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ABSTRACT

Title of Document:	The Usefulness of Freight Performance Measures in Urban Policy
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This dissertation investigates the usefulness of freight performance measurement (FPM) in urban policy. Currently, decision-makers determine policies with robust data on people movement but limited data for freight, especially for freight mobility as this data involves proprietary private sector risks. However, freight mobility data is critical for urban policy. This dissertation poses two questions: Do performance measures influence urban policy? Are they worthwhile? These questions are explored using a retrospective, current and future assessment of FPM use and benefit. The use of elite interviews and a follow-up focus group helps to provide subjective accounts while regression analysis helps provide an objective lens. The results show that FPM is perceived as useful and influential in urban policy, but in limited ways primarily due to its availability. Newer freight mobility data is a statistically significant predictor of funding decisions and appears worthwhile as a policy tool.

THE USEFULNESS OF FREIGHT PERFORMANCE MEASURES IN URBAN POLICY

By

Nicole Jennifer Katsikides

Dissertation submitted to the Faculty of the Graduate School of the University of Maryland Baltimore County in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

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Dedication

For Tom, Kiriakos, and Annie, Mom and Dad.

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Chapter 1: Introduction

This dissertation investigates the usefulness of freight performance measurement (FPM) in urban policy.[1] It explores how FPM shapes transportation and the efficacy of this information in influencing urban policy decisions. Currently, decision-makers determine policies in the form of strategies, investment, and statutes with robust data on people movement but limited data for freight, especially freight mobility.[2] Freight mobility information is the most limited for public agencies yet perceived by the transportation planning community as critical for decision-making (Transportation Research Board (TRB), 2014). This research explores the criticality of FPM with a focus on mobility and its usefulness in the scope of its perceived value[3] in urban policy.

An exploration of this type is significant due to noteworthy urban freight impacts and transport costs, which require state and metropolitan region attention. It is necessary to incorporate freight concerns into planning and policy due to federal mandates (Moving Ahead for Progress in the 21st Century (MAP-21) 23 U.S.C., 2012) (Fixing America's Surface Transportation (FAST), 2015). There is also a parallel movement among cities to be competitive and improve economic development, to which the efficient movement of freight contributes (Short, 2006). However, governmental access to freight data and FPM practice is limited,

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[1] For this research, freight refers specifically to the movement of goods on the transportation network.
[2] Freight mobility is how well freight moves on the transportation network. For example, are trucks in bottlenecks along the routes and what is the delay? Are bottlenecks predictable or unpredictable. These are defined later in the literature review.
[3] Value is used in this research informally and is not quantified.

especially in the case of mobility data. This lack of information is primarily due to private sector ownership of freight modes and the risk of sharing proprietary data without a sufficient perceived benefit by the private sector (TRB, 2012). The absence of public data creates challenges for transportation agencies in responding to federal requirements, as well as to identify policies including investment locations that best support the urban economy.

Despite efforts to develop FPM mobility data, particularly over the past 15 years, public agencies still only have access to highway data. They need multimodal data to illustrate the movement of goods much in the same way they have multimodal data to illustrate people transit (TRB, 2018a).

The resources that have gone into developing FPM and the federal mandates led me to question why this problem exists and why it seems to persist. I contemplated if an improved understanding of FPM usefulness and value in policy development, especially for urban settings, might help engage the public and private sector in resolving data risk issues for developing FPM.

In relevant literature, a gap exists in research on the specific usefulness and efficacy of FPM for urban policy. There are many studies on performance measurement and management for the public sector. There is also a growing body of research related to transportation performance measurement, the development of freight measures and measurement of bottlenecks, as well as costs of congestion. The gap is in research that illustrates how FPM results influence urban policy decisions and if there is a perception or level of value created.

Therefore, this research seeks to contribute to the field of knowledge by exploring the usefulness of FPM and if it is influential or valuable in urban policy development. Specifically, I ask, are FPM measures useful in urban policy? Answering this question requires investigation of three subsequent queries. First, do existing performance measures influence urban policy, with the example of freight transportation? Second, did performance measures influence urban investment decisions? Third, are performance measures worth the effort?

The hypothesis I test is that FPM is useful, or influential in urban policy, and it is worthwhile, meaning that it provides some level of benefit or value. Concepts of decision-theory point to status quo public agency decision-making as incremental, meaning that decision-makers create rushed and sparsely informed decisions due to low availability of resources (Anderson J. , 2003). I theorize that that FPM could improve status quo incremental decision-making through greater awareness of freight issues in the urban policy process. I also contemplated how greater awareness might support the urban economy and concepts of the urban theory on competitiveness. In other words, would decision-makers invest or strategize differently? If so, I questioned the value related to the theory of value of information and the concept of how learning something before a decision is made, affects the expected value of making an informed decision compared to an uninformed one (Lawrence, 1999).

The research objective is to answer these questions through a retrospective and current analysis of usefulness through research on what decision-makers do with FPM for urban policy. Then an analysis is conducted of what occurred with use of FPM for urban investments (what they actually did). I also incorporate a forward-looking approach to analyze perceptions of FPM use as worthwhile.

The research methods first include a series of interviews with expert elites in urban freight transportation to identify ways in which FPMs influence urban policy. I then quantitatively explore the roles of FPM on funding decisions by analyzing characteristics of freight projects chosen for funding in the Baltimore region. Finally, I use a feedback loop meeting with a group of urban transportation decision-makers in Baltimore to explore perceived usefulness of FPM for urban policy in light of initial insights from the elite interviews and funding decisions.

This dissertation is structured in the following way. Chapter 2 defines the research problem. Chapter 3 provides a literature review including theory and relevant research that helps identify the gap in information and what research is available to support the analyses. Chapter 4 provides information on the general methodology and development of research related to the research questions. Chapter 5 focuses on the elite interviews for a current view of FPM use in urban policy. Chapter 6 provides the regression analysis of funded projects for the retrospective view. Chapter 7 presents the focus group research and results on perceptions of FPM as worthwhile. Chapter 8 presents a discussion on findings, and Chapter 9 provides insight into policy significance of this research.

Chapter 2: Defining the Problem

Urban economies benefit from efficient, strong transportation networks, as they are "vital for a city's competitive advantage" (Short, 2006, p. 169). Per day, U.S. infrastructure supports 55 million tons of freight valued at over $49 billion and approximately 63 tons of goods per citizen per year with most of this activity occurring in urban U.S. regions. Freight transportation will likely increase 42 percent by 2040 commensurate with an increase of the current population by approximately 319 million (United States Department of Transportation (USDOT), 2015). Currently, 44 million U.S. jobs directly depend on freight transportation, and this is also expected to grow as demand increases, companies bring back production of goods to the U.S., and the volume of our imports and exports traveling within our freight system doubles by 2040 (USDOT, 2015; Bureau of Transportation Statistics (BTS) , 2012; BTS, 2015).

Mobility bottlenecks for freight in urban areas negatively affect the urban economy (The White House, 2014; Eisele, Tardif, Schrank, Lomax, & Villa, 2011). Bottlenecks on the transportation network create congestion and cost $1 trillion annually, which is nearly seven percent of the U.S. economic output (USDOT, 2015). The National Strategic Freight Plan (NSFP) reports that every day, nearly 13,500 miles of the highway system have vehicles moving slower than the speed limit, and a further 8,700 miles suffer stop and go conditions. Trucking companies experience approximately $27 billion in losses each year due to costs associated with congestion that results in lost time and additional fuel costs (Winston & Shirley, 2004). This drives up the price of transportation and the price of products being moved (USDOT, 2015; Winston & Shirley, 2004; O'Rourke, Besheres, & Stock, 2015). Consequently, improving performance is an important focus for decision-makers to support economic sustainability and growth.

Improving freight performance has been a key federal objective in an aim to support the economy, especially in the form of surface transportation laws. Namely, both Moving Ahead for Progress 21 (MAP-21, 2012) and Fixing America's Surface Transportation Act (FAST Act, 2015) look to address the economy through transportation. Despite the priority assigned to improving freight measurement and data, available public freight mobility performance data in the U.S. covers only truck movements (Federal Highway Administration (FHWA), 2015a; FHWA, 2015b).

New federal mandates and an unprecedented $10 billion freight-funding program in surface transportation law require freight policy, planning, and investment including the establishment of urban freight corridors (FAST, 2015). In order for states to use the funding available for freight projects, a state must articulate need via statewide freight plans and prioritized investment lists. States need to identify the most necessary freight investments and show coordination with metropolitan regions on urban freight routes, planning, and performance measurement (FAST, 2015).

Challenges in Understanding Freight Performance

Understanding freight mobility to improve performance for urban areas is a challenge. Freight data and performance measurement approaches are limited compared to the robust, publicly available people movement data and analysis (TRB, 2012). The private sector is often reluctant to release data on their transportation performance and costs for fear competitors would capitalize on the information (TRB, 2012). In cases of major projects, such as a tunnels or port berths, a private entity will provide specific data and performance information to justify the project. However for system analysis, continuous data feeds present proprietary risks (TRB, 2012).

Another challenge is scale. For example, people movement trips, in either cars or transit (buses or passenger rail), tend to be within metropolitan areas or specific jurisdictions. They are also more likely to involve one or two modes, such as car and transit. In contrast, freight movement trips occur at a variety of geographic scales, such as between countries or regions. Freight often traverses jurisdictional borders and transfers among several modes (i.e. ship to rail to truck) by private carriers whose data are proprietary and not available to the public (TRB, 2012). Without publicly available data, decision-makers struggle to comprehend where bottlenecks are occurring and to make beneficial decisions. Other federal agencies collect and analyze private data, but they have a legislative authority to protect the data. Some of these examples include health and business production data; both of which are protected by either the United States Department of Health and Human Services or the Census Bureau.

Efforts to Improve Freight Performance Measurement

Government transportation agencies have invested in data development and policy tools such as performance measurement (Melaniphy, 2013; Yusuf & Leavitt, 2014). The USDOT and FHWA actively pursued freight data and performance measurement improvement for over fifteen years. FHWA has led the development of truck data since 2002, when it entered into a third-party agreement with the American Trucking Association (ATA) and its American Transportation Research Institute (ATRI) to pull probe data from the on-board computers of a sample of commercial trucks belonging to members of the ATA (Sedor & Jones, 2006). ATRI served as a trusted, third party that protected and anonymized proprietary truck data in addition to providing analysis of truck bottlenecks on select corridors (Sedor & Jones, 2006). To this day, ATRI provides FHWA with analysis of truck probe data from over 600,000 trucks presently in the U.S. (FHWA, 2015b). Recently, FHWA awarded a contract to INRIX, a leading probe data provider, to make a national public data set of travel times for all traffic and truck traffic referred to as the National Performance Management Research Data Set (NPMRDS) available. This data set is required for use by the MAP-21 and FAST Act performance requirements. The project represents a growing market for proprietary data with the purpose of transportation performance measurement (FHWA, 2017a).

The private sector expertly measures transportation performance for their own products and business policies, but the public sector has only made a few strides in understanding freight flows through freight analysis and modeling (TRB, 2012). Companies are employed by the private sector to protect its data and track products down to the actual good.[4] Advancements in the use of scanning and Radio Frequency Identification (RFID), allows the private sector to know specific locations of its product and to analyze supply chain bottlenecks at multiple levels

[4] For example, they know where each unit of a good is at any given time.

(TRB, 2012). Public sector stakeholders continuously cite challenges in working with the private sector on data. This is primarily due to the proprietary nature of private sector information (TRB, 2014).

Initial public assessments of freight for performance and modeling began by copying models for transit and people movement, but challenges in accessing data stalled advancement (Bachman, Kennedy, & Roorda, 2015). For transit, a public performance measurement structure leads to improvements in transit systems (Poister, Pashe, & Edwards, 2013). However, there can be significant challenges when multiple stakeholders, such as private sector stakeholders for freight, and consequently multiple points of view are involved (Koliba, Campbell, & Zia, 2011; Radin, 2006;Frederickson & Frederickson, 2006).

Public sector analysts documented frustration with these models, specifically the issue of multiple stakeholders. These analysts discovered that freight moves much differently than people, and the data did not exist (Friedrich, Haupt, & Noekel, 2003; (Holguin-Veras, List, Meyburg, Ozbay, Teng, & Yahalom, 2001; Meyer & Miller, 2001). Analysts started to develop data on how freight is moving to identify trip origins and destinations. Limited data on origin and destinations, tonnage, value, mode of transport, and commodity were organized and used in models (Southworth, 2002; Hancock & Sreekanth, 2001; Southworth & Peterson, 2001). As this developed over time, analysts found growing frustration in getting data and matching it up with the actual routes to understand travel time (de Jong & Ben-Akiva, 2007; Wang, Goodchild, & McCormack, 2016; Zhao, McCormack, Dailey, & Scharnhorst, 2013).

To date, freight modeling is not as sophisticated as general transportation modeling. The public sector has mostly advanced to understanding truck travel times with truck probe data. Truck probe data is increasing in availability, but there are still numerous problems in using it for performance and modeling (van Lint, Van Zuylen, & Tu, 2008). Data on other modes remain proprietary and difficult to obtain (Bachman, et al., 2015; Rudra & Roorda, 2014; Lawson & Riis, 2001). The public sector has made a pitch to the private sector advocating the planning benefits from having more data, but the private sector has yet to embrace this. The private sector has still not realized a high value or reduced risk of competition from sharing data (TRB, 2012).

Canada is a global leader in freight analysis for decision-making. The federal transportation agency, aptly named Transport Canada, developed the Freight Fluidity Program (FFP) as a resource for public decision-makers in economic development and transportation policy (Eisele et al., 2011). Its program analyzes combinations of railways, airports, highways, and key ports of entry or exit then uses movement data to identify where bottlenecks are occurring (Tardif, 2014). This information helps identify delays that are affecting their economy (Tardif, 2014). Transport Canada receives origin and destination data, travel time and speed information, and transport cost data directly from marine, railroad, air, and trucking carriers to feed the fluidity program. An example of this analysis is how Transport Canada tracks the supply chain of goods coming into a port and follows the transfer to rail and then truck through to its termination in a specific city or province.

Transport Canada can see every segment of the trip from ship to truck and can identify specifically where bottlenecks are occurring. They can determine the nature of the bottleneck and then quantify the costs and travel time impacts. The agency then uses this information for transportation planning to alleviate bottlenecks and guide economic development. Transport Canada argues that the Fluidity Program has become one of the nation's leading economic, as well as transport, tools to the extent that the Prime Minister has established a Fluidity Office at the Cabinet level after seeing how the information benefited Canadian policy and investment (Tardif, 2014). One key aspect of this program is that Canada is legally able to withhold private sector data from the public.

