Hybrid Development of Smart Transportation: Through the Lens of the Triple Helix Model of Innovation

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

To build a Smart City of the future, Smart Transportation is a necessity. In essence Smart Transportation entails using modern technology to empower a city's residents to participate in their communities through multi-modal access to transportation. The definition of a Smart City is constantly changing, but the common thread among the many definitions is the application of new technologies, particularly information and communications technologies, to impact the lives of citizens. Even harder to define is one of the major subsets of the definition of a Smart City, Smart Transportation. It is fitting that given this nebulous meaning, executing the vision of a Smart Transportation is difficult for a variety of reasons which will be explored herein. The smart transportation industry is growing, and by analyzing previous research and case studies I hope to show how the triple helix model of innovation be applied to understand the hybrid development of smart transportation by universities, industry, and government.

Literature Review

Background

Building an intelligent transportation system is expensive, but ultimately economically viable. Without public support, it can be difficult to justify spending millions of taxpayer dollars on modernizing a transportation system. But according to the American Public Transportation Association, “Every $10 million in capital investment in public transportation yields $30 million in increased business sales” and “Every $1 invested in public transportation generates $4 in economic returns.” Studies show that investing in public transportation makes fiscal sense (Public Transportation Benefits, 2019). With this in mind, consider the fact that Gallup found

75% of Americans support increased federal spending on infrastructure (Newport, F. 2020). The funding of the smart transportation business is built on these two facts. Americans want better infrastructure and public transportation is beneficial to all parties.

Although economic viability is the basis for the growth of the Smart Transportation industry, the competitive nature of the market adds complexity. Many proprietary technologies and competing companies provide services necessary for intelligent transportation systems. The market for intelligent transportation systems is projected to grow to from 21.77 billion to 29.16 billion dollars by 2024 (Global Intelligent Transport Systems… 2019). It is an expanding market, which means companies are competing for contracts. They are creating proprietary tools and applications. This results in a more difficult and expensive process of choosing a vendor, and cities risk being locked-in with their chosen vendors. In addition, ridesharing and micro-mobility platforms like Uber, Lyft, Lime and Byrd all have individual apps. A city wishing to create a combined application with all transportation modes in it cannot include these, because of the company's intellectual property. While competition is ultimately good for the consuming cities, in the smart transportation industry's nascent stages it will make it difficult for cities to realize the full potential of intelligent mobility (Glancy, D. J., 2016). This is not an ideal situation for the people who are meant to benefit from this business: the citizens.

While Smart cities as a whole are being developed by private companies for profit, they are not working in a vacuum. Governments and universities are also integral to the implementation and future of the industry. Many consulting companies have entered the smart city industry, forming public-private partnerships with governments. Deloitte published a report with a list of ways to build productive public-private partnerships (Deloitte Center for Government Insights, Diego Canales et al., n.d.). Essentially, it is a starter guide for local

governments to “attract” private partners to satisfy their smart city needs. The private companies which are enabling governments to achieve their goals are in turn enabled by a steady stream of new ideas from universities. Research done by universities provides both the private and public sector with better tools to build smarter cities. But most importantly, the knowledge and ideas graduating students bring into both the public and private sector drives innovation (British Council). These interactions are well documented, and indicate a synergistic development of smart transportation.

Framework

Universities are in a very unique position when considering emerging technologies. Universities interact with industry in two essential ways. They transfer knowledge through students graduating and entering industry, and through the faculty research being utilized in industry. Universities interact with government through policy decisions and public funding. Finally, government interacts with industry via regulation and policy. These interactions can lead to a hybridization of the three stakeholders, notably resulting in public-private partnerships and integration of industry and government interests into universities. This is called the triple helix model of innovation, and is used as a lens to better understand how these interactions affect science, technology, and society.

R. P. Dameri, E. Negre and C. Rosenthal-Sabroux found that the uniting factor of the triple helix model of innovation when applied to smart cities at large is the improved “quality of life for citizens” They distilled a list of driving forces for innovation using a variety of literature sources. While they used the triple helix model of innovation, they combined it with a definition of Smart Cities laid out by Nam and Pardo 2011. Nam and Pardo laid out a well-accepted and often cited model of smart cities that splits a smart city into three factors – Technology,

Institutions and Human (Nam, T., & Pardo, T. A. 2011). This complements the triple helix model of innovation so that when this model of smart cities is combined with the triple helix model of innovation, a clearer understanding of both can be achieved. By using these models in conjunction, the driving factors behind the innovations leading to smarter cities is far less nebulous, and far more defined.

