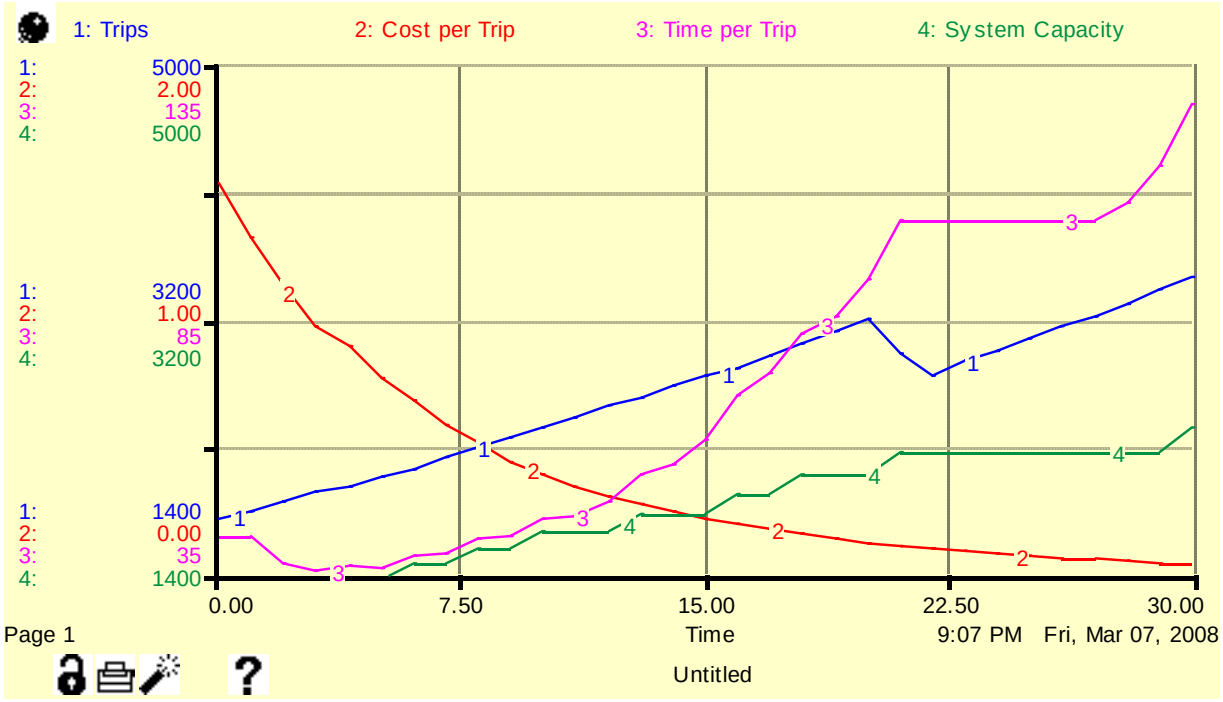
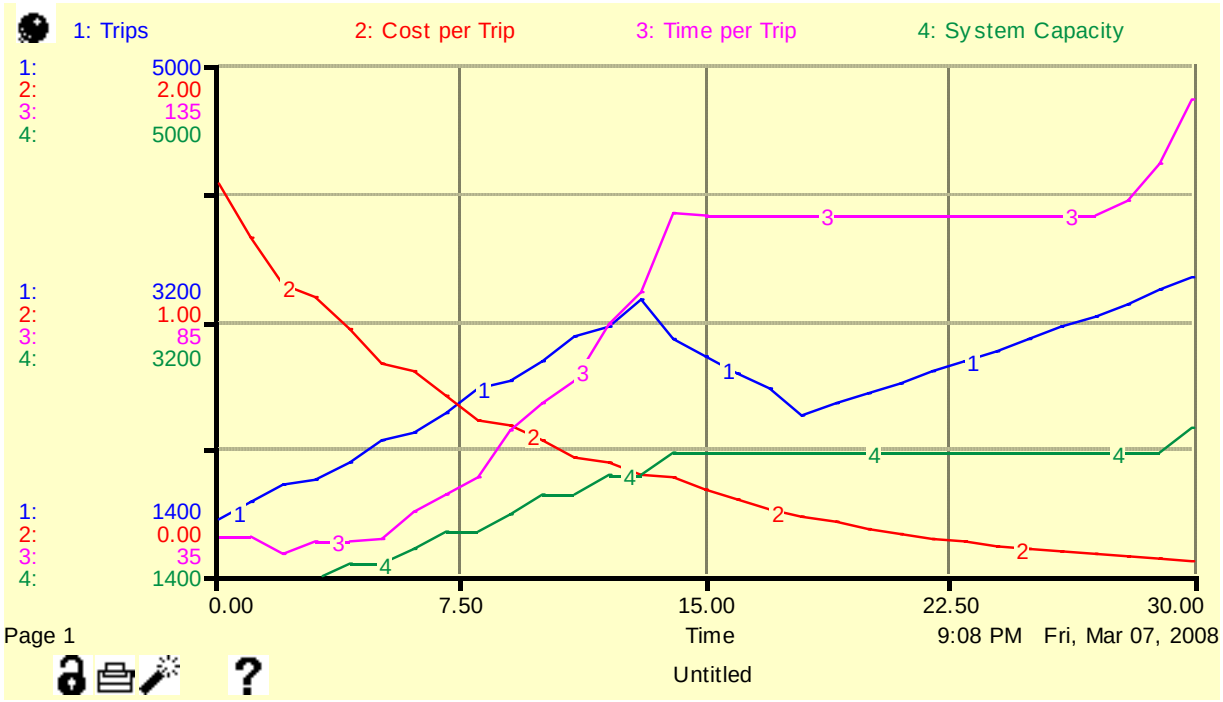