In the U.S., government leaders seeking to improve freight measurement have not seen the same level of success. U.S. Freedom of Information Act laws require public agencies to release data and information. The private sector fears that the benefits of providing data do not outweigh their concerns. At the crux of this concern is the very real difference between public and private sector interest and the challenge facing the private sector to act in the public good if negative externalities to them are present. A trusted third-party provider currently provides truck analysis for the federal government, but access to raw data is not provided (FHWA, 2015b). Without seeing how policy outcomes could improve, the private sector has been reluctant to work with USDOT and FHWA (TRB, 2014). Changes to federal laws or options with trusted third parties may help if both the public and private sector are comfortable on the value FPM brings.

In 2015, FHWA collaborated with the Department of Commerce (DOC) and the I-95 Corridor Coalition to evaluate freight movement, in the vein of the Canadian FFP, using a supply chain approach[5] predominantly with truck data (I-95 Corridor Coalition, 2016). Instead of combinations of infrastructure options, as exemplified by Canada, this work looked at some of the key U.S. commodities and the infrastructure used transport the commodities from origin to destination. Following that, metrics to understand the freight trip identified performance and bottlenecks. This analysis was national in nature, in that it focused on major commodities and high-level supply chains that traversed the country. It demonstrated how to look at segments of the trips to see bottlenecks and the cost of the trips for each segment (I-95 Corridor Coalition, 2016).

Research Goal for Analysis

Time, attention, resources, and federal mandates for freight performance continue while the measurement of freight lags behind that of people movement (Bassok, et al., 2013). This puts urban decision-makers in the position of making transportation decisions for people and freight movement without equal availability of performance information.

Therefore, a problem emerges where urban transportation agencies need to respond to federal mandates, engage in freight planning, and make decisions for urban policy but remain limited in understanding how freight is actually moving through their region. This is especially

[5] A supply chain approach is the start-to-finish trip a product or component makes from origin to destination. This could be from country of origin by boat to a U.S. port, to rail, and then to truck as an example.

true from a multi-modal perspective. The gap in information continues to exist with much effort expended to achieve FPM and seemingly only incremental results for freight information.

The goal of this research is to contribute to the field of knowledge for both transportation and urban policy by exploring the usefulness of FPM with the hypothesis that it is value added. Through the remainder of this document, I explore the development of public performance measures and the evolution to transportation and freight measures. I then test the hypothesis to determine FPM's usefulness in urban policy and perceptions of value in policy-making.

Chapter 3: Literature Review

In defining the problem for this research, I observed that there has been a push for public transportation agencies, especially in urban areas, to focus on freight and incorporate freight into planning. There is a push from Congress for multi-modal freight planning and analysis, and millions have been spent by the public sector in an attempt to analyze freight performance and develop multi-modal approaches (MAP-21, 2012; FAST Act, 2015; TRB, 2014). Despite this momentum, there is still a lack of evidence that FPM is beneficial. Potential benefits are assumed. The collective question on the public side is why would measuring freight help us make better decisions for our transportation network? What are the benefits of this? It may be that FPM is critically important and should be done by every transportation planner. It may also be that the information that freight data tells us is only marginally better than the information currently available on the transportation network (Eisele, 2018; Schrank, 2018).

This push for FPM is like its predecessor, the shift for performance measurement in public agencies ushered in during the 1990s with efforts of new public management. This shift was labeled as a movement and a phenomenon (Radin, 1998). It had a bandwagon type of response with federal, state, and local public agencies engaging in performance management for reasons such as "it works for the private sector," and "government needs to be more accountable." Despite the push, years later there are still questions surrounding the effectiveness of performance management (Radin, 2009).

I contemplated the usefulness of FPM and if it was perceived as worth the effort given the challenges in developing FPM, working with the private sector, and the mixed opinions of public performance measurement. For the literature review, I considered the type of theories tested in this research. I then studied the performance measurement movement and its perceived usefulness. A literature review related to freight, freight policy, urban freight, and freight performance measurement follows.

Theory

Several theories converge in this research. These include urban, decision, and value of information theory. The hypothesis is that FPM is useful and worthwhile. That it ultimately adds value to decision-making. Value is not tested quantitatively but is assumed to provide some improvement or benefit to decision-making that can improve urban policy and aid in urban competitiveness. These theories are explored below.

Urban Theory

The ideas behind FPM revolve around ideas of economic competitiveness and efficiency while both federal policy and stakeholders consider the impacts of congestion on competitiveness. The hope is that by doing better freight analysis, planning, and operating the transportation network to keep freight moving, the economy can be supported and grow especially in urban areas where congestion is often greatest (TRB, 2014).

Competitiveness aligns with the concept of the Competitive City in urban theory. Short (2006) described the competitive city as the growth of new urban entrepreneurialism where cities are re-imaging, repackaging, and re-marketing themselves as pro-business and high quality of life locations. Over the past thirty years, technological advancements have allowed globalization of manufacturing jobs that were once the backbone of cities. Cheaper labor costs drove location over access to markets or skilled labor, and cities entered a period of decline while jobs left to industrializing countries with cheaper labor to offer (Short, 2006).

Cities are now in a position of having to compete globally and to reinvent or recreate themselves with a goal of business attraction and quality of life options for tourists and residents alike (Short, 2006). Short (2006) further explained the rising intensity in recent years resulting in an unprecedented competition among cities and new urban order. Part of this situation involves engaging the private sector in government business and advisory groups to help guide the vision for competition in this new paradigm. This competition includes a focus on enticing business by aiming to offer efficient operating costs that include transportation access and efficiencies in addition to quality of life improvements (Short, 2006).

As cities and the metropolitan regions face mounting global competition, it is important to use limited public resources as efficiently as possible and make decisions that help optimize economic and quality of life outcomes. I discuss the use of performance management programs later in this literature review, but cities are using data and measures in their planning and investments to achieve competitive goals.

Decision Theory

Policy-makers must consider a number of decisions to achieve their goals and remain competitive in a global market. When it comes to transportation decisions, they are making choices for both the movement of people and freight. They have to make choices from among numerous alternatives. In a perfect world, we would hope that policy-makers would have all the information they need to make a decision. However, we know that policy-makers have varying levels of information to make decisions (Anderson, 2003). In the case of transportation, we know that there are robust data on the movement of people and limited data on the movement of freight. FPM information is thought to provide information that would improve decision-making and that there would be value in improving the transportation system, especially in urban areas where freight movement is significant and there is a higher population that demands goods and services (FHWA, 2015b).

Anderson (2003) presents three theories of decision-making that involve procedural and intellectual activities concerning making a decision among alternatives: the Rational-Comprehensive Theory, the Incremental Theory, and Mixed Scanning. The rational-comprehensive theory is described as one of the best-known theories of decision-making. It is believed to be based on the economist's view of how a rational person makes a decision and from theories developed by mathematicians, psychologists, and theorists in other branches of social science (Anderson, 2003). It specifies the procedures involved in making decisions in order to maximize the goals of an organization (Anderson, 2003). These decisional elements usually include the following:

1. The decision-maker can identify a problem separate from other problems or consider it meaningfully in comparison with the other problems.
2. The goals, values, or objectives of the decision-maker are known and can be clarified and ranked.
3. Alternatives for dealing with the problem are examined.
4. The consequences, such as the costs and benefits, are investigated for each alternative.
5. Alternatives are compared.
6. The decision-maker will choose the alternative that maximizes attainment of goals, values, or objectives.

*As adapted from Anderson (2003).

This form of decision-making is thorough, aligned with goals, values and objectives, and provides a defensible mechanism for the resulting decision (Anderson, 2003). There are many criticisms of this theory however. First, public decision-makers are often not working with concrete, clearly defined problems. They must identify and formulate the problems, which is a process in itself (Lindblom, 1959; Anderson, 2003). Second, it assumes that there is enough information to analyze alternatives and a comparison can be made. In reality, there are data challenges as highlighted by this research, analytical issues, and other elements of analysis that present problems (Lindblom, 1959). Third, the public decision-maker may have conflict with personal values and organizational values, as well as hardships in separating facts and values during the analytical processes (Lindblom, 1959). Fourth, sunk costs can limit the analytical process in this decision-making. If an organization is already well-invested in an alternative, this may cloud decision-making and result in investment when another option should have been considered (Lindblom, 1959). Finally, the process of rational-comprehensive decision-making is challenging when the decisional entity is multi-headed, much like a legislative body (Lindblom, 1959; Anderson, 2003).

Alternatively, Lindblom (1959) presented the theory of incrementalism as a form of typical decision-making that actually takes place in the public arena. Instead of a process, it is more of a give and take resulting in mutual consent among numerous participants. For example, selection of goals, objectives, and analysis of alternatives are intertwined and it maybe that only some of the alternatives are considered, especially those that are only slightly different or incrementally different from existing policies (Lindblom, 1959). The analysis is limited and the problem receives continuous adjustments instead of a comprehensive analysis and policy change to address the problem. This can make the problem more manageable (i.e. baby steps) (Lindblom, 1959; Anderson, 2003). Further, Lindblom argues that incrementalism is realistic because it recognizes that decision-makers do not have resources like time, information, data, and funds to do a full comprehensive analysis for alternatives to problems (Lindblom, 1959).

Lindblom's (1959) incrementalism theory of decision-making is likely the truest for the public sector (Anderson, 2003). Critics argue that it is too conservative, pessimistic, and a barrier to innovation that can really change public policy (Etzioni, 1967; Anderson, 2003). Though, to engage in rational-comprehensive decision-making requires an investment in resources, analytical tools, stakeholder engagement and thoughtful decision-making that public sector decision-makers may not always have available (Anderson, 2003).

Mixed scanning presents a middle option. It is another decision theory that is an attempt to combine rational-comprehensive with incrementalism (Etzioni, 1967). It focuses on the capacity and power of decision-makers, and that decision-makers with power can achieve a more comprehensive solution to problems and advance beyond incremental policy changes. This is especially the case when there is power, a policy window, and political support (Etzioni, 1967).

FPM is a resource that the public sector believes will move decision-making in the public sector from incrementalism to a rational-comprehensive method or perhaps improve upon the mixed scanning approach that may be in play. FPM is thought to improve upon knowledge and to provide an improved lens for transportation policy. The theory is that with better freight data and analysis, there will be a greater public value in that more significant policy changes will occur for freight (TRB, 2014). Currently, with the power of freight's prominence in Congressional transportation proposals and law, this mixed scanning approach may have weight to help improve upon freight policy. FPM is thought to articulate the freight system within the policy analysis functions.

Information Theory and Value of Information Theory

If FPM is a resource that can help improve decision-making and move in the direction of rational-comprehensive decision-making, then FPM should have value. This research attempts to examine that value and to determine if the major efforts to advance FPM are worthwhile given the effort and costs that the public sector have expended, or would need to expend, to advance FPM. Though this research does not compute or quantify this value, the research questions are designed to capture usefulness in the form of an identified benefit for using FPM information that might exist over not using it for urban policy.

Claude Shannon (1948) first described this idea of the value associated with information. He designed it to quantitatively measure the amount of information in a communication. In other words, a communication or message has some level of value that can be quantified (Shannon, 1948). The concept stressed that the information measure was dependent only on the probabilistic structure of the communication process (Shannon, 1948; Howard, 1966).

However, this concept and the ability to measure the value of information is a complex and difficult concept. Shannon's work was initially applied to engineering and communication of messages (Shannon, 1948). Howard found that attempts to apply this theory to problems outside of communications did not work out well due to (Howard, 1966). He attributed this to the need to consider that no theory that involves just the probabilities of outcomes without considering their consequences and uncertainties (Howard, 1966). Instead, Howard found that it was important to consider probabilistic nature of the uncertainties along with economic impacts (Howard, 1966). Others have found that there are variations on the way the concept has been applied and differences between the technical and semantic applications of the concept (Floridi, 1998).

To maneuver around these shortcomings, Howard developed the theory of value of information. This theory considers both the probabilities and economic factors influencing decisions. A limited and simplified example of this is that the value of information is the difference between the current state and the benefit of the decision made with the information (Howard, 1966).

Lawrence's text on the economic value of information helps to explain decision theory and the value of information mathematically (Lawrence, 1999, p. 1-6). I adapted the following from his description of the algebraic concepts for information value.

> Lawrence (1999, p.1) writes that a decision that requires a thoughtful solution is a "decision problem" and that making the decision involves choosing from two or more courses of action. A decision-maker has control of a set of actions, which is termed the action space. A decision is a choice of a specific action "a" as an element of a set of actions, "A," that is the most optimal for the decision-maker. This is expressed as $a = \{A\}$.
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> The point of decision theory is to create a structure for the reasoning process for the selection of a solution so that the decision-maker can avoid negative consequences. The identifying characteristic of decision-making when there is uncertainty is that the decision-maker cannot know the exact outcome of the action or decision chosen. The results of the action chosen are not under the decision-maker's control, so this is considered a random variable, expressed as X. In decision-theory, the decision-maker creates a set of actions that all have potential results. This is expressed as X ={x}. Lawrence explains that the outcome of the decision problem is a payoff function of π (x, a) that depends upon the combination of the action that the decision-maker chooses and ultimate realization of that choice, X. Further, if the problem is well framed, the decision-maker can either choose an optimal action or exercise and option to change their knowledge and seek information relative to X.

When there is uncertainty in decision-making, the distribution p(x) is used to describe the distribution of the decision-maker's initial knowledge. If the decision-maker seeks an information source and obtains a message from it that builds on the prior state, this may lead the decision-maker to make different choices. It may cause the decision-maker to eliminate some of the choices in the set of "a," to decrease the probability of others, and increase the probability of some. This creates a new probability distribution based on actions related to the new information source. It is called the posterior distribution and denoted as p(x|y). Based on the new information, the decision-maker may take a new course of action that results in much different payoff.

This difference in payoff that the new information creates is what generates economic value from its impact on the solution to a decision problem. To quantify the difference or economic value that the information created, it is necessary to subtract the value of choices prior to the information from the value provided by the information. This is described as the ex-post value of the information. This difference may not always be positive. It could be positive, negative or zero. Information may not always guarantee that the decision-maker achieves a favorable outcome and as Lawrence (1999, p.6) puts it, "decision theory offers no defense against bad luck."

It is important to consider that the value of information must consider the cost of obtaining that information. The case of FPM, getting the data comes at considerable cost. Any analysis of the value of information should include the net impact by subtracting out the cost of information. Additionally, the information gained may not provide an absolute understanding of the value of

X or the choice. Therefore, in calculating the value of information, there is the expected value or mathematical expectation of what X will be. In assessing X, the decision-maker must use the information to evaluate and compare options (Lawrence, 1999). Understanding the value of information is done by calculating the potential payoff prior to the information and the potential payoff of the options with the information (Lawrence, 1999).

Summary on Theory

To summarize, FPM is touted as a way to improve decision-making and help transportation decision-makers improve the transportation network. It is assumed that by using freight data and performance measurement, we can know something more about the transportation network that will help us to better optimize investments and operations, that this will improve freight flow and have a positive impact on economic efficiency. In the case of urban areas, it is expected that FPM will help the urban economy and encourage job growth.