According to R. P. Dameri, E. Negre and C. Rosenthal-Sabroux, universities research and develop useful technologies, as well as their impacts on quality of life. Private companies then in turn enable these technologies by implementing profitable solutions and convincing local governments that these technologies will benefit their constituents. The governments coordinate between both private companies and universities within their jurisdiction, as well as impose regulations which impact smart city technologies. These insights alone are useful to the point of answering what the driving factors of the growth of the intelligent transportation industry is. But according to Nam and Pardo's model of a smart city, technology factors are only one of the three major stakeholders in a smart city. There are human factors and institutional factors to be considered as well. Universities find a diminished role in human factors, mostly defining the role of people within a smart city, whereas private companies view the people as a customer of smart technology solutions they are providing. In addition, private companies attract human talent to a smart city, which benefits both universities and government. The government aims to make a more hospitable environment for the implementation of smart cities through policy decisions, aiming to provide equal opportunities for the citizens. Finally, there are institutional factors. Universities impact policy decisions through research and laying out "top-down" methods of implementing smart cities, centered around the government. Private-companies, in comparison,

lobby for a “mix solution between top-down and bottom-up approach”. Finally, it is reiterated that the government is limited by “the need to find financial support for smart city initiatives”.

Case Studies

While this provides a good basis for understanding the how the triple-helix model of innovation impacts and drives the development of smart cities, it is useful to see this in action. Using a case study on the quality of life of citizens in Curitiba Brazil, the triple helix model put forward will be put to the test. This case study seeks to better understand how a smarter city impacts the quality of life of the people inhabiting it (Macke, J., Casagrande, R. M., Sarate, J. A. R., & Silva, K. A. 2018). This was accomplished through a questionnaire based upon the Eurobarometer, an opinion survey used to study quality of life in the European Union. The study concluded that there were four factors that marked a successful smart city. They are socio-structural relations, environmental well-being, material well-being and community integration. They then conclude “citizens, policy-makers and researchers should be collaboratively involved in the decision-making processes” (p.724). This neatly fits into the triple-helix model of innovation, suggesting that without using this framework for the study, they arrived at the same conclusion that this is an essential dynamic for a successful smart city. They go on to state that technology is far from the end smart cities should require, but rather that the quality of life of citizens is of equal importance. This fits well with Nam and Pardo’s model, specifically that of human factors and that industry exists to serve the needs of the citizens. A smart city requires a give-and-take environment where all stakeholders, industry, government and citizens are working together to increase the quality of life within the city.

A 2018 case study about smart technologies in Barcelona hits many of the same notes, adding that cities are in competition with one another for “companies, tourists and especially

human talent" (Gascó-Hernandez, M. 2018, p.50). This study carefully examines Barcelona's journey to become a world leading smart city. The study suggests that smart cities should not necessarily be judged based upon "output", but rather factors like economic growth, quality of life, or environmental improvement. It highlighted the difficulty of the government in carrying out the vision of a smarter city, due to the constituents not sharing this vision. The human factors must be considered, the people of the city must be educated on the benefits of the systems that are meant to benefit them. Without this crucial education step, the people have significant influence on the triple-helix model. The study also stated "It was the City Council that conceptualized the smart-city strategy and implemented it, involving other actors, mainly businesses and research centers and universities, to pursue what it thought was best" (p. 56). By using the triple-helix model of innovation, one can better understand the who the actors are and what they hope to achieve toward the goal of smarter cities.