Figure 30 Output for Constant 15% Cost Savings and a Reinvestment Rate of 50%



The sensitivity of the model to Time Savings Reinvested is quite similar to that of Cost Savings Reinvested. Under normal operating conditions, there is no noticeable change in the output if the

Time Savings Reinvested is set to 0% or 100%. But again, if there is a constant time savings of 15%, setting Hub Network Time Efficiencies to 15% for the 30 years of the model, you can see the rebound effect. Figure 31 and

Figure 32 show this behavior for a Time Savings Reinvested of 50% and 100% respectively. The interesting thing to note here is that the model is more sensitive to Time Savings Reinvested than Cost Savings Reinvested. This is shown because the rate at which Trips is increasing is greater.

Figure 31 Output from Model with Constant 15% Time Savings and a Reinvestment Rate of 50%

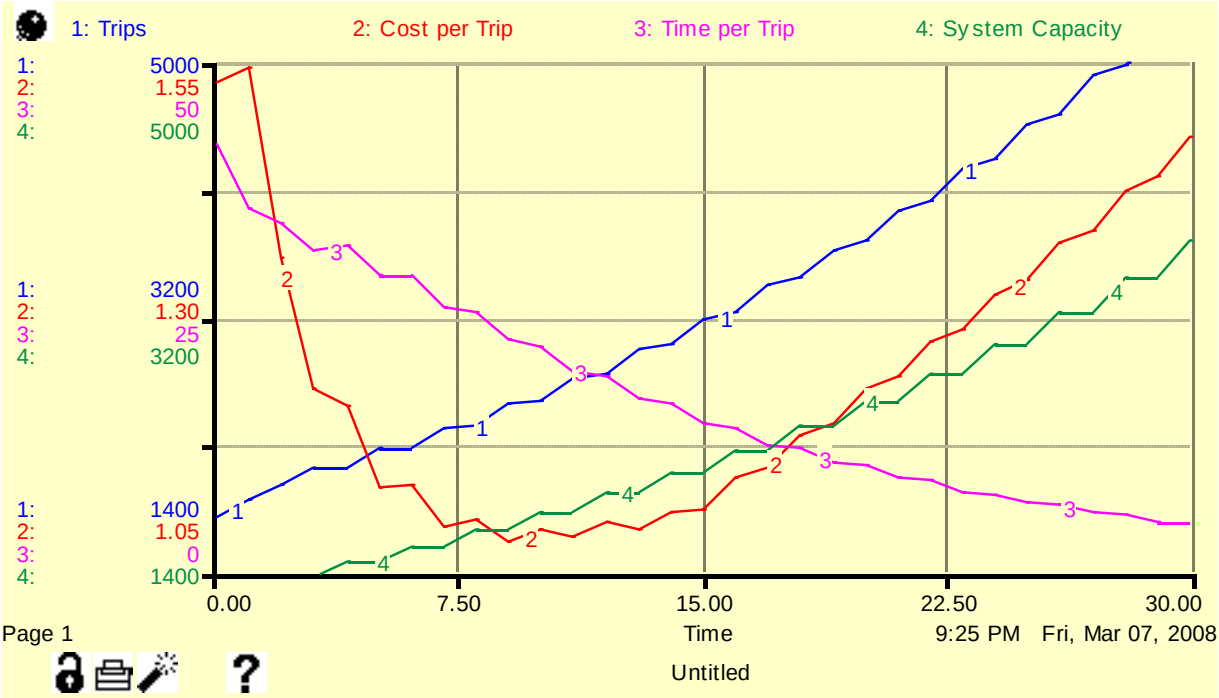
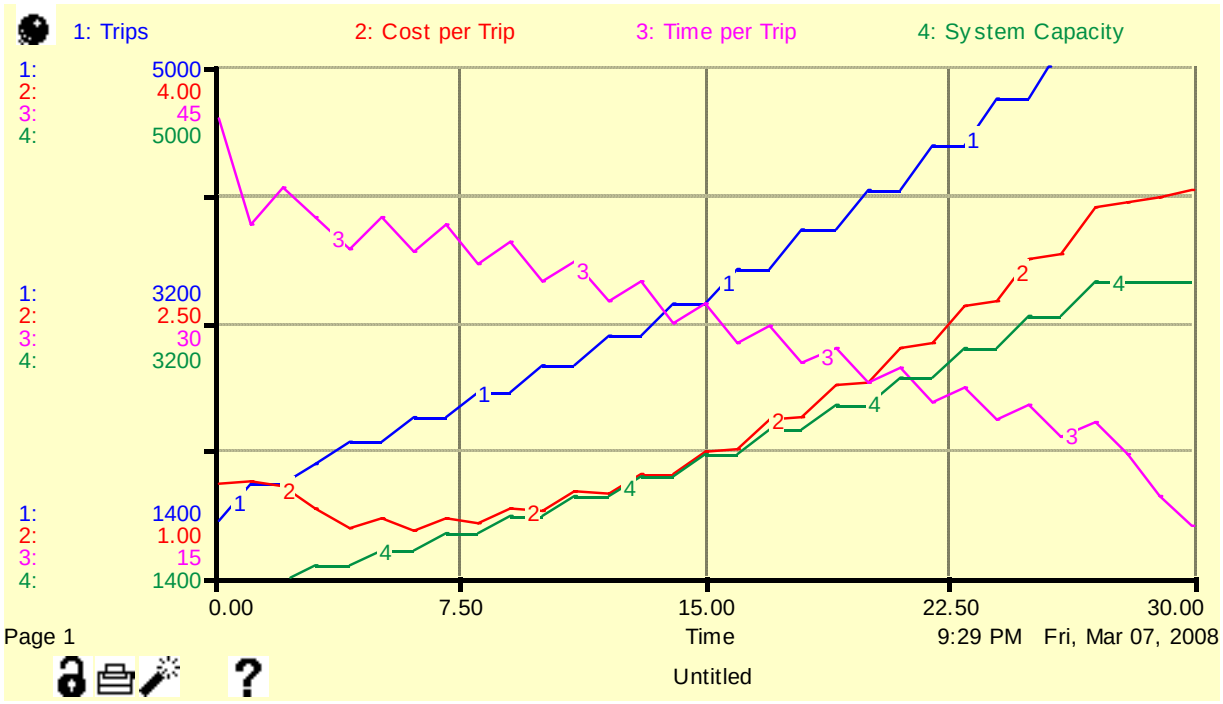