An improved transportation network can help achieve the concepts of the competitive city through improved decision-making. FPM would improve decision-theory and move decision-makers closer to rational-comprehensive decision making by offering a view of transportation different from what they use. Additionally, more FPM development would improve on their ability to make stronger decisions that better support urban competitiveness and economic decisions. Using FPM should result in a positive value of information. Though costs and efforts are expended, it is expected that the efficiencies achieved for the transportation network will outweigh the effort.

Importance of Freight Transportation

Freight transportation is perceived as important for the economy. Businesses depend on the national infrastructure to move goods and believe that investments in the system, particularly highways, have a significant economic return on investment (Nadiri & Mamuneas, 1996). Highway investments have generated positive economic growth rates, and the availability of infrastructure has a positive relationship with regional growth (Isserman & Rephan, 1995;Weisbrod, 2008).

Glen Weisbrod (2008) described four specific theories on how freight investment is important through historical examples. His four points include enabling new forms of trade and locations of trade; reducing loss and improving trade reliability; expanding market size and improving economies of scale; and increasing productivity through accessibility to diverse, specialized labor, suppliers and markets (Weisbrod, 2008). I paraphrase his points below:

> First, theories of inter-industry trade accounting or input-output analysis and supply chain management can be seen in action from over 2,000 years ago when the development of caravan routes such as the Silk Road and Spice Route were established to bring goods to European markets (Leontif, 1951; Bowersox & Closs, 1996). This helped to develop trade and economic growth and led to the development of networks that grew additional services and products.
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> These early traders understood that infrastructure improvements helped improve the flow of goods. To improve or streamline the transit of goods and reduce losses,

Romans built over 50,000 miles of road network for trade and national defense. Locations like Gaza and Caesarea became intermodal centers for ship connections to land routes that improved reliability. This type of efficient development led to the theories of risk analysis and mathematical algorithms for loss rates (Bedford & Cooke, 2001).

Almost 200 years ago, like the Romans, the new U.S. government invested in trade routes to expand markets and create economies of scale. The U.S. developed federal programs for roadway and trade route development such as the Cumberland Pike in 1818 or waterways like the Erie Canal in 1825. These efforts resulted in access to markets, lower crop prices and improved farmer incomes. Later, in 1919, the concept of market scale economies was produced (Marshall, 1919).

In the 1960s, market access improvement continued with development of the nation’s highway network, which was a means of improving income growth from market access to labor, product, and market. The FHWA reported in 1970 on the benefit of interstate development to improve market access. In the 1960s, Congress acted to fund the Appalachian Development Highway System to help increase Appalachia’s access to markets for greater economic development in that region. This led to work on the economic efficiency benefits of greater access to diverse inputs (Krugman, 1991;Fujita, Krugman, & Venables, 2001;Weisbrod, 2008).

Today, urban areas throughout the nation are experiencing massive amounts of transportation congestion that negatively affects the U.S. economy. Schrank, Eisele, Lomax and Bak. (2015) found that the congestion problem in the United States is large. Currently, congestion in urban areas costs Americans 6.9 billion hours in travel time delays, as well as and 3.1 billion gallons of wasted fuel to the tune of over $160 billion in 2014. They have developed this metric every year and found that it continues to grow. The problem is not just during peak commuting times either. In the biggest urban areas, congestion occurred at all hours of the day and week (Schrank, et al., 2015).

In addition to the wasted time and fuel that both passengers and trucks experience, Schrank et al. (2015) considered congestion a type of tax. Collectively, the tax to U.S. urban areas is over $160 billion a year. 18 percent, or $28 billion, of that is truck movement on highways, which does not account for the value of the commodity or additional delays to the industry supply chain (Schranket al., 2015). This perspective places an interesting idea of inequity among urban areas where the higher the congestion an urban area has, the higher the tax or premium for living there and for businesses to move goods to, from, or through the area.

Inefficient freight movement in urban areas may have negative consequences necessitating remedies. "Goods trade delivers unquestionable returns to metropolitan economies, making it imperative that metropolitan leaders understand how their economic base relates to current and prospective trade partners" (Tomer, Kane, & Puentes, 2013, p.1). If congestion is taxing or impeding upon the economy of the urban area, there may be negative consequences. Tomer et al. (2013) argued that urban areas must understand their economic position, which includes understanding the criticality of their transportation assets to enable trade, and that current policy is limited to national indicators that fail to consider urban position. At the time of their research, the FAST Act did not exist. Tomer et al. (2013) called for a national freight strategy that considered urban impacts. The FAST Act does require a National Multimodal Freight Plan and the establishment of critical urban freight corridors.

Federal Requirements

Federal freight initiatives and legislation date back to the earliest of federal history, but specific focus on measuring freight performance and freight planning requirements is more recent. In the past half-century, focus was first on highway development in the 1950s and deregulation in the 1970s and 1980s. For a period after the 1980s, there appeared a greater focus on funding and analysis of transit programs than freight (Curristine, 2002).

Freight planning, performance and project development consideration in surface transportation law appears a relatively recent development with much of the beginning effort or new era for freight occurring in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) (Bassok, et al., 2013). The previous surface transportation law, the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, first emphasized freight as important to public sector decision-makers, primarily states and MPOs, should consider in transportation planning. SAFETEA-LU, however, improved freight consideration increasing the importance of freight transportation inclusion in MPO and state freight planning (Bassok, et al., 2013). Since then, freight consideration in public transportation planning and investment has increased significantly. MAP-21 included freight planning recommendations and a requirement for states to measure freight performance and bottlenecks. It also included an increased federal share for freight transportation projects funded with, logically, federal funds (MAP-21, 2012).

The most recent federal surface transportation laws, MAP-21 and the FAST Act, included significant freight programs focused on performance, planning and project development with a dedicated freight formula program in FAST Act (MAP-21, 2012; FAST Act, 2015). When the FAST Act passed in December 2015, it included the first ever freight formula program at $10 billion over five years and continued requirements for freight performance measurement and planning (FAST Act, 2015). This was funding for states to use to complete freight projects on the highway network. It included continued freight planning and performance measurement requirements, as well as the establishment of a National Highway Freight Network that required states and MPOs to coordinate on critical urban freight routes. Additionally, it required USDOT to be responsible for developing national strategic freight plans, port performance programs, along with other freight policy and planning efforts (FAST Act, 2015).

A problem with the federal freight actions by Congress and USDOT is that freight measurement and planning is required, but the data to do this are limited. The laws demonstrate the obvious belief that freight is important to the economy, and they requires FPM by states and MPOs, but FPM is challenging to measure and to use in a plan for freight. Public sector freight data is primarily limited to highly aggregated tonnage and value data, truck travel time data and limited information, or project specific information on bottlenecks, delay, and estimates of costs and emissions (Eisele & Schrank, 2010). To achieve the federal requirements or meet the intent of the law, multi-modal freight data are needed.

There have been many efforts by the public sector over the past two decades to improve FPM and promote better freight planning. These include numerous federal efforts, USDOT studies, research by the National Academies of the Sciences, as well as work by the American Association of State Highway Transportation Officials and countless other projects, committees, and workshops (FHWA, 2016a). Those efforts have helped to understand freight flows, to push the incorporation of freight into planning, and to try to forecast and predict freight flows and their issues in the future.

Public sector work created some advancements, but freight measurement is still ambiguous and challenging in the U.S. If freight is so important and the network so tied to business, why is freight so hard to understand and measure? To answer this question, it is helpful to look at the development of performance measurement and management as well as the challenges when applied to the transportation sector.

Performance Management in the Public Sector

The permeation of performance management in the public sector that has occurred over the past thirty years helped to provide some context to public sector engagement of performance practices. Some of the challenges and issues shed light on why transportation performance management in public agencies developed the way it did and why freight performance measurement is difficult.

Performance Measurement and Management

To start, I would like to define the terms performance measurement and performance management. Performance measurement is an input to performance management. The Government Accounting Office (GAO) (GAO, 2011, p.2) describes performance measurement as the following:

> The ongoing monitoring and reporting of program accomplishments, particularly progress toward pre-established goals. Program or agency management typically conducts it. Performance measures may address the type or level of program activities conducted (process), the direct products and services delivered by a program (outputs), or the results of those products and services (outcomes). A "program" may be any activity, project, function, or policy that has an identifiable purpose or set of objectives.

Alternatively, some key scholars in the field provide the following definitions. Poister (2008, p. 1) defines it as a "process of defining, monitoring, and using objective indicators of the performance of organizations and programs on a regular basis." Poister, Hall, and Aristigueta (2014) described it as "the systematic, orderly collection of quantitative data along a set of key indicators of organizational (or program) performance" (Poister et al., 2014, p. 4). Hatry (2006) defined performance measurement as simply "regular measurement of the results (outcomes) and efficiency of services or programs" (Hatry, 2006, p.3).

These definitions differ to a degree in their terms, but they all include a requirement of time or systematic, repetitive measurement implying that the continued measurement yields insights on performance. The GAO, Poister (2003), and Poister et al. (2014) definitions include a reference to strategic planning and the identification of goals and objectives. Hatry's (2006) definition implies a link to planning and objectives since the measurement is of results or outcomes of services and programs.

The link to strategic planning is an important component of performance management. Much of the research on performance management suggests that there is a critical link between strategic planning and performance measurement. Measuring performance without having the backbone of strategic planning and guidance to identify the goals and objectives of an organization results in measuring without purpose. Goals and objectives help to define what needs to be measured, and the measures can reveal progress or not in achieving the goals (Moynihan, 2008). Using this information to improve is performance management (Moynihan, 2008; Behn, 2003).

Development of Public Performance Management

As I considered the push by the public sector to measure freight and engage the private sector, it was important to research the development of public performance management and its roots. The behaviors that drove the push for public sector performance measures are similar to what I observed in freight performance discussions. The research indicated that it was a movement and that agencies flocked to embrace this culture or had mandates to do so and to do so with seemingly little evidence that they would achieve efficiency goals. Similarly, transportation planners are being mandated to measure and plan for freight. This push led me to question the behaviors behind public performance management, which set the tone for transportation agencies to push for adoption of performance practices as well.

Public performance management has its roots in mirroring private sector business practices that helped business achieve efficiencies and profits. Some of the early literature on LEAN management, for example, cites Toyota's work on eliminating "muda" or waste through process mapping, measuring performance, and eliminating wasteful practices while improving outputs (Womack & Jones, 2003). Ford Motor Company adopted similar evaluations of performance to improve products and reduce costs, benefitting the company's profit (Womack & Jones, 2003).

Ideas of management and public sector efficiencies and operations emerged with a focus on public management in the 1920s (Poister et al., 2014). Concepts involving program improvement related to public services continued to grow with the provision of social programs in the 1960s and 1970s. Mindsets of urban choice theory and efficiency in programs continued in the Reagan era as the federal government focused on decentralizing public services and encouraged competition among urban entities in line with the ideal of "vote with their feet" - that citizens would migrate to the places providing the best quality of life and economic opportunity (Tiebout, 1956).

The most significant push for public performance management came with the work of New Public Management that focused on using business practices to help make the public sector more efficient (Hood, 1991). The National Performance Review (NPR) was created by President

Clinton in 1993 as a focus on reforming how government works. Its goal was to do more with less (National Partnership for Reinventing Government, 2017).

The Government Performance and Results Act (GRPA) marked the first legislated requirement on federal government to engage performance measurement and management (Poister et al., 2014). GRPA mandated strategic planning and required the development of federal agency goals, objectives, performance targets, and measurement that was tied to the federal budget process. GRPA set the stage for what has been called a movement or reform (Radin, 2006; Henirich, 2007; Stone, 1997).

GRPA is believed to have encouraged pervasive (Radin, 2006) performance measurement and management activities within the federal government that continued to bleed into state and local government practices. It grew quickly and performance management emerged in many programs and requirements, which continued into the first decades of the 21st century (Moynihan, 2008; Poister et al., 2014; Radin, 2006).

Public Performance Management Issues and Challenges

The most striking aspect of performance management over the past thirty years is how everyone jumped on the bandwagon and continues to believe that it is important without much real research or proof in its success (Moynihan, 2008; Poister, et al., 2014; Radin, 2006). Multiple scholars, whether they support performance management or not, believe that measuring performance is a good practice. Harvard professor, and key performance management scholar, Robert Behn wrote, "Why measure performance? Because measuring performance is good. But how do we know it is good? Because business firms all measure their performance and everyone knows that the private sector is managed better than the public sector" (Behn, 2003, p. 586).). Of course, there is a hint of sarcasm in that assertion and Behn goes on to say that business performance measurement is not exactly appropriate for public sector functions.

It seems that the skepticism is in how performance information is actually used. Poister et al. (2014) described three camps among some of the key scholars in the field. For example, supporters include Harry Hatry of the Urban Institute, Joseph Wholey, and Robert Behn of Harvard University. "Pragmatists" includes the work of Moynihan. In contrast, "skeptics" include Beryl Radin (Poisteret al., 2014). I describe their positions below.

Supporters describe numerous ways in which performance management should be done. In my research, I counted seventeen different reasons, ranging from accountability and spending limited public dollars wisely to engaging stakeholders and describing how the government is doing to the public. Hatry cites ten reasons for measuring performance. His reasons include: 1) accountability, 2) budgeting requests, 3) internal budgeting, 4) performance problems, 5) motivation of staff and employees, 6) government contracting monitoring, 7) evaluation of public programs, 8) support for strategic planning, 9) communication with the public, and 10) improvement (Hatry, Performance measurement: Getting results, 1999). Behn proposed that there are only eight purposes including: 1) evaluation; 2) control or staff/subordinates; 3) budget, spending of resources; 4) staff motivation; 5) promotion of the program – demonstrating the good; 6) celebrating accomplishments; 7) identification of what works and what does not; and 8) improving performance. After the description of the eight items, however, Behn describes that seven of his purposes could all be behind one purpose and that is to improve performance (Behn, 2003).

From Hatry and Behn's list, I propose that these purposes could be grouped into the following categories.

- Decision-Making: How should scarce and increasingly limited public resources be spent?
- Accountability: Did the program or agency do what it was supposed to do?
- Efficacy: Is the program design working? Are the means justified?
- Communication: How to best inform stakeholders and the public of issues and successes?

These purposes hold a lot of promise to public managers. The notion of being able to articulate progress to elected officials and the public, to better spend limited public dollars, to have a basis for accountability, and to improve on programs and services is constant in a vision for better government (Moynihan, 2008). Wholey and Hatry (1992) paint quite an optimistic picture of performance management as performance monitoring. For them, performance monitoring can stimulate program performance and communicate value, strengthen public confidence, gain resources and enhance programs (Hatry & Wholey, 1992). They go further and say that performance monitoring does not require sophisticated program evaluation techniques and that it should grow less expensive over time. They provide examples of successes in a range of government performance areas including economic development, healthcare, education, transportation, public safety, and more (Hatry & Wholey, 1992).