With this information in mind, now consider a study proposing a smart transportation framework to address transportation problems in the city of Karachi, Pakistan (Aamir, M., Masroor, S., Ali, Z.A. *et al*). This serves as a perfect example of how the triple-helix model of innovation works in practices, and shows what factors drive the development of smart transportation systems. The foundation of this study is the belief that Information and Communication Technologies are the most fundamental building block of a smart city, and that the goal of a smart transportation system should be to mitigate traffic congestion. The benefits to the citizenry are twofold, the first being less traffic and the second being less carbon emissions from vehicles. The study uses a familiar definition of a smart city: "The basic concept of the smart city is to uplift the living standards of its residents, the city resources are utilized in an effective manner, rising the sustainability, and thus improving the city environment, by using

different optimization approaches, innovations, and comparison of past and present real time data" (p. 29). Once again, it is seen that the quality of life of the citizens of a smart city is the paramount concern. The study cites that despite efforts from the city government, no development plan has been effectively employed since 1949 resulting in a very infrastructurally dysfunctional city. With population increase, and the city railway closing in 1999, the road system is severely overburdened. The proposed solution involves smart technologies beyond the scope of this paper, but the social aspects of it are relevant to the triple-helix framework. The study states in the conclusion that both the government and the private sector have no interest in developing the transportation sector. The study argues that "it is the responsibility of city residents to explore the problems and presented some solution which can help Government or Transportation policymakers" (p. 29). This is an excellent example of the University part of the triple helix calling to action and laying forth a plan for a public-private partnership. It shows that a university alone cannot bring innovations to fruition, but rather they require a synergistic relationship with the public and private sectors for the benefit of society.

Discussion

After parsing the research, it is clear why the intelligent transportation industry is blossoming. It is a core component of any smart city as it is essential to the quality of life of citizens. What is harder to place is what specifically is sparking the advances seen in smart transportation. The implementation of smart transportation takes years to complete, and consistent cooperation between the and public and private sectors. This might lead one to believe that the government implements smart city policies because their constituents request them. But

as shown in the literature, some city governments implement these policies without public support, to the degree that the mayor of Barcelona lost an election.

The two primary drivers in a shorter timeframe are the public and private sectors. Universities produce a constant body of research on the implementation of smart technologies, policies, and other related topics. It is difficult to know how far this body of research reaches into the private and public sectors. While the literature explains the effectiveness of various implementations of technologies, it shies away from the public-private partnerships that lead them to the completion of a smart transportation system. University research certainly finds its way into the public and private sectors, but at a much more delayed rate than the scale of which smart cities are implemented. Policy changes much faster than emerging research is applied in industry. Thus, university research plays a delayed role in the triple-helix model of innovation.

Between the public and private sectors, it seems the public sector is the source of capital, and the private is the source of innovation and services. The government contracts intelligent transportation companies to fulfill their needs, which is beneficial to all parties involved. The literature debates on whether a “top-down” or “bottom-up” approach is better, but often times the public and private sectors disagree. The literature states that while government organizations often times prefer a “bottom-up” approach based on citizen input; industry typically uses a mixed approach. It could be worthwhile to research how these varied approaches impact the synergy between triple helix stakeholders.

The “human factors” involved in the development of smart transportation and smart cities as a whole are substantial enough to merit further discussion. The literature revealed that human factors permeate the triple helix of innovation on every level. Universities constantly produce educated individuals with fresh ideas and skills, industry and government alike try to attract

these individuals. Government organizations exist to serve people, and industry relies on people to both produce and consume their services. Human factors are at the core of each of the three parts of the triple helix. They influence them all in separate ways, existing outside the three organizations. For this reason, the quadruple helix first suggested by Elias G. Carayannis and David F.J. Campbell with a fourth component being civil society and the media could perhaps be used to represent these pervasive human factors in the development of smart transportation and smart cities.

Conclusion

The triple-helix model of innovation is a useful framework for understanding the synergistic development of smart transportation. Each of the three components interacts to produce results in real cities. Universities puts forth new ideas, technologies, and people which in turn enable the government and private companies to take action. Smart transportation at its core is meant to improve the quality of life of a city's inhabitants, while remaining sustainable and improving efficiency. Once the government takes the initiative, whether pressured by its citizens or not, private companies are available to realize their goals. All throughout these three prongs are human factors which must not be forgotten, as they are truly the ones driving the innovation across all levels. A mutual desire to improve the city's they live in, and provide better more efficient transportation is what is driving the growth of this industry. The citizens are expecting great things from the government, the government working with private companies to make them a reality, and universities are providing new and excited technologies and ideas for private and public sectors alike to utilize.

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