Figure 32 Output from Model with Constant 15% Time Savings and a Reinvestment Rate of 100%



We ran a sensitivity analysis on Percent Government Subsidy because it is a policy lever that the government could use to change Cost per Trip. To determine how sensitive the model is to Percent Government Subsidy its value was varied from 0% to 50%.

Figure 33 through Figure 35 show the output from the model for 0%, 25% and 50% Percent Government Subsidy respectively. It is interesting to note that the final number of Trips does not change based on the amount of subsidy, just the shape of the Trips line. This is because the subsidy lowers the Cost per Trip to such a low level the first time it is introduced that the government never has to introduce another one. Because of this we believe that this model is fairly insensitive to the Percent Government Subsidy in the long term, but it could be used as a policy lever to decrease the Cost per Trip thus increasing the number of Trips in the short term.

Figure 33 Output Graph for the Model with 0% Government Subsidies

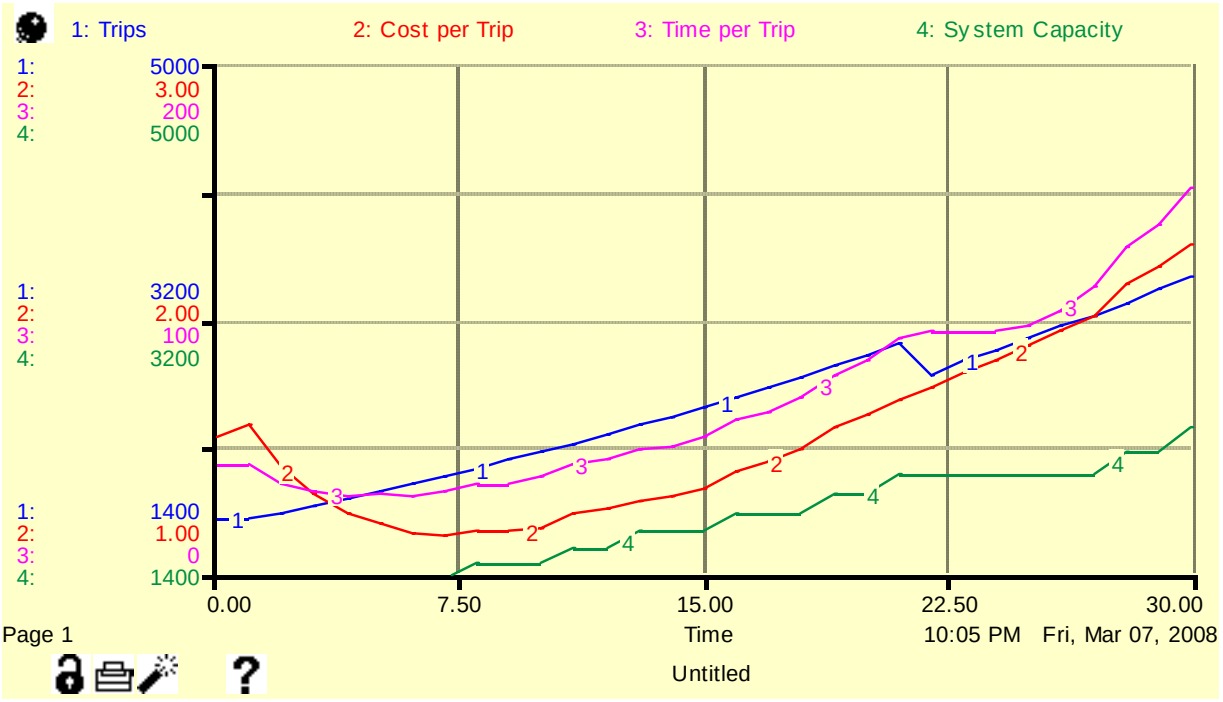


Figure 34 Output Graph for the Model with 25% Government Subsidies

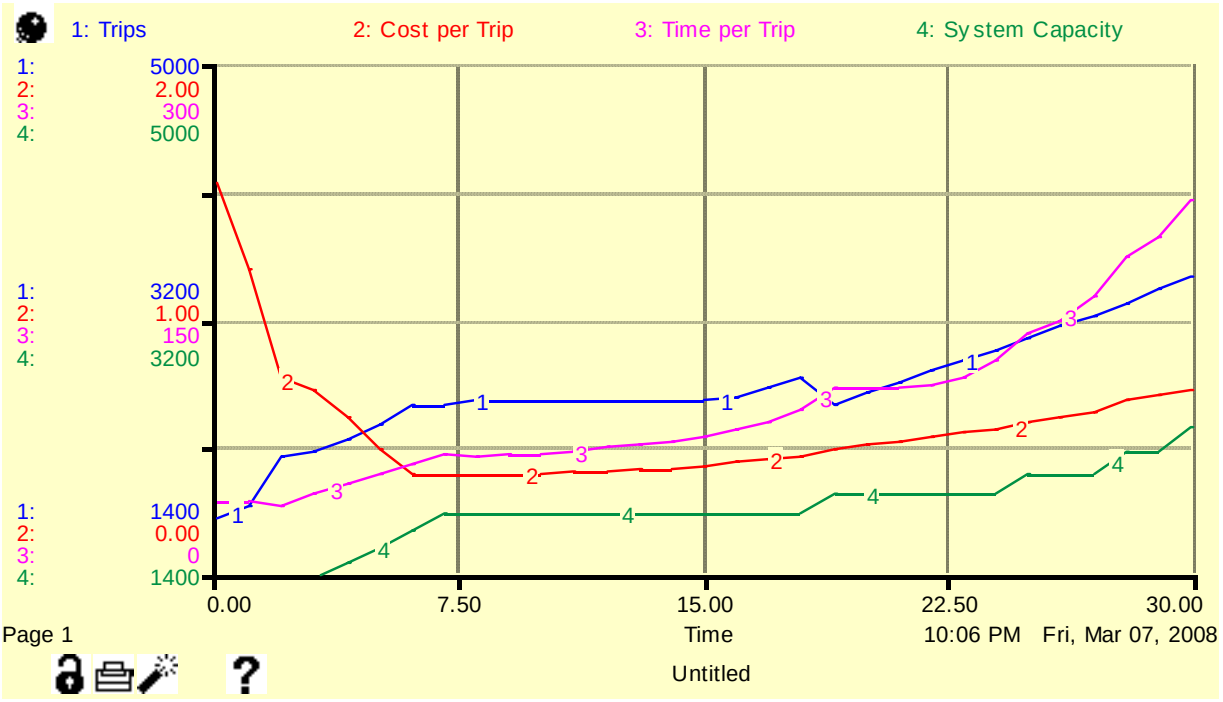
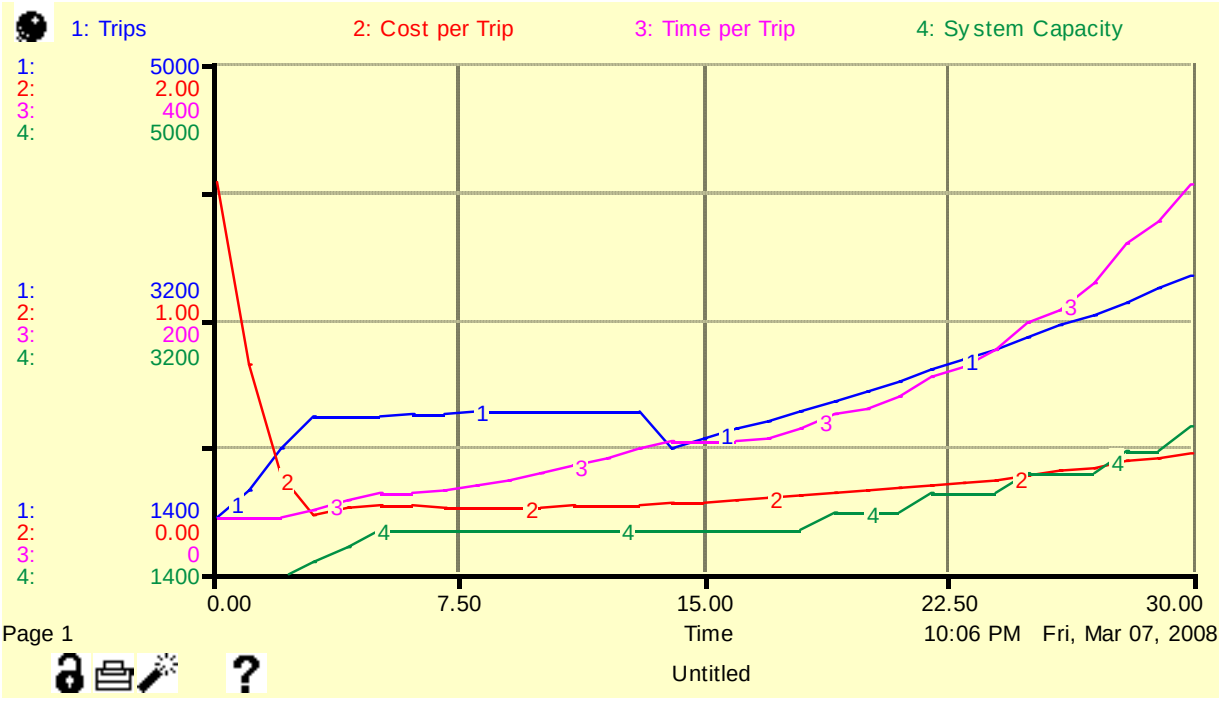