Benefits cited include the ability to get more resources out of leadership and improved program performance. For example, in a case of the Public Health Service, the Bureau of Community Health monitored the Community Health Centers program performance and provided staffing and funding based on performance. The annual reports of performance to Congress showing better management, productivity, and an increased collection of fees helped convince Congress to increase funding for the program when the trend was to cut services. Another example is the Job Training Partnership Act of 1982 where the U.S. Department of Labor set performance standards, subsequently monitored performance, and found that despite some issues they helped to provide more services in hard to serve areas and improve overall performance (Hatry & Wholey, 1992). They go on to cite other examples of how monitoring performance is leading to reforms or changes and improvements.

Other well-known success stories include the CompStat program in New York City and the CitiStat program in Baltimore. Smith (2009) described the near bankrupt New York City in the mid-1970s and the beginning of a performance management program as follows. At the time, there were both policy failures and management failures that contributed to enormous fiscal challenges. City leaders noticed that there was a disconnect between the performance of the City's programs and finances. This led to the creation of a new office, the Mayor's Office of Operations. The office was charged to create a Mayor's Planning, Management, and Reporting System. Following this, the city council legislated a Mayor's Management Report that required performance indicators for all agencies. This report grew quite large and had so many indicators that were mostly inputs and activities measures. There were not many output or outcomes measures. So far, this does not indicate a successful program. Years went by where it was not successful. Smith (2009) reported that twelve years after the beginning of this program, the City only had the reporting system and no legitimate performance management system. They were just collecting measures.

What changed for New York was when the Giuliani administration made a bold pledge to reduce New York City crime by ten percent in the first year post election (Smith, 2009). This aligned the outcome with a charge or goal for the New York Police Department (NYPD). At the time Police Commissioner William Bratton, who was familiar with studies of performance in other police departments, implemented the use of "timely operational feedback on crime patterns, constant review, and discussions of strategies for reducing crime, with decentralized commanders empowered to respond but also responsible for results" (Smith, 2009, p. 500). CompStat was born as a process of learning what works, providing education department-wide on the lessons learned, demanding accountability, and learning from experience to improve outcomes. This has been hailed as a success in that since 1994. There was a large decrease in crime and many other agencies adopted this model successfully. Performance management grew throughout the City government, and it was institutionalized based on the success of CompStat (Smith, 2009).

Similarly, CitiStat was a program championed by former Maryland Governor and Baltimore City Mayor, Martin O'Malley, which was modeled after CompStat. CitiStat focused on accountability of staff to the leadership of the City, and top leadership were called before the Mayor and city leadership to describe the performance of a range of indicators. This program and its model, CompStat, became models themselves touted as successful throughout the nation (Smith, 2009; Radin, 2015). I will describe some of the criticisms of these programs later on.

All of these purposes for the use of performance management sound fantastic, and everyone jumped on board, but skeptics started to have their doubts. The fallout occurs in actually doing the work and how information is used. Performance management seems simple and straightforward, but it is actually quite difficult (Poister et al., 2014). There is a weak understanding of performance information and how to use it. These past few decades are a time where there are many performance requirements but a lack of the "theoretical and empirical justifications for performance-reporting requirements" (Moynihan, 2008, p. 5).

Moynihan (2008, p. 5) pointed out "we have poor theories of performance information use, largely informed by a combination of common sense, some deeply felt assumptions about how government should operate, and a handful of success stories." The operating theory of performance management reform appears to hold that it is an unambiguous benefit to governance, it should be adopted, and it will foster smarter decisions that lead to better governance. The current theory of performance information use might be characterized as "if you build it, they will come." It assumes that the availability and quality of performance data is not just a necessary condition for use but also a sufficient one" (Moynihan, 2008, p. 5).

Skeptics of performance management question its benefits and applications as a policy tool. Beryl Radin, already identified as a skeptic of performance management, penned an article in response to the GRPA questioning performance management as a "hydra-headed monster or flexible management tool" (Radin, 1998, p. 307). Though her criticism focused on the requirements of GRPA, she raised issues with performance management that appear in any performance management program. Her concerns are prevalent in works of other scholars as well.

For example, with the lauded CompStat and CitiStat, Radin (2015) described the challenges of a program generalized across the board and every government function subjected to similar measurement. First, with these types of programs, the thinking is that every facet of the city can be measured in much the same way, or that what a city does can also be done at different geographies. Radin cautions against generalizing across governments in different geographies and that special attention should be made to different specialized functions (Radin, 2009). Second, quantitative measurement should not prevail above qualitative assessment of service. In this case, more does not always mean more. Third, measures used were intended to maximize efficiency of services, which was thought to lead to budget reductions. For this, Radin cautions of “worshipping the Gods of efficiency and ignoring the issues of equity” (Radin, 2009, p. 510). Finally, pressure to perform in CompStat led to manipulation of the data, especially as it was tied to salaries. This cautions of linking performance to personal incentive (Radin, 2015). Overall, Radin warns of managing only what can be counted and that a balance between qualitative and quantitative measurement of performance is needed.

Even Smith (2009), a relative proponent of the NYC CompStat work, acknowledged some challenges with the program. Most notably, he drew attention to the many years it took for NYC to progress from the 1970 standards to having a performance management program where measures were helping to drive improvements and not just contributing to what he termed as a phone book of metrics. Smith noted NYC as taking almost thirty years to get to a place where it had a system and way of work rather than a report. Additionally, it is notable that policy actors played a role in the City's success. The CompStat program, for example, seemed to flourish when the performance was tied to a goal, reduce crime, and when the leadership, Commissioner Bratton, both understood performance and supported its use (Smith, 2009).

As optimistic as Wholey & Hatry (1992) sound in their rather supportive testament to performance monitoring, one can read between the lines on some of their statements to observe challenges. For example, they pointed out that performance monitoring depends on an understanding of goals and objectives, clear performance indicators, and an acknowledgement that there may not be data or ways to measure performance for some functions. When this occurs, unmeasured activities could be ignored. Additionally, measurement and indicators may not always mean causality. Success and or failure could be due to external factors not measured or considered. They warned of manipulating data where the public-sector worker may know that more favorable performance comes from certain functions, so those functions get more attention or they report more positive numbers to show better outputs and outcomes (Hatry & Wholey, 1992). Some key areas of challenge include data and measurement techniques, goal definition, leadership and organizational support, political support, and stakeholder engagement (Radin, 1998; Behn, 2003).

Beginning with data and measurement, much of the focus that has been on performance management assumes there is data to measure. This may be a false assumption. Radin (1998) delved into this challenge in GRPA where requirements for performance plans assumed that data was available or agreed upon for use. However, not all performance efforts recognize the challenge of data. In the case of GRPA, these requirements came at a time when the Paperwork Reduction Act of 1995 was put in place, and some data needed for measurement were no longer allowed to be collected.

Additionally, data systems can be expensive and costly to maintain for the purpose of measurement. One of the most difficult aspects of data in public hands, however, is understanding that the government cannot control who uses the data and for what purpose. The government can use it for performance, but others can use it in a myriad of ways, some of which could be political, malicious, or to support policy positions against the government (Radin, 1998).

Some organizations are more prone to performance management than others. Measurement alone will not affect change and there must be organization buy-in for performance management to occur (Holzer & de Lancer Julnes, 2001). Moynihan (2008) cautions that performance measurement cannot be symbolic and must be substantive for performance management to work. This was the case in New York City where there was measurement, but the staff were so focused on handling the crisis of the moment that it was not until years later that the City evolved to performance management. This demonstrated a lack of flexibility and organizational culture, leadership commitment, and motivation that can stymie performance management (Moynihan & Lavertu, 2012; Moynihan & Pandey, 2010). In NYC's case, they were measuring performance, but they were focused on the applicable crisis of the day (Smith, 2009). In other cases, public sector actors may make passive use of performance data, and minimally comply with requirements of performance programs. In relation to GRPA, Radin (1998, p. 309) noted that performance programs work best when organizations have “relatively stable histories that are amenable to a planning approach; have cultures of data production (with agreement on typologies and belief in the accuracy of information); and have manageable levels of conflict between the external actors (or stakeholders) interested in the program.” Therefore, organizations with a strong culture of planning and clear goals and roles for stakeholders succeed best with performance programs.

Decentralization, fragmentation, and other disconnected elements of government present hurdles than can challenge performance management. For example, Radin (1998) cited the basic structure of U.S. government represents fragmentation in decision-making where it is challenging to look at crosscutting issues across the executive branch, legislative branch, and among stakeholders such as state and local government actors in the process. Additionally, she described more decentralization efforts to devolve power from the federal government to states as a challenge to observe federal performance. Any organization with so many tiers or devolved processes may find performance management of the whole difficult to do (Radin, 1998).

Political actors can present problems for objective performance management. Radin (1998) remarked that political actors making it difficult to derive information, measure it, and manage it such that the result serves all purposes, further exacerbate the normal fragmentation of government, as described above. Political actors may find ways to use performance information in conflicting ways or to serve their purposes (Radin, 1998).

A program could have too many goals or roles making it a challenge for the program to be measured and managed using performance management (Behn, 2003;Hatry & Wholey, 1992; Radin, 2006). This occurs when the mission is complex or goals are too ambiguous (Behn, 2003) (Radin, 2006). Additionally, public actors face issues when it is hard to compute or quantify the outputs or make a clear connection to outcomes (Jennings & Haist, 2004; Willson, 1991). Additionally, programs may have difficult operating environments or problems that are problematic to resolve no matter how performance is tweaked (Behn, 2003; Radin, 2006).

Understanding who is a stakeholder and engaging them may present particular challenges depending on the diversity and role of the stakeholders. Stakeholders may include public, private sector, and nonprofit representatives (Moynihan, 2008). It is understood that these stakeholders may have diverse views (Boyne, 2003). However, stakeholder criteria are not always specified or addressed in terms of who has the authority to determine what good performance includes (Andersen, Boesen, & Pedersen, 2016).

Lessons Learned from Public Performance Management Literature

I found dissecting and understanding public performance management opportunities and challenges difficult because there are so many facets. There is a general agreement that measuring performance is good, but use presents issues ranging from mathematical analysis to stakeholder engagement and political actors. Despite hoping that the act of performance management brings about objectivity and truth, it seems to have presented opportunities to further politicize processes through data manipulation, control, and subjective decisions on what is important or not depending on who set the strategic goals for the organization. Still, there seems some merit in simply looking at the performance numbers and being informed (Radin, 2006; Behn, 2003; Moynihan, 2008) that performance measurement cannot be the only decisional information used in any process (Hatry, 2006).

Performance Management and Transportation

Performance management in public transportation became a movement or industry in itself much like general public performance management efforts (Radin, 2006; Henirich, 2007). Among practitioners, this is called Transportation Performance Management or TPM. Public-sector practitioners believe that it helps from a policy and planning perspective so that they can be more accountable to the public or customers, and they claim it helps them to spend their limited resources (TRB) (Hancock M. , 2014). One of the key aspects of TPM is creating links to policy goals and objectives, program and project delivery, and to support maintenance and operations. There seems to be general belief among transportation decision-makers that TPM is helping them (Park, Campbell, & Bremmer, 2014).

There is a lack of academic research on the benefits and challenges, or policy outcomes, of general TPM in public transportation agencies. For now, most academic research on performance has accomplished by the Transportation Research Board of the National Academies of the Sciences (TRB), AASHTO, transportation consultants or think tanks, and a few academics.

Evolution of TPM – Shades of GRPA

Like the rest of government, the public transportation sector began embracing performance management in the 1990s with GRPA and developments within surface transportation reauthorization, which authorizes and funds USDOT (Curristine, 2002). The ideas of transportation performance management emerged with ISTEA, which first mentioned the use of performance measures in transportation planning and project identification at the state and MPO level. Following ISTEA, SAFETEA-LU attempted to further the requirement for performance measurement and managing in the planning process (Curristine, 2002; Compin, 2008).

MAP-21, however, was the first time that federal transportation law required states and MPOs to engage in measuring performance for multiple areas aligned with federal goals. Congress set seven national goals in MAP-21: safety, infrastructure condition, congestion reduction, freight movement, economic vitality, environmental sustainability, and reduced project delivery delays (MAP-21, 2012). It required USDOT to establish measures for the national goals and to define transit state of good repair. Through this effort, the USDOT would set the requirements for states and MPOs to set targets and measure transportation according to the rulemaking (Melaniphy, 2013). This work has been underway since 2013 and was recently finalized. All states must now submit performance reporting for measures aligned with these national goals.

One of the challenges for USDOT in doing this work was that they needed to pick measures that were the most meaningful but simple for states to do (Slone, 2017). The purpose of

MAP-21 was to raise the level of transportation performance measurement and management capability among the states. What USDOT found was that it is hard to find a one-size-fits-all solution, yet that is what the MAP-21 law (Slone, 2017) required. Butch Weidelich, Deputy Administrator of FHWA, remarked that, "I do think at the national level where we struggled was how do you tell the story with a level of consistency from state to state around the country at that high level." Certainly, applying the right measures for the right circumstances is a challenge (Slone, 2017, para. 9).

The most recent FAST Act includes continued reliance on transportation performance measures. For freight, there are specific requirements that states do freight planning, identify critical urban and rural corridors, use performance measures for freight and in project development, and for the USDOT to develop a multi-modal freight plan that implements port performance measures (FAST Act, 2015). Like GRPA, there is an assumption here by Congress that data and methods exist. As Radin (1998) cautioned, there are assumptions made that could make the federal requirements problematic. Challenges include the assumption that data exists when it does not, the diversity of private sector stakeholders, and a lack of public control over freight movements. The cart would appear to be before the horse, and it is hard to discern if the push for TPM from MAP-21 and FAST, especially for freight, will help improve freight understanding emerge with a positive impact on planning or if it will be painful for TPM staff. As a colleague mentioned recently divulged about a state TPM employee, "they are hiding under a rug and won't come out until [all these] [MAP-21 performance requirements] goes away."

TPM Use by the Public Sector

There are some examples where states believe in the success they have had with TPM. Washington DOT has one of the most notable programs for TPM, where they produce the Gray Notebook and communicate performance information with the public so that they can make a case for funding (Campbell & Lorenz, 2014). They demonstrate the success of projects to accomplish goals, and they report that this has led to improved voter confidence and legislative support. They have committed to it so completely that they received two gas tax increases for investments and revue packages (Campbell & Lorenz, 2014).

In addition to Washington, Missouri DOT, North Carolina DOT, Michigan and Maryland DOT all have performance programs with self-reported success (Hancock M., 2014). Hancock (2014) revealed that Missouri DOT reported TPM helped them strengthen organizational infrastructure and to demonstrate progress to the public. North Carolina reports increased effectiveness of internal management and decision-making, as well as accountability. Maryland reported that TPM aided them in highlighting the impacts of decisions and to identify trends for performance-based planning (Hancock M., 2014). Michigan DOT reports using TPM since 2006 to public comprehensive surveys of customer satisfaction (Steudle, 2014).

State TPM practitioners point to three key areas for TPM use. First, states use TPM to inform the public and improve internal operations. An example of this is the Michigan work cited previously where information helped to improve relationships and gain stakeholder support. This information has helped Michigan successfully obtain funding from the legislature even during difficult financial times. They have also used TPM to develop dashboards that they use in discussions with legislators or other officials to demonstrate how a project idea would be successful or not based on previous performance measurement information (Steudle, 2014).