Figure 35 Output Graph for the Model with 50% Government Subsidies



Percent Infrastructure Improvement was subject to a sensitivity analysis because it is a policy lever used by the government to deal with mobility. If congestion is consistently high in an area, the government may choose to increase the amount of infrastructure that they add at any given time. If Percent Infrastructure Improvement is varied from 5% to 30% to 55%, it is clear that it has an impact on all of the output.

Figure 36 through Figure 38 show this behavior. It will drive the number of trips up and smooth out the curve so people are always taking more trips. It will also drive Cost per Trip and Time per Trip down since it lowers congestion in the system. Of course, it is most likely not feasible to add an additional 55% of capacity into an existing transportation system with huge capital expenditures that most governments are unwilling or unable to make.

Figure 36 Output Graph for the Model with 5% Infrastructure Improvement

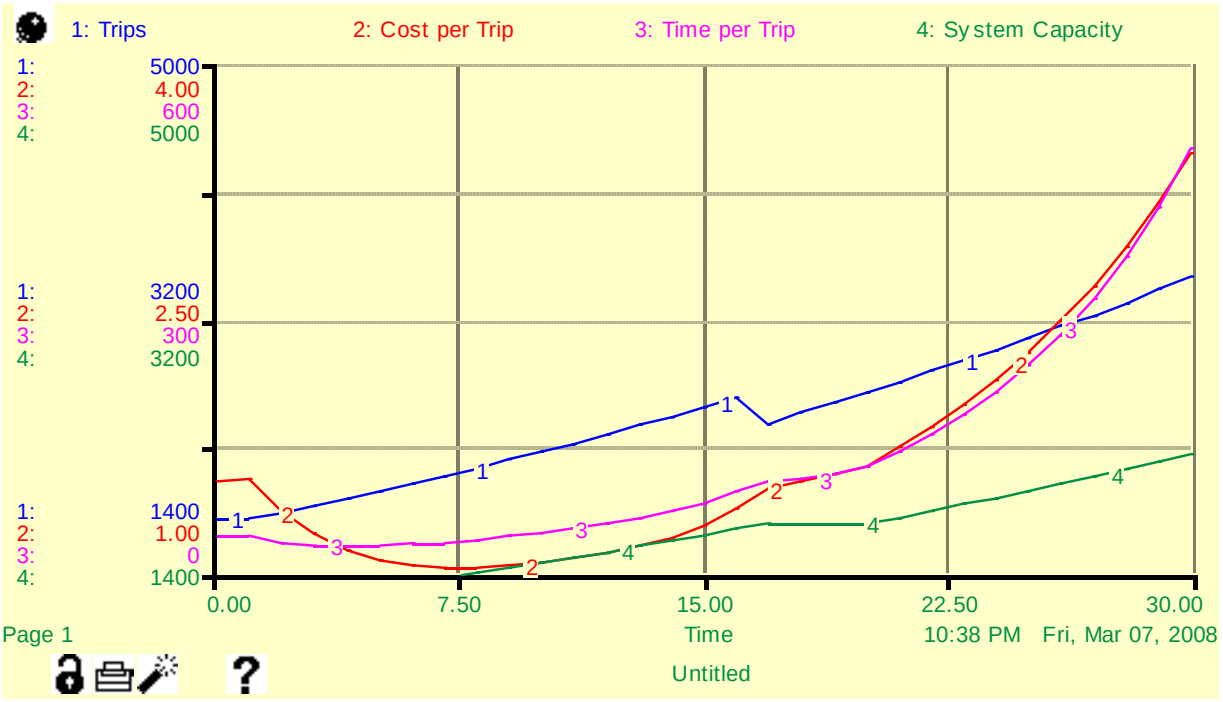


Figure 37 Output Graph for the Model with 30% Infrastructure Improvement

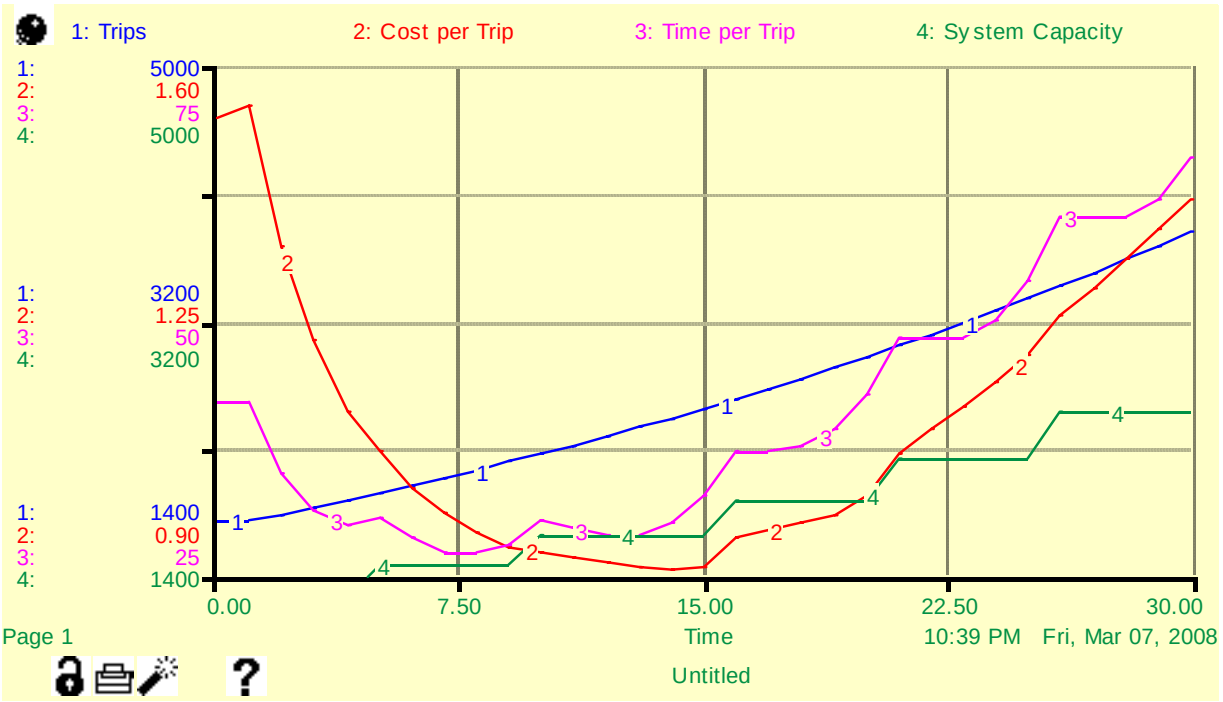
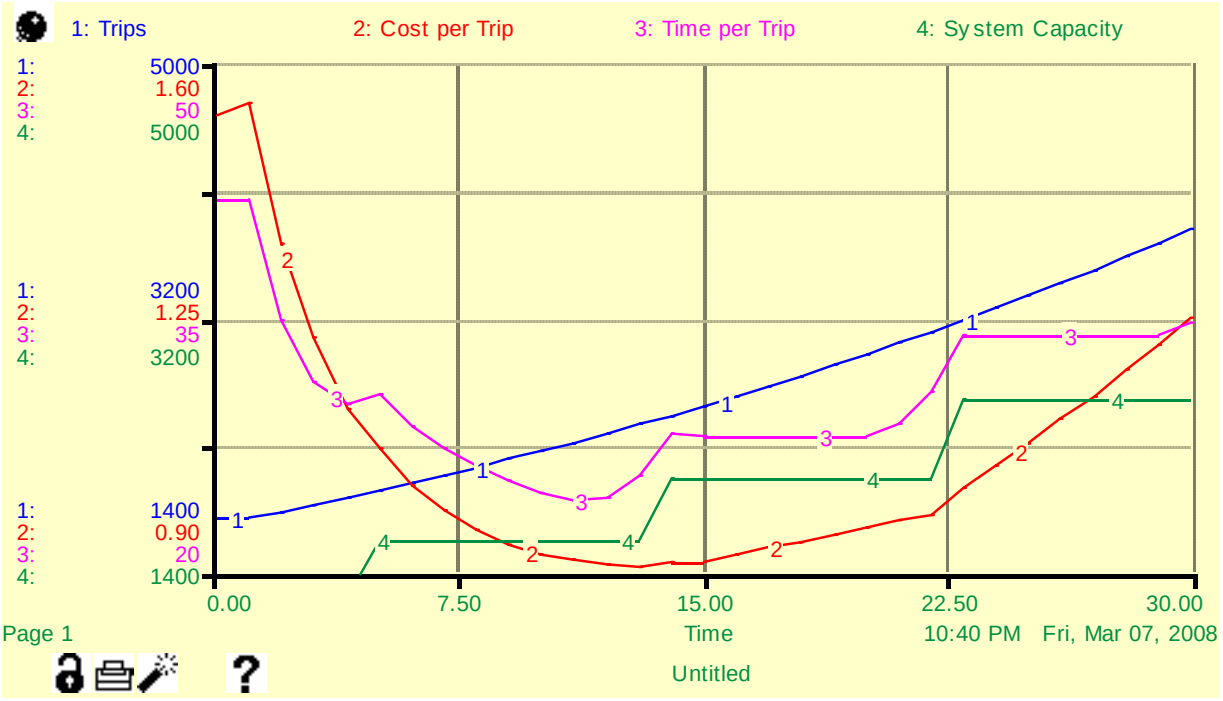


Figure 38 Output Graph for the Model with 55% Infrastructure Improvement



Ways to Improve the Model

There are a number of ways the model could be improved to be more accurate. First, this model assumes that cost and price are synonymous and that all rides are subsidized by the government given certain conditions. Secondly, the model is based on average income per capita rather than classifying the population into different income brackets and modeling their amount of ridership. Cost per trip could be enhanced by including the cost of fuel overtime. Increase in trips could be influenced by income growth. The congestion could impact the overall economy of the region including population growth and income per capita thus influencing ridership. And the hub network and system capacities could be enhanced by including vehicle types, average ridership, queue length, congestion hours, and wait times to more accurately reflect the changes in the system.

Appendix – Stella Equations

Stocks and Flows

Average_Income(t) = Average_Income(t - dt) + (Income__Growth) * dt
INIT Average_Income = Initial_Average_Income/Hours_Worked_per_Year
INFLOWS:
Income__Growth = Average_Income*(Growth_in_Income)

Cost_per_Trip(t) = Cost_per_Trip(t - dt) + (Increases_in_Cost - Decreases_in_Cost) * dt
INIT Cost_per_Trip = Initial_Cost_Per_Trip
INFLOWS:
Increases_in_Cost = IF(Congestion_Factor>=Inefficient_Cost_Congestion_Factor) THEN (Cost_per_Trip*(Inflation+(Congestion_Factor-Inefficient_Cost_Congestion_Factor))) ELSE (Cost_per_Trip*(Inflation))
OUTFLOWS:
Decreases_in_Cost = Cost_per_Trip*(Hub_Network_Cost_Efficiencies+Government_Subsidies)

Population(t) = Population(t - dt) + (Population_Growth) * dt
INIT Population = StartingPop
INFLOWS:
Population_Growth = Population_Growth_Rate*Population

System_Capacity(t) = System_Capacity(t - dt) + (Planned_Increase_in_Capacity) * dt
INIT System_Capacity = StartingPop*YearlyTrips*PercentMotorizedTrips/Initial_Congestion_Factor
INFLOWS:
Planned_Increase_in_Capacity = IF(System_Capacity>=Maximum_Capicity) THEN 0 ELSE System_Capacity*Infrastructure_Improvements/Time_to_Add_Capacity