Second, TPM helps states integrate performance measures into the transportation planning process. There are varying practices among states and MPOs in using TPM to develop performance based planning so that investments are based on performance needs. Challenges exist in the ability to get good data, tools, and best practices for using TPM in planning (Park, Campbell, & Bremmer, 2014). In particular, some state and metropolitan plans vary in content and level of analysis such that some are simple and others are detailed and linked to other public functions like housing or environmental protection. This variability leads to differences in how TPM is used (Campbell & Lorenz, 2014). However, success among states like Minnesota, Maryland, Michigan, and Kentucky is found in their work using measures to provide scenarios for planning. This helps to engage the public in discussions on trade-offs and funding (Hancock M., 2014).

Third, TPM helps decision-makers maximize their budgets and their resources (Campbell & Lorenz, 2014). For example, Daniela Bremmer of Washington DOT remarked, "Most transportation agencies operate under challenging circumstances, whether it's a funding crisis, a leadership change, or legislative partnership. This can lead to credibility issues" – "embracing performance management is one of the biggest ways to combat that" (Campbell & Lorenz, 2014, p. 13). Decision-makers face great challenges in determining how to best spend funds. The public always wants to know how their funds are being spent (Campbell & Lorenz, 2014).

Despite the reported success, a look at the effectiveness of these programs raises concern. The success of these programs is touted by leading practitioners at State DOTs, executives, or program managers touting success in a report with wide distribution among peers. Without research, or a mechanism to evaluate the outcomes of the performance programs, it is difficult to determine whether these are dog and pony shows or if they are truly helping to drive the goals of the transportation agency and achieving success. The touting of these TPM programs is similar of a critique by Radin (2015) on Baltimore's CityStat program where there was no shortage of self-accolades for the program. The program was in actuality not achieving the results it claimed (Radin, 2015). It is easy to wonder if there may be elements of this happening here.

Additionally, with federal mandates in MAP-21, states are concerned that they may be required to measure transportation in a prescribed manner when they need both the quantitative analysis and qualitative stakeholder, as well as political accommodations. Christos Xenophontos of Rhode Island DOT said that, "One of the biggest fears we have with the new rules is unintentionally enforcing a 'worst first' approach" (Slone, 2017, para. 14). He remarked that states have limited resources and need to make decisions about a range of assets in varying jurisdictions. TPM cannot fully dictate where investments should be made (Slone, 2017).

More research is necessary to determine the effectiveness of these programs. For TPM to be effective, it is necessary to evaluate the transportation network as a system (Melaniphy, 2013). It must consider the multi-modal and interconnected nature of the system and not modes or segments individually. TPM cannot measure one mode or transit without considering freight. In other words, it must be considered comprehensively so that it evaluates the entire transportation system in states and regions (Melaniphy, 2013). It also must push for a data driven program with an emphasis on good data collection for monitoring, analysis, and decision-making. What TPM should not be, is merely a checkpoint for grant delivery (Melaniphy, 2013; Poister et al., 2013). I would further add that it should not be merely customer focused but include an internal and external analysis of performance that looks at business practices internally and the outcomes (customer measures) that are realized externally (Balanced Scorecard).

Poister, Pasche & Edwards (2013) found that in small to medium U.S. transit systems, there is some evidence that performance management led to improved outcomes. They found that when the organization engaged in conventional practices for performance management, there were gains in effectiveness and productivity (Poisteret al., 2013).

Additionally, when the mission or focus of the public transportation organization was clear, performance measurement activities outweigh the effects of formal strategic planning. It seems that when the goal is obvious, such as maintaining ridership on a transit system, strategic planning is not as necessary to clarify goals. Performance measurement is however, needed to ensure ridership is attained (Poister et al., 2013). Poister et al. (2013) noted that the findings aligned with Jennings and Haist's (2004) criteria for performance management potential where public programs are likely to achieve success when there are clear, observable outputs and outcomes (like ridership and on time performance). More ambiguous transportation like freight movement, where there is less control over the movement by the public sector, may not fare as well.

Getting To Freight Performance

There is limited research or information on whether or not freight performance measurement used as a policy tool makes a difference in transportation. Like performance measurement, the substantial freight requirements for planning and performance measurement included in surface transportation law seem to be in the vein of something we must surely do with a "build it and they will come" mindset per Moynihan (2008, p. 5).

Most of the ideas about freight performance and planning stem from the private sector's work in supply chain management and attempting to reduce transportation costs. The private sector's goal is profit, and profit depends on providing a product that customers demand as efficiently as possible. Businesses use performance measurement and management to reduce costs, meet customer demands, and to focus on core competencies in delivering products. These goals have helped businesses better examine their business structure and to understand where their inefficiencies lie. For example, businesses recognize that when their organization has too many silos, it is difficult to coordinate their functions to efficiently meet customer demands (Staib & Michaelson, 2002).

This has led to work in supply chain and purchasing management, industrial organization, lean manufacturing, total quality management, and other areas of business efficiency using private sector performance management practices (Womack & Jones, 2003). Businesses work to optimize the performance of their system as a whole and not just operational units so that they can achieve overall efficiency (Staib & Michaelson, 2002). In doing this, businesses typically establish a feedback loop so that they can have a cycle of information for continuous improvement. In applying this to TPM, the transportation network is multi-modal and works as a system. Transit is not independent of highway performance, which is not independent of intermodal and rail performance. A system-level view is needed.

In more recent times, the ideas of just in time (JIT) production have permeated the private sector as a means of reducing business transportation costs. JIT is used to minimize distribution costs by eliminating warehousing and getting goods to customers just as they are needed. An example of JIT is that retailers will rely on large distribution centers and consolidate shipments to stores or customers, and customize shipments (Held, 2003).

JIT and the related distribution network are highly sensitive to transportation costs that the public sector can influence through transportation decision-making (Held, 2003). This includes travel time to stores, highway access, and whether or not the local jurisdiction can make necessary highway or intermodal access improvements to better move freight. Though non-transportation factors like business climate and workforce contribute to costs, transportation cost is a significant driver of overall cost. In business site selection and economic development efforts, businesses are seeking ideal locations based on the most efficient transportation access in addition to workforce, quality of life, and other factors (Held, 2003).

As previously noted, congestion challenges that impact the private sector are increasing (Schrank et al., 2015). Congestion impacts private sector supply chains and adds cost due to delay and fuel losses (TRB, 2014). With increasing pressure for economic competitiveness and the new federal freight requirements, transportation decision-makers find themselves in a quandary for urban freight planning.

For freight performance measures, there have been several resources published both by FHWA and by the Transportation Research Board to catalogue measures. What they found was that there are several categories of freight measures, but mobility measures that demonstrate congestion and network inefficiencies are where the challenges of proprietary data and the lack of information are slow to resolve. To illustrate this point, FHWA's Freight Performance Measurement Primer (Primer) is a resource for states to use in developing freight performance measures programs. It catalogues the categories of freight demand, mobility, safety, environment, economic, asset conditions, and accessibility along with the types of measures and metrics, as well as available data (Katsikides, Easley, Kucharek, Shamo, & Tiedeman, 2017). Mobility measures are the measures that rely on understanding the efficiency of freight movement on the network and require the use of proprietary data. The other measures can be developed using publicly available information; although, currently available economic information such as tonnage and value might be improved by proprietary sources as well.

Freight Performance Measure Research

Freight research is broad, but work specifically on freight performance measurement and freight planning is sparse. Most of the academic work in freight planning or performance has to do with trying to fit freight into transportation models or truck routing, costs, and delivery times (Bassok et al., 2013). There is a lack of comprehensive studies to document the relationship between goods movement and land use (Bassok et al., 2013;Woudsma, 2001). Bassok et al. (2013) found that the only comprehensive analysis of integrating freight and land use in research focused mainly on long-haul interstate movements and presented options for creating buffers or zones, such as Baltimore's MIZOD, and not ways to accommodate or integrate freight into the urban environment (Bassok et al., 2013; Strauss-Wieder, 2003). Allen and Browne (2010) produced research on the relationship between the urban form and freight transportation. They found that freight is less connected to urban form than passenger movements and those higher densities in urban areas would likely reduce distances traveled for freight flow between origins and destinations, potentially reducing costs. This work seems to try to fit findings about people movement to freight movements without fully understanding how freight needs to move within an urban area. Freight and people movement have different needs, so what works for people will not necessarily work for freight.

Some studies look at specific urban area growth and freight issues such as congestion, parking, loading areas, and truck only lanes. Nothing appears comprehensive and related to specific benefits or challenges of measuring for freight to inform policy. Morris et al. (1999) found that transportation managers are concerned about roadway congestion and that real-time traffic information could help with routing (Morris, Kornhauser, & Kay, 1999). Golog and Regan (2001) identified specific areas that concern the freight private sector. These include slow speeds, unreliable travel times, driver frustration, lowered morale, fuel and maintenance costs, and cost due to accidents and insurance (Golog & Regan, 2001). Holguin-Veras and Wang

(2001) catalogued freight stakeholder perceptions of electronic toll collection, a technique used in urban settings to improve traffic flow (Holguin-Veras & Wang, 2011).

A challenge for the urban planner is the lack of freight data and analytical tools to understand freight mobility movement, its needs and impacts or how to resolve urban freight conflicts with residential land uses**.** Comprehensive regional modeling tools that can demonstrate the land-use and transportation interaction primarily consider passenger movement at this time and do not adequately capture freight movement (Bassok et al., 2013). This is likely the reason for the high number of research studies in modeling and trip time analysis for freight – trying to fit freight into existing transportation models. Schrank et al. (2013) found that there are few analytical techniques that incorporate freight into transportation system monitoring, system evaluation and project selection. Investments are often based on passenger-based assessments of performance without considering goods movement.

Developing Urban Freight Data

Getting freight data to measure mobility performance and inform policy is the largest impediment for the public sector in terms of freight analysis. There have been incremental advancements. This section describes the evolution of freight data over the past 15-20 years.

Data for transportation mobility analysis today typically comes from three key sources. First, technology such as traffic readers, induction loops, or other types of automated detection and counting, as well as GPS data or probes, toll tag readers, RFID, cellular data from phones, and Bluetooth readers are in use for real data (Cambridge Systematics, Texas A&M

Transportation Institute (TTI), University of Washington, 2016). These sources help derive speeds, volumes and occupancy, and some classification (i.e. truck or car and type of vehicle). Second, data can be derived from planning models such as outputs of travel demand models. Data are expressed as vehicle miles traveled and delay estimates or projections. The data is predicted or estimated based on historical information. Third, data can be from link based sources that includes roadway inventory data such as capacity, number of lanes, etc. (Cambridge Systematics et al., 2016).

To date, freight mobility data is limited and not exactly public (Gordon Proctor & Associates, Cambridge Systematics, ATRI, StarIsis Corporation, & CSCPM, 2011). The public can use traffic devices to count and identify trucks, and this is in use nation-wide. This data is public data, but it can only tell volume and speeds in limited locations. There are not counters everywhere (Cambridge Systematics et al., 2016). A newer data source for truck data is from Global Positioning Systems (GPS) and called probes within the industry. Probe data comes from the on-board devices in mostly fleet trucks. The trucking management companies use these devices to monitor location and other aspects of their fleets (Cambridge Systematics et al, 2016).

In 2002, FHWA embarked on an effort to grow freight data through use of automatic vehicle location (AVL) (Sedor & Jones, 2006). AVL would later be termed probe data. At the time, the president of transportation firm Cambridge Systematics and chair of the TRB Performance Measurement Committee, Mr. Lance Neumann, said that one of the "most difficult challenges faced by transportation agencies is identifying freight performance measures that (1) are in the areas the public sector can influence and (2) are meaningful to freight stakeholders in the private sector" (Sedor & Jones, 2006, para. 10). FHWA worked to identify what would be meaningful to public sector managers and what transportation decision-makers in the public sector can actually influence. It found that planners wanted to understand speeds and reliability information. Private sector stakeholders who were shippers, such as manufacturers, distributors, and retailers moving goods, told FHWA that velocity and reliability are among their primary measures of interest. Carriers are more interested in profitability and return on investment, but even these lean heavily on reliability (Sedor & Jones, 2006).

FHWA worked with the American Trucking Research Institute to develop a program to glean position and speed data from these on board computers (OBC) and use it for analysis of freight movements and congestion on key corridors (Sedor & Jones, 2006). The data was anonymized and analyzed by ATRI and the analysis was provided to FHWA. As the trucking companies began to see how the data could be used to help relieve congestion, they became more open to sharing data. However, a major provision of this data is that it not be used in a harmful way for trucking. Meaning, it cannot be used by the government to try to regulate truckers or to impose standards. It can only be used for congestion analysis (Sedor & Jones, 2006).

Over time, the ability to use this data and analysis grew. Today, the ATRI data comprises data from over 600,000 trucks, which are mainly the long-haul carrier type trucks moving goods long distances. FHWA, states and MPOs are working with this data to analyze truck trips and understand freight impacts on the system. Some limited freight modeling work has been done with this data as well (FHWA, 2017b).

In 2012, FHWA acquired a new dataset that included travel times for all traffic, passenger cars, and trucks. Unlike the ATRI data where ATRI provided the analysis or limited data, this data set, the National Performance Management Research Data Set (NPMRDS), provides actual travel times in five-minute intervals historically by month for use in congestion analysis, planning, and other transportation analytics as needed. FHWA made this dataset available free to states and MPOs. The truck information in the dataset was initially provide from ATRI and their 600,000 trucks (FHWA, 2017a).

As this data could be used by many states, their consultants and researchers/academics, the reliability and validity of the data was scrutinized. Though FHWA provided a report on the data quality, analysts found challenges with the truck sample not being robust enough to be accurate on some roadways. For most interstate locations, the sample was decent on interstates and was checked against stationary traffic devices they found to be fairly equivalent (FHWA, 2017a).

In 2017, FHWA rebid the NPMRDS and a new provider was chosen. This time, the dataset was provided by INRIX, a leader in probe data (FHWA, 2017a). Though no information is provided on the arrangements INRIX has with the trucking companies included in its data set, it is assumed that INRIX is able to provide the truck travel times along with passenger times as part of the NPMRDS. At the time of this dissertation, no research is available on the reliability and validity of the data. However, FHWA does require INRIX to provide continuous reports on data quality (FHWA, 2017a).

The challenge to paint the freight picture lies in getting the mobility data. As with FHWA's development of truck probe data with ATRI, data were a problem in 2002 and the private sector connection and trust was an issue cited at the time as to why freight was difficult to measure (Sedor & Jones, 2006). To date, we still are working with limited freight data and do not have robust multimodal data to evaluate, visualize, and describe impediments to the freight system. The private sector has remained reluctant to engage with the government and share data on its supply chains or transportation costs and performance. For them, this information is highly proprietary and the U.S.'s Freedom of Information Act (FOIA) laws could jeopardize the proprietary information (TRB, 2014). FOIA requires the government to be open with its data and information in hand except under certain pre-decisional circumstances. The private sector fears both how the data will be protected and how the information may be used. This has shades of GRPA where Radin (1998) described how political use of data could be and how performance measurement could be construed.

With the current freight planning and performance mandates requiring multi-modal plans, performance measurement, and other freight specific practices, another one of Radin's (1998) warnings about GRPA proves true. The cart is before the horse in that there are federal mandates for something where data is not mature and practices are not fully established for measurement. The major hang-up is private sector data and a way to get that data, anonymize it and use it to support business in the nation.

Using Freight Data

In public transportation agencies, the freight mobility data that are available help measure mobility by congestion and reliability. This helps to identify bottlenecks on highways. Congestion is one of the most problematic issues for freight movement, especially in urban areas. The focus of research in the past two decades has been on identifying bottlenecks and determining the best statistical methods to evaluate them. Some scholarly institutions and consulting firms have been building off each other's work in conjunction with FHWA over these years. FHWA, Cambridge Systematics, Texas A&M University's Texas A&M Transportation Institute (TTI) and University of Washington have all been part of this arena to advance freight data and measurement practices. Their work is reviewed below.

Bottleneck Analysis

A challenge is in the definition of bottleneck. In highway performance research, bottlenecks have been defined a number of ways. They have been defined as a restriction or point at which there is a separation between moving or free flowing traffic and queued traffic (Daganzo, 1997;B ertini & Myton, 2005). They have also been defined as areas where capacity is impacted or a roadway where speed measurements are poor (Zhao et al., 2013). Alternatively, they are considered as locations where congestion is experienced consistently (Chen, Skarbardonis, & Varaiya, 2004). This range suggests that bottlenecks can be classified in different ways depending on the analysis.

There are a range of ways to measure highway performance and identify bottlenecks. Most analysts report using statistical metrics, especially reliability (Zhao et al., 2013). Reliability is typically defined in engineering as the probability that an entity performs satisfactorily for a specified time under certain operating conditions (Kececioglu, 1991). Zhao et al. (2013) described how this engineering concept has been extended to transportation analysis. It is done by applying the concept to the uncertainty of travel time in that it is the probability that a trip can be made on time. As such, it displays the variability between expected and actual travel time (Emam & Al-Deek, 2006; Shaw & Jackson; Zhao et al., 2013; Lyman & Bertini, 2008).

In 2005, Cambridge Systematics, a leading transportation consulting company, made the first effort to locate and quantitatively assess highway truck bottlenecks nationally (Cambridge Systematics, Inc. & Battelle Memorial Institute, 2005). Much work on general traffic bottlenecks had already been done, but truck analysis lacked. They located highway sections with a high level of truck congestion and then estimated the truck hours of delay. Their analysis used the number of trucks in proportion to capacity or the volume to capacity ration. They classified bottlenecks into groups by constraint type. These were then ranked them by hours of delay. Though this was a start for bottleneck identification, it was based on derived data and did not directly account for real-world truck behavior (Cambridge Systematics, Inc. & Battelle Memorial Institute, 2005).

Since then, there has been work by both ATRI and Texas A&M Transportation Institute to use data to identify bottlenecks and congestion for freight in different ways. ATRI assesses and ranks bottlenecks using their data. To do this, they calculate average miles per hour below free-flow speed for a specific segment. A segment may be a critical highway location or intersection such as I-95 in Baltimore or the intersection of I-95 and I-495 in Washington, D.C. They then multiply this result on an hourly basis by the number of trucks on the section of road to find the hourly freight congestion value. The sum over 24 hours produces the total freight congestion value. Then, segments can be ranked by severity. This information has been used every year in ATRI's own reporting, and ATRI claims that it has led to policy-makers prioritizing some bottlenecks on the ATRI list for improvement (ATRI, 2017). No concrete example of this statement exists.

Each year, TTI develops an Urban Mobility Scorecard, as well as an Urban Congestion Report (UCR) for FHWA. The UMR provides an analysis of traffic conditions for 471 urban areas in the U.S. This helps to examine congestion issues and provide decision-making support for transportation planners in urban areas (Schrank et al., 2015). For FHWA, TTI produces the UCR that provides quarterly trends for mobility and reliability based on archived traffic operations data (Federal Highway Administration, 2018a). Both reports rely on the use of probe data for the analysis, and most recently in the UCR, the NPMRDS data set is being used (FHWA, 2017a).

Through this work and others, there has been about a fifteen-year evolution of the measurement of all traffic using the traditional data collection techniques and the emerging probe data sources, as well as the testing of metrics among academics to understand the best techniques for measuring performance. However, measuring freight bottlenecks remains mostly a highway-based activity. Freight trips are usually multi-modal in that they involve the movement of goods by two or more modes of transportation such as through a port to a rail line and then by truck for the last mile delivery (I-95 Corridor Coalition, 2016). Measuring just highway segments and corridors or area-wide measures does not describe the true freight trip experience.

Freight Fluidity

Freight fluidity is a concept developed by TTI to understand the mobility experience of freight trips or supply chains. The concept focuses on the bottlenecks that businesses actually experience in moving goods from origin and destinations and seeks to understand and prioritize bottlenecks from the business trip perspective. This gives freight analysis the added dimension of understanding the routes of most value to regional businesses and then being able to identify the worst bottlenecks on those routes. They then prioritize those that are most important to the local economy (Cambridge Systematics et al., 2016). The concept of freight fluidity was originally developed with researchers at TTI who worked with the Canadian government to help them address the same freight performance struggles experienced in the United States (Eisele et al., 2011). Except for Canada, their laws allow the Canadian government to hold proprietary data without releasing it publicly. This seems to be the lynch pin because the level of comfort with the data protection was enough to get private sector stakeholders to provide the data.

Canada wanted a way to better find and mitigate challenges to its freight transportation network (Eisele et al., 2011). The government sought ways to improve freight flow with data and performance measurement. TTI worked with the Transport Canada to identify key freight corridors and combinations of freight facilities for measurement. For example, they identified combinations of ports of entry and exit, railroads, intermodal facilities, and highways supporting supply chains critical to Canada's economy (Eisele et al,, 2011).

Measures on key Canadian supply chains identified performance. The results were compelling. They were able to identify recurring bottlenecks and to understand seasonal impacts, as well as to identify where significant weather or workforce issues affected delays (Eisele et al., 2011).

Transport Canada has since used this information to prioritize freight bottlenecks in transportation planning for mitigation that they attest has improved freight flow. They also report that they have been able to use this analysis as a business tool to recruit industry by demonstrating how reliable the supply chains are and where opportunity would be for these industries to locate. Finally, they report that this analysis has become so important to the Prime Minister that an office has been created within the Prime Minister's Division just for the consultation of fluidity analysis with any economic policy. It has become a critical policy analysis tool for the nation (Tardif, 2014).

In the U.S., FHWA has had a goal of achieving fluidity analysis to obtain the same level of economic development support realized by the Canadians. FHWA has sponsored a series of fluidity programs to attempt to copy the Canadian system. The first project was a partnership between FHWA, the U.S. Department of Commerce (DOC), and the I-95 Corridor Coalition. The goal was to establish an end-to-end conception of performance and measurement across modes and stages. They evaluated freight bottlenecks strings throughout the entire I-95 corridor using the ATRI truck probe data. Some of the findings include that there are multiple stakeholders as bottlenecks impact a range of jurisdictions and boundaries, agencies and modes, and business sectors (I-95 Corridor Coalition, 2016).

The study provided insight as to how fluidity analysis could be applied to five supply chains of major U.S. industries. Researchers worked with the industry representatives for automobiles (Chrysler and GM), retail (Target), electronics (Panasonic), agriculture (soybean producers), and food processing (Perdue). These industries provided insight as to what their specific routes for their transportation supply chains are. These routes were national, international, and regional in nature. Analysis was done for transit time, reliability, cost, safety and risk, or disruption. What was learned was that applying this type of analysis to national supply chains was possible. We could know at a macro level how well the supply chain was performing and where bottlenecks were occurring that could potentially be mitigated by a state or local government in the transportation planning process. Additionally, the study found that the fluidity metrics were common across the supply chains and could be scaled for national, multistate, and metropolitan use. This information could help transportation decision-makers to address the bottlenecks, target investment, or plan for rerouting in the event of an emergency (I-95 Corridor Coalition, 2016).

This work was seen as successful by FHWA but it did highlight continued challenges with freight data. The most robust information from this work came from the truck analysis. Though the researchers were able to get some limited rail information, this was not expected to open doors for the continued use of railroad data. This work was mainly to prove that measuring supply chains, like the Canadian fluidity work, could be done in the U.S. (TRB, 2014)

FHWA is embarking on the continued monitoring of national supply chains at the time of this dissertation. The work includes developing a national performance monitoring system that would provide high-level indicators of supply chain performance and to pilot fluidity in regional areas of New York, New Jersey, and Chicago. FHWA recognized that more work must be done to achieve the level of sophistication that Canada has achieved. Additionally, the DOC has an Advisory Committee for Supply Chain Logistics where top industry leaders of shippers and carriers come together to discuss strategies for improving freight bottlenecks. They are considering all bottlenecks such as paperwork, or regulatory bottlenecks, border wait time issues and transportation bottlenecks, but one of their directives was to use transportation performance information to support fluidity analysis in the U.S. Even with the DOC focus, private sector reluctance to provide data continues to be an issue.

In addition to FHWA, the State of Maryland has been researching ways to understand freight flows and transportation-related bottlenecks (Eisele, Juster, Sadabadi, Jacobs, & Mahapatra, 2016). The Maryland Department of Transportation (MDOT) recently contracted TTI to do a fluidity framework at the state level with the intention to eventually measure freight continuously for planning. To date, TTI provided a framework that looks at some corridors within the state and applies the same reliability metrics to these corridors (Eisele, Juster, Sadabadi, Jacobs, & Mahapatra, 2016). Without multi-modal data, however, only the highway picture can be seen. An additional dimension that the Maryland explores s commodity. FHWA picked the commodity and fit supply chains to that commodity based on the industry description. The Maryland work analyzed freight flows or areas of significant freight activity and then developed costs or measures that would better articulate what is happening by being able to have different weights based on the cost or type of commodity. This is an emerging area of analysis TTI continues to develop (Eisele et al., 2016).

Mobility Metrics

The research above has helped to develop some general agreement among scholars that the use of travel time reliability metrics is the best way to evaluate traffic mobility for freight or passenger traffic, in multi-modal situations and in different geographic scales (Cambridge Systematics et al., 2016; Pu, 2011). Development of travel time metrics has occurred commensurate with bottleneck analyses and has been built and tested by the same group of scholars. For States and MPOs, FHWA recommended measures of travel time reliability when evaluating congestion on U.S. roadways, and the recent MAP-21 law performance measures require use of travel time reliability for yearly reporting by states and MPOs (FHWA, 2017b).

Travel time reliability refers to consistent and dependable travel times no matter the time of day (Lomax, Schrank, Turner, & Margiotta, 2003). FHWA notes past congestion analysis has been measured in terms of averages such as average trip time or average speed. However, FHWA reports that the average does not tell the full story for what users of the highway network experience. Travelers find that travel times vary and what they tend to remember are the few bad days, not so much the average (FHWA, 2019). Because of this, measures of reliability have become the key measures for mobility performance measures throughout the U.S. Although, most scholars agree on the use of reliability metrics, it is measured in different ways (Pu, 2011).

FHWA recommends using measures of travel time reliability because these measures capture the unexpected delay (FHWA, 2019). FHWA formally defines reliability as "the consistency or dependability in travel times, as measured from day-to-day and/or across different times of the day." Measure of travel time reliability can be applied to any user of the highway network, passenger or freight, and it can be used beyond highways in multi-modal analysis (FHWA, 2019, para. 4). Using reliability helps users of the transportation system make predictable plans for routes to ensure on time arrival. This is especially important for freight users because these users need to ensure delivery windows for their customers at a high degree of certainty (FHWA, 2019).

Lomax et al. (2003) are a group of the earliest scholars to research travel time measures for practical use in analyzing passenger and goods movement. They explored a number of statistical options to understand reliability and ultimately selected the use percent variation, misery index, and buffer time index (Lomax et al., 2003). A later project of the Transportation Research Board, the National Cooperative Highway Research Program (NCHRP) identified five key reliability measures. These were Buffer Index, Planning Time Index, Percent Variation, Percent on Time, Arrival, and Misery Index (Cambridge Systematics, Dowling Associates, System Metrics Group & TTI, 2008). The FHWA Strategic Highway Research Program 2 also recommends five measures similar to the NCHRP report (FHWA 2017c). The SHRP 2 Program choices include buffer index, planning time index, skew, percent on time arrival, and misery index (FHWA, 2017c). Pu (2011) notes that standard deviation has also been used to express reliability, but is not recommended by FHWA nor included in the NCHRP work. Table 1 chart describes the measures for reliability that are typically used (Lomax et al., 2003; Pu, 2011).

Table 1: Mobility Measures

Measure	Description
High Percentile Travel Time (Usually 95th, 90th or 80th)	Identifying high percentiles of travel time shows how high delay could be on a route or the heaviest traffic days.
Misery Index	Provides the length of delay for the worst trips. The average travel rate is subtracted from the upper percentile travel rates to get the time above average for the slowest trips.
Buffer Time Index	Measures the amount of extra time to be on time for a certain percentage of trips (usually 95%). This is a time and distance neutral measure.
Percent Variation	A multiplication of the average travel time by the percent variation to produce the time that should be used to plan the trip. The resulting value indicates the travel time needed for 85% of the trips. Higher values indicate less reliability.
Skew	The skew statistic is the ratio of the difference between the 90th percentile travel time and median, as well as the difference between the median and the 10th percentile. It shows the range of the distribution and how much is above the median as compared with the range below median.
Planning Time and Planning Time Index	This is the total travel time (including buffer time) that is needed to make a trip on time and a resulting ratio. The ratio is calculated by dividing the 95th percentile travel time by free flow speed (speed at no congestion).
Travel Time and Travel Time Index	This is the time and ratio of actual average travel time to free flow travel time. It is a congestion intensity measure and not a reliability measure.

For freight, travel time analysis is still an emerging area. TTI's mobility and fluidity work, the I-95 Corridor Coalition/FHWA fluidity analysis and other continued efforts, will apply and refine the metrics over time. The significant challenge is in the growth of freight data and analyzing freight beyond highways such as in the application of freight fluidity analyses for multi-modal freight trips instead only single mode trips. Several of the measures above are discussed in the elite interviews and included in the analysis of funded projects later in this research.

Urban Practices

Since a major focus of this work involves interviews with urban areas that have FPM programs, it is necessary to consider what is known about urban FPM practices. There are several MPOs that are working to advance freight programs mainly due to federal surface transportation law mandates but also as efforts to improve economic opportunities throughout the urban region (Cambridge Systematics, Transmanagment, TransTech & Heanue, K., 2008). Some of the economic reasons include the recognition by urban business and community leaders that efficient freight flow is critical in urban economic competitiveness in order to attract and retain business (Cambridge et al., 2007). There is also the continued globalization and reliance on international trade that has increased the importance of safe, reliable, and secure transport of goods. There is also an acknowledgement from the private industry that public investments could help meet growing freight demands, which is a motivator for them to engage in freight improvement discussions (Cambridge et al., 2007).