Time_per_Trip(t) = Time_per_Trip(t - dt) + (Increase_in_Time - Decrease_in_Time) * dt
INIT Time_per_Trip = Initial_Time_per_Trip
INFLOWS:
Increase_in_Time = IF(Congestion_Factor>=Initial_Congestion_Factor) THEN Time_per_Trip*(Congestion_Factor-Initial_Congestion_Factor) ELSE 0
OUTFLOWS:
Decrease_in_Time = IF(Congestion_Factor<=1) THEN Time_per_Trip*(Hub_Netwrok_Time_Efficiencies+.1) ELSE Time_per_Trip*Hub_Netwrok_Time_Efficiencies

Trips(t) = Trips(t - dt) + (Increase_in__Trips - Decrease_in_Trips) * dt
INIT Trips = PercentMotorizedTrips*StartingPop*YearlyTrips
INFLOWS:
Increase_in__Trips = IF(Trips>=(Population*YearlyTrips*PercentMotorizedTrips)) THEN (Cost_Savings_Reinvested+Time_Savings_Reinvested+Population_Growth_Rate) ELSE (Population*YearlyTrips*PercentMotorizedTrips)-Trips
OUTFLOWS:
Decrease_in_Trips = IF(Cost_per_Trip>Cost_Threshold) OR (Time_per_Trip>Time_Threshold) THEN Trips*Percent_Decrease_Due_to_Threshold ELSE 0

Converters

- Congestion_Factor = Trips/System_Capacity
- Cost_Savings_Reinvested = IF(Decreases_in_Cost<Increases_in_Cost) THEN 0 ELSE (((Decreases_in_Cost-Increases_in_Cost)/Cost_per_Trip)*Trips)*Percent_Cost_Reinvested
- Cost_Threshold = 3
- Factional_Income_Spent_on_Transport = .3
- Government_Subsidies = IF(Cost_per_Trip/(Average_Income*(Time_per_Trip/60))>Factional_Income_Spent_on_Transport) THEN Percent_Government_Subsidy ELSE 0
- Growth_in_Income = 0.087
- Hours_Worked_per_Year = 2080
- Inefficient_Cost_Congestion_Factor = 1.5
- Inflation = .03
- Infrastructure_Improvements = IF(Congestion_Factor>=Threshold_for_Action) THEN Percent_Infrastructure_Improvement ELSE 0
- Initial_Average_Income = 2200
- Initial_Congestion_Factor = 1.4
- Initial_Cost_Per_Trip = 1.53
- Initial_Time_per_Trip = 42
- Maximum_Capicity = StartingPop*PercentMotorizedTrips*YearlyTrips*Room_for_Capacity_Improvement
- PercentMotorizedTrips = .85
- Percent_Cost_Reinvested = .25
- Percent_Decrease_Due_to_Threshold = .1
- Percent_Government_Subsidy = .02
- Percent_Infrastructure_Improvement = 0.15
- Percent_Time_Reinvested = 1
- Population_Growth_Rate = 0.0274
- Room_for_Capacity_Improvement = 4
- StartingPop = 5.7
- Threshold_for_Action = 1.5
- Time_Savings_Reinvested = IF(Decrease_in_Time>Increase_in_Time) THEN ((Decrease_in_Time-Increase_in_Time)/Time_per_Trip)*Percent_Time_Reinvested*Trips Else 0
- Time_Threshold = 90
- Time_to_Add_Capacity = 2
- YearlyTrips = 365
- Hub_Network_Cost_Efficiencies = GRAPH(TIME)

(0.00, 0.00), (1.00, 0.136), (2.00, 0.106), (3.00, 0.0892), (4.00, 0.075), (5.00, 0.0593), (6.00, 0.045), (7.00, 0.036), (8.00, 0.0308), (9.00, 0.024), (10.0, 0.018), (11.0, 0.0173), (12.0, 0.0165), (13.0, 0.0135), (14.0, 0.00825), (15.0, 0.00), (16.0, 0.00), (17.0, 0.00), (18.0, 0.00), (19.0, 0.00), (20.0, 0.00), (21.0, 0.00), (22.0, 0.00), (23.0, 0.00), (24.0, 0.00), (25.0, 0.00), (26.0, 0.00), (27.0, 0.00), (28.0, 0.00), (29.0, 0.00), (30.0, 0.00)

- Hub_Netwrok_Time_Efficiencies = GRAPH(TIME)

(0.00, 0.001), (1.03, 0.179), (2.07, 0.139), (3.10, 0.117), (4.14, 0.09), (5.17, 0.061), (6.21, 0.042), (7.24, 0.035), (8.28, 0.032), (9.31, 0.024), (10.3, 0.023), (11.4, 0.023), (12.4, 0.018), (13.4, 0.013), (14.5, 0.00), (15.5, 0.00), (16.6, 0.00), (17.6, 0.00), (18.6, 0.00), (19.7, 0.00), (20.7, 0.00), (21.7, 0.00), (22.8, 0.00), (23.8, 0.00), (24.8, 0.00), (25.9, 0.00), (26.9, 0.00), (27.9, 0.00), (29.0, 0.00), (30.0, 0.00)

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