The major challenges of focusing on freight have become known as urban areas began addressing surface transportation law and working with the private sector. Freight traffic is growing rapidly and outpacing passenger travel, which is straining the system (Cambridge et al., 2007). While FPM is an attempt to do something about that, freight is too intermodal and difficult to address within urban boundaries due to regional and mega-regional freight flows (Cambridge et al., 2007). Additionally, the public sector planning timeframes and relative slow pace of public sector action is nowhere near the pace of the private sector, which is much more nimble and elastic. Because of the planning timeframes and slower pace, as well as the public sector's comfort with uncertainty or risk versus the private sector's bottom line, business leaders have been reluctant to engage in the public sector transportation planning and programming process. Instead, they institute a workaround that is faster and better for their business. In other words, they indicate they do not to invest time with the public sector (Cambridge et al., 2007).

Despite the oil and water atmosphere of the public and private sector for FPM and freight policy and investment, there are urban areas taking steps to engage in FPM. For example, the North Jersey Transportation Planning Authority (NJTPA) has a robust freight measurement program that considers the health of major freight corridors in the urban area (NJTPA, 2018a). They do have a director who has been a long-time consultant in the industrial logistics scene, which may be a reason for their apparent success. Under her leadership, they have developed numerous FPM tools and resources that are consulted in the planning process. They still struggle with data and make use of the available limited data and resources that are available. They constantly seek multimodal data and improved analysis (Strauss-Wieder, 2003). Currently, they have a number of commodity flow profiles to assess the tonnage and value of the key commodities being shipped in and out of the region, inventory assessments, forecasts, and guidance by a Freight Initiatives Committee that is a group of public and private stakeholders serving as a forum for guidance on freight issues (NJTPA, 2018a).

Chicago's MPO provides analysis and planning for the major freight hub that Chicago is, with the crossroads of railroads and major freight infrastructure that is of national significance (Chicago Metropolitan Agency for Planning (CMAP), 2018). They use available data to develop Freight Cluster Reports on the infrastructure, workforce, challenges, and opportunities that impact Chicago region freight and strategies that could help sustain and grow the regional economy (CMAP, 2018). CMAP's expertise in FPM analysis, as well as inventories and asset conditions for freight help them in the planning process both in the short and long term (CMAP, 2018). In addition, CMAP has played a role in a major railroad project to help drive efficiencies in a very tangled railroad crossroads through the Chicago Region Environmental and Transportation Efficiency Program (CREATE) program (CREATE, 2018). CREATE employs 70 projects in an attempt to achieve 30-year benefits of $31.5 billion by improving the rail and intermodal infrastructure in Chicago. While CMAP is particularly skilled in freight analysis and has a seat at the table with freight stakeholders, they still struggle with not having robust freight data that would help them, especially with their critical position in the national transportation network (Murtha, 2018).

The Baltimore Regional Transportation Board (BRTB) or Baltimore MPO has also been a leader in FPM but Baltimore is probably an example of where there is remarkable FPM expertise and resources but low utility of the information. BRTB has expended numerous resources over the years to develop freight data tools like a Freight Finder, as well as a Freight Transportation Model. The translation to planning and the engagement of the private sector continues to plague them (Akundi, 2018). BRTB has as much data and analytical expertise as is currently available and continues to try and keep FPM as an activity and focus, but the competition with passenger roadway and transit projects in the region is stiff (Akundi, 2018). Though BRTB has taken great strides in past years, they, like the other MPOs continue to question the investment in time and data when engaging the public sector. Even the attention of public leaders has been an issue (Akundi, 2018).

The methodology I have developed in this next section looks at the issue Baltimore has articulated. It considers the time and resources and the perceived impact on urban policy. It also goes a step further to look at region, in this case Baltimore, to attempt to quantify the value of using FPM.

Value of Information

Though performance measurement has multiple uses and applications in the public sector, the focus of this dissertation is on how it is value added for policy-making, particularly in urban areas. The most documented success in using FPM is from the Canadian fluidity applications, though not urban specific. In November 2016, the Government of Canada announced that it “will invest $10.1 billion over the next 11 years in trade and transportation” to “build stronger, more efficient transportation corridors to international markets and to help Canadian businesses compete, grow and create more jobs for Canada’s middle class” (Transport

Canada, 2018, para. 1). According to Transport Canada (2018), much of this program was determined because of the Fluidity analysis program.

As previously described, the Fluidity program has been in existence since 2007. As a collaboration of the government with provinces and public and private stakeholders, the fluidity analytical framework has been used to support the trade routes in Canada and to identify the capacity and demand of the multimodal transportation system. Canada has been able to identify operational issues and impacts and bottlenecks as well as competitiveness issues. They have recently expanded this analysis to include forecasting (Transport Canada, 2018).

Information provided by the Fluidity program allows Canada to focus investments comprehensively in support of supply chains. They focus on ports, surface transportation infrastructure, developing data systems, and other necessary improvements. Overall, the country has established a $180 billion Investing in Canada Plan. Much of the planned infrastructure investment has been identified using Fluidity analysis. Specific funding contributing to the $10.1 billion investment includes $2 billion toward the Canadian National Trade Corridors Fund to reduce bottlenecks in freight mobility along key corridors and $5 billion toward the Canada Infrastructure Bank to fund specific trade and transportation projects (Transport Canada, 2018).

In the U.S., the use of performance measures and the resulting investments is less defined. The Texas A&M Transportation Institute has developed an Urban Mobility Report for almost 30 years that has documented congestion in the U.S. urban areas (Eisele, Schrank, Bittner, & Larson, 2013). Historically, the UMR's focus was on passenger or commuter congestion, but recent growth in truck probe data and methodologies developed by TTI have helped to incorporate truck congestion into this analysis. It has provided an added dimension that TTI believes is useful for decision-makers (Eisele et al., 2013).

The UMR (Eisele et al. 2013) showed that in 2010 trucks moved $7 trillion in commodities on America's urban streets and highways. Urban locations such as ports, intermodal and warehouse districts are all areas where truck congestion is a problem. In addition, what is particularly useful about the UMR in relation to this research is that it found travel times of commercial vehicles were nearly eight percent higher than vehicles in the traffic stream when using travel times from toll tags under free-flow conditions and six percent higher during congested conditions. While the researchers attributed the slower times due to inherently slower truck starts and stops, difficulty changing lanes, and frequent urban area restrictions, it is important to observe that the truck times were generally worse than commuter traffic. This information is only a recent development for traditional performance analysis in the U.S. (Eisele et al., 2013).

While there is no indication that the UMR is being used to make policy decisions or that it has led to the alleviation of a particular bottleneck, TTI notes that some public sector agencies are beginning to implement decision-making processes based on performance information. For example, the following are adapted from Eisele et al. (2013):

- Rhode Island Department of Transportation (RIDOT) now includes freight representatives on their Transportation Improvement Program evaluation committee to determine transportation investments.

- Washington Department of Transportation (WSDOT) implemented a Freight Mobility Strategic Investment Board to help prioritize freight projects in selection.
- Wisconsin Department of Transportation (WDOT) established a forum for freight industry stakeholders to provide input on the types of projects and selection.
- The MPO, Delaware Valley Regional Planning Commission (DVRPC) links a standalone freight plan to current MPO planning efforts.
- Toledo's Metropolitan Area Council of Governments now uses a targeted public outreach process with freight stakeholders to identify freight needs.

Again, while there is no quantification of value or benefit from using FPM, these states and metropolitan regions were moved to establish some relation between FPM to their decision-making.

In addition to TTI's findings, an assessment of state freight plans by the American Trucking Association (ATA) American Transportation Research Institute (ATRI) found a growing link between FPM and decision-making (Boris & Murray, 2018). It highlights TTI's work for Texas Department of Transportation (TxDOT) in developing the Texas 100 and Texas 50 which are lists of top bottlenecks. TxDOT uses this information to align operational practices and to prioritize investments in his planning process. Additionally, other states like Florida, California, Ohio, and Mississippi all are using a level of FPM to develop their plans and make specific recommendations for investment.

There are two critiques about the TTI and ATRI's work worth noting. First, both provide examples of agencies using data to make investment decisions, but neither provide specific examples where an investment was made because of FPM in the same way Canada has. Additionally, TTI's status as the founding institution of travel time measures and ATRI's status as a truck probe data provider presents a conflict in that both are elevating the topic to advance their programs. Though the programs may be beneficial, the reporting of states using FPM to drive investments needs further, independent research.

In addition to TTI and ATRI findings, ATRI has marketed its annual Top 100 Truck Bottleneck List, which measures bottlenecks nationwide, as the catalyst to a particular state investing in a major bottleneck. Director of ATRI, Dan Murray, has mentioned the anecdotal story that because of ATRI recognizing bottlenecks, the governor of Illinois grew tired of Illinois having the worst bottleneck in the nation and invested in capacity improvements such that it would no longer be on the list (Murray, 2015).

Research Gap – FPM and Value

The above research in the U.S., as described by both TTI and ATRI, represents major steps forward in transportation analysis. However, they are still limited and lack an assessment of value or quantification of contribution to decision-making. For most applications, they are limited to a single mode, highways, and there is not an academic analysis of usefulness or value added applications. Canada's successes are well marketed, maybe not academically analyzed. U.S. applications are documented but not evaluated.

The literature reveals a gap. There is a disconnect between the federal focus on FPM and the understanding of freight congestion impacts on the economy and the public sector's ability to demonstrate a value added aspect of FPM to engage the private sector. I found that there is a need to map the policy outcomes of FPM and to capture perceptions of usefulness and value added applications of FPM.

Chapter 4: Research and Methodology Plan

The literature review helped demonstrate that there have been numerous studies on the topic of freight, development, guides for freight measures (FPM), value of their use by the private sector, as well as some collections of policy impacts of freight. I found a bevy of work that recommended more data and robust, multi-modal performance measures. Most of the urban research, such as what I include in the literature review pertains to delivery efficiencies, measuring freight in urban regions and documenting urban freight issues.

Missing from this body of work seemed to be research that focused on the "so what," or value, in terms of usefulness of using FPMs in urban policy. I did not find research that specifically demonstrated ways in which use of FPMs led to urban policies (laws, investments, programs) and any evaluation of their usefulness. I found limited information from Canada on the purported use of FPM to influence policy and investment but not for the U.S. I found that jurisdictions in the U.S., both state and metropolitan areas, use FPM in decision-making. I did not find an assessment of usefulness or value – anything that would demonstrate outcome or value of that outcome.

This dissertation research addresses this gap in understanding public policy outcomes and value-added usefulness of FPM. While my work will not solve the issues related to the need for FPM in the U.S. and the proprietary risks associated with public use of private sector mobility data, it takes a step forward in exploring the topic.

As discussed earlier, theories on decision-making, urban competitiveness, and value of information all converge in this research to form a theoretical basis for testing the hypothesis. Scholars argue different theories on decision-making where some view the incremental approach is the status quo and a rational-comprehensive approach as the goal for decision-making. The real result may be somewhere in between a mixed scanning type approach. In relation to the theory of the value of information and urban competitiveness, if FPM can move the mode of decision-making away from the quicker, less informed incremental approach and urban decisions can include a higher awareness of freight activity, then there may be usefulness or value of this information in supporting the urban economy.

The hypothesis I developed reflects these thoughts on theory in that it assumes FPMs are useful and worthwhile in decision-making for urban regions. To test this I ask the following research question, are FPM measures useful in urban policy? I explore this question by dissecting it further and asking, do existing performance measures influence urban policy, with freight transportation? Did performance measures influence urban investment decisions, and are serving as an example? Second, are performance measures worth the effort?

The approach to answering the research question and subsequent questions relies on a retrospective and current analysis of usefulness through research on what decision-makers do with FPM for urban policy and then an analysis of what they did with use of FPM for urban investments. I also use a forward-looking approach to analyze perceptions of FPM use as worthwhile.

Selection of Research Questions

There are likely numerous ways to research these questions, especially since freight activity and urban functions are diverse as well as multi-faceted. I chose methods that would provide a past, present, and future view of FPM usefulness that also balances objective and subjective information in addition to an applied research aspect to get feedback from urban transportation planners. I also chose methods that would help to get different lenses for decision-making that helped investigate relationship to decision theory and understand usefulness of FPM in improving decision-making. Analysis of usefulness both objectively and subjectively helps to understand whether FPM is helping decision-makers move toward a rational-comprehensive approach to decision-making. The subjective feedback helps to identify some of the elements of mixed scanning related to power and policy windows or opportunities that existed.

I first explored this question by using examples of present and past use of FPMs and their policy outcomes. I documented I examine by documenting real world examples of ways in which measures moved the needle on urban policy. I asked public sector experts in the urban transportation arena to describe and provide thoughtful reflection on how they use measures and how those measures and the information they produce are used to influence policy. The questions I selected (detailed in Chapter 5) were crafted based on an interest in discovering the type of decision-making and to relate it to decision-theory, as well as to assess if they could move from one view of decision-making such as incrementalism to another such as rational-choice. I used questions that focused on current and future decision-making in order to identify policy effects and where decision-making falls within the theories.

I then analyzed whether or not known freight project candidates were funded in an urban area and the relationship of funded projects to those identified in a freight plan as high performing or beneficial for freight. This analysis helped understand how decisions may have been made and what relates to decision-making. The key element was to see if the decision-making aligned with agency norms such as what the public agency valued (incrementalism) or if the information on benefit or freight impact helped improve decision-making.

Finally, the method for the first question provides a current view of how measure use and outcomes in policy using self-reports and outcomes from policy actors. It also provides a retrospective view looking back over ten years to see whether freight performance information influenced decisions through a way to dissect funding decisions to see the characteristics of funded projects. In designing this question, I sought targeted the interviews to provide detailed, in-depth explanations of how FPMs are currently being used and the ways they influence urban policy. I targeted the project funding decision analysis to provide an objective lens by identifying the characteristics or information drivers of funded projects.

Second, I explore this question by seeking input from urban decision-makers on perceptions of use and value. This ties to the theory in that I sought perceptions of value of information and thoughts on urban competitiveness and changes in decision-making. I examined this by using a focus group of transportation decision-makers to reflect on findings and offer feedback on their thoughts related to usefulness and effort. This created an applied element to the research in that it helps to hear the ideas and thoughts of practitioners who engage in transportation issues daily and who are and would be users of FPM in their policy work.

Figure 1 illustrates the way in which these research questions relate to explore the research concept.

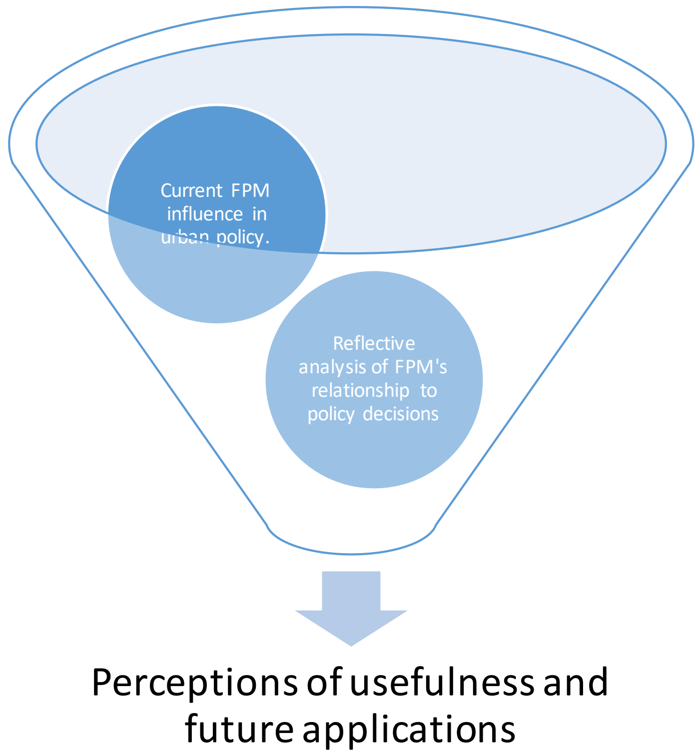

Figure 1: Relationship of Research Questions

Research Approach

I used a combination of qualitative analysis and logistic regression analysis. Part of the analysis relied on elite interviews, a focus group, and qualitative analysis of responses. The remaining effort relied on data collection and statistical analysis.

In general, this work is a case study of FPM usefulness and one involving the Baltimore metropolitan region. Although, I do involve elite interviews with other metropolitan areas for context. Babbie (2005) describes case studies as descriptive in that they involve in-depth study of an area to provide explanatory insights. Case studies have also been described as involving observations of a single event at a particular time and could be, as an example, "an observation of a community after an urban renewal program, a political system after general elections (Frankfort-Nachmias & Nachmias, 1996, p. 146).). Findings of case studies may have generalizations and applications for other areas (Frankfort-Nachmias & Nachmias, 1996; Babbie, 2005).

A limitation with the case study approach is that a case study does not explain causality. The topic of freight movement and urban policy is nebulous, and it may be difficult to glean inferences of causality. Given the challenges identified in focusing on audience and type of analysis with FPM, the elite interviews may be a starting point to frame stakeholder viewpoints or needs.

Definitions

Several terms I use require a definition or context for how they are used in my research. These terms include performance measurement, freight performance measurement, urban policy, and urban freight.

Freight Performance Measurement

There are a number of measures that are considered measures of freight performance or FPM. Measures can be categorized in terms of national, state or urban/local measures, and also by performance categories such as mobility, safety, or environment. Research sponsored by FHWA to develop a freight performance measure primer lists the basic categories for freight measures (as adapted from the FHWA Freight Performance Measurement Primer (Katsikides, et al., 2017)):

- Freight Demand Measures: Measure of volumes of freight vehicles, tonnage and value on the system.
- Freight Mobility Measures: Mobility measures, bottlenecks in the system.
- Freight System Condition Measures: Condition of the freight system such as bridge and pavement quality.
- Freight Environmental Condition Measures: Air emissions, hazmat, non-point source pollution and greenhouse gas emissions.
- Freight Safety Measures: Fatalities and crashes or incidents.
- Economic Measures: Measures of economic impact.
- Freight Accessibility Measures: Measures of freight facility access to transportation facilities.

In terms of definition for FPM for this research, I mainly focus on mobility measures. Most of the data challenges lie with the mobility measures since this is where data is often proprietary and only highway data for FPM measures are available (TRB, 2018a). I recognize throughout the analysis that FPM is broad and reference other measures as they are revealed in the research findings; however, the focus is on usefulness of FPM in terms of mobility.

Figure 2 depicts mobility measures in relation to TPM and FPM.

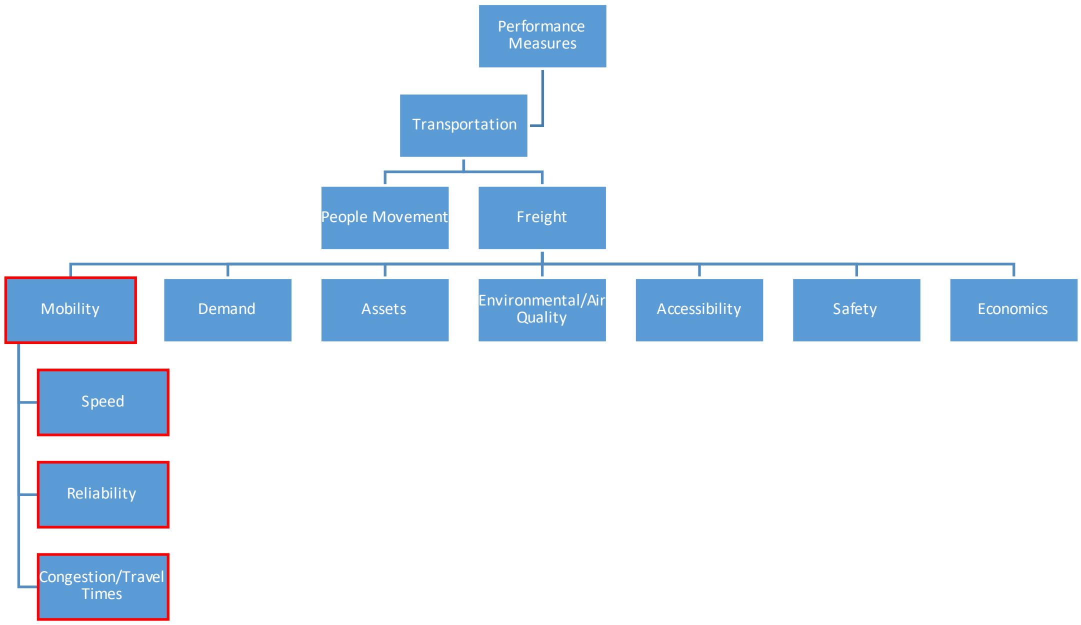

Figure 2: Relationship of Mobility within FPM

Urban Policy

There are a number of ways to define public policy. For example, Merriam-Webster defines it simply as "government policies that affect the whole population" (Merriam-Webster, 2018). Dye (2010, p. 2) defines it as "whatever governments choose to do or not to do." Others have defined it as a more definitive result of action. For example, Anderson (2011, p. 5) defined it as "a purposive course of action followed by an actor or set of actors in dealing with a problem or matter of concern." My definition is a combination of these things and considers policy as what government chooses to do (specific plan or strategy), and then a course of action to remedy it such as a funding decision or statute change. I define urban policy (public policy) as within an urban or metropolitan region and not just limited to a municipal boundary.

Urban Freight

Urban freight logistics is a term that is also referred to as city logistics. It has been defined a number of ways in literature (Ballantyne, Lindholm, & Whiteing, 2013). The first formal definition was presented by Hicks (Hicks, 1977, p. 101) as "all journeys into, out of, and within a designated urban area by road vehicles specifically engaged in pick-up or delivery of goods." Since that definition, there have been others as many have questioned what freight is and have defined it in relation to the multi-modal aspects of freight. Ballantyne et al. (2013) note that the wide array of definitions speaks to the diverse and often nebulous characteristics of freight movements. For their research, they developed a definition of urban freight that is fitting for my research. I will use the following definition based on Ballantyne et al. (2013, p. 94): *"Urban freight transport is defined as all movements of goods (as distinct from people) into, out of, through or within the urban area made by light or heavy goods vehicles. Also included are service vehicle movements (refuse collection, utilities etc.) and demolition/construction traffic."*

Organization of Research

The following chapters reflect the analysis as stated above: elite interviews, retrospective analysis of funding and focus group on perceptions of usefulness. This is then followed by a discussion of results and ideas for future research, as well as a discussion of the policy significance of the results.

Chapter 5: Do Performance Measures Affect Urban Policy?

Introduction

This question investigates the relationship between performance measures and urban policy with the example of freight performance measures. To accomplish this I performed elite interviews, meaning I interviewed experienced, subject matter experts who could discuss this topic in detail and provide in-depth responses for how measures are used, what challenges and opportunities exist, the level of effort compared to their perceived value, and specific policy influence.

I follow Zeemering's (2014) methodology assessing urban sustainability and policy through elite interviews. Zeemering (2014) conducted a series of elite interviews to produce a case study about urban sustainability policies in Baltimore. He asked a range of actors involved with urban sustainability how they define urban sustainability and their personal perceptions of in-place policies and programs

Zeemering's elite interviews focused on the specific section of the population that had a level of experience in his topic area. Unlike a research design with a random sample or diversified sample including people with no or little experience in sustainability, the elite interview approach targeted those identified with a level success or involvement in the issue. This was important so that he could explore the relationships between sustainability actions and policies in detail, including the actions of specific policy actors and their unique perceptions.

He conducted 85 elite interviews and identified participants by looking at city urban sustainability plans, or those named in media coverage of urban sustainability, and then identified additional people from those interviews to add to the interview list (Zeemering, 2014). He acknowledged the bias in a sample like this, but noted that he was seeking people who were policy actors with a level of expertise that could speak to sustainability efforts. In other words, this was a targeted sample of experts who achieved some success or productive efforts in sustainability work for Baltimore.

Zeemering (2014) employed a semi-structured interview approach that included eight to ten basic questions adjusted to complement the information provided by the interviewee. He used the questions as a guide but allowed for flexibility in the interview depending on the information interviewees provided. He collected information from the interviews and analyzed them for consensus, areas of common concern, and differing observations. Then he cataloged his findings in the analysis.

I followed this methodology because freight and sustainability research have numerous parallels. I observed that like freight, sustainability policies involved numerous stakeholders, organizations, and points of view (Zeemering, 2014). Research considering sustainability in the Baltimore region cited challenges in reaching all of the stakeholders to interview due to the unclear conceptual boundaries of what is urban sustainability. In fact, this research called identifying and measuring the full populations and organizations working on sustainability impossible (Zeemering, 2014). Zeemering's sustainability research also addresses sampling issues by acknowledging that in the elite interview process, it is difficult to obtain diverse samples. In his work, Zeemering sought as much of a diverse group of stakeholders who had had success or activity in sustainability as possible (Zeemering, 2014).

I used elite, semi-structured interviews to gain in-depth information from experts in the field who could describe in detail how they use performance measures for freight transportation and what policy changes or influence occurred. I chose this method to reach people who were directly involved in the process of policy setting for the urban area, specifically in transportation, and who had a level of success or activity to explore.

Methodology

The following section provides a literature review of the elite interview research design and description of my adaptation for this research.

Literature Review – Elite Interview Research

Interviews, in general, help in qualitative research to understand how theory and public policy align are an important tool in social science research to gather data (Brower, Abolafia, & Carr, 2000; Zeemering, 2014). Elite interviews, where specific, knowledgeable people or experts on a particular subject are interviewed, can be an important method of identifying and gathering data (Patton & Sawicki, 1993). This is in contrast to other types of interviews that employ more random, diverse samples, usually of a larger population. Elite interviews help to focus in on individuals with specialized knowledge of particular subject matter and to provide researchers with access to people who can provide information that they otherwise cannot obtain from published information or other sources and research designs (Patton & Sawicki, 1993).

In the context of public policy and political arenas, elite interviews help target those who are directly involved and may have specific or special understanding and awareness for context (Dexter e. L., 1970; Beamer, 2002). They help address complex and abstract policy issues that would be difficult to assess through other methods and provide a mechanism to help explore behaviors and ideals of policy actors in depth (Beamer, 2002). In other words, the elite interviews help to focus in on some of the interpersonal actions or specific-actor decisions that led to policy change (Beamer, 2002).

Elite interviews require careful planning and execution. Patton and Sawicki (1993) advise that it is important in research design to understand that elite interviews are only one way to collect information and that care must be taken in the development of the methods. They recommend beginning with background research on historical data and context, basic facts of the situation, political information, forecasts or projections, and any additional contacts or materials that can help the interviewer in approaching the elite interviews. This is satisfied by the literature review I provide in Chapter 2. It is important to consider what information is required, whom to interview, how to interview and the types of what questions to ask (Patton and Sawicki, 1992).

Investigative approaches provide an opportunity for the researcher to let the interview expound on the topic often helping to define or frame the problems, questions, and the characteristics of the issue. This helps researchers consider the issue of study from multiple perspectives, which can then frame the issue in ways that a literature review or other forms of research do not (Patton & Sawicki, 1993). The approach contrasts with research designs that use specific questions and evaluates responses based on types of answers or a scale such as mass interviewing and open ended interviews.

However, validity in design must be considered. Beamer (2002, p. 86) provided that the "utility and validity of information produced by elite interviews is dependent upon the analyst's research design… Poorly prepared and unstructured interviews can yield poor information and funnel an inquiry away from the primary research focus to a respondent's stream of consciousness thoughts and biased perceptions." In other words, even if the elite interview allows for respondent interpretation and framing of problems or questions, it is still important for the researcher to prepare the interview format by understanding bias, having guiding questions and a clear understanding of the goal throughout the interview process.

In terms of format for elite interviews, Beamer (2002, p. 87) provided four basic steps for developing elite interviews. First, a researcher must "identify the constructs of interest and develop observable measures and instrumentation to tap into them." Second, sampling procedures should be developed to maximize study validity. With elite interviews, random sampling and diversification can be a problem because the goal is to target people with specific expertise. However, steps can be taken to work toward validity of the study. Third, interviews should be conducted and data collected. Fourth, data analysis commences (Beamer, 2002). More on each of these steps is described below.

Construct Development

Identifying constructs requires defining concepts in measuring to help answer the research question. Developing a clear concept and understanding of whom to interview that can provide that expertise is a critical first step. "Who the generic interviewee will be depends on upon the research question and, most importantly, who has the information the researcher wants" (Beamer, 2002, p. 87).

In developing questions, a researcher should determine the set of questions to ask or if the interviews should be unstructured. Unstructured interviews allow questions to be asked in response to earlier answers - an initial question is asked and then interviewees expound on the issue. There are advantages and disadvantages to both styles. The structured questions allows for consistency and symmetry of responses, but unstructured questions allow for flexibility, added depth such as in how the respondent perceives the question or issue and the opportunity to express their understanding (Patton & Sawicki, 1993). Given the range between structured and unstructured, it is necessary for the researcher to be transparent and detailed about how the interview was planned (Zeemering, 2014).

When concepts, like freight or sustainability are abstract, it is often challenging to ensure that the interview instrument or questions yield valid responses (Beamer, 2002). The elite interview is attractive because abstract concepts are difficult to assess with other research approaches (Carmines & Zeller, 1979). Researchers should address both convergent and discriminant validity in their approach. Convergent validity is whether a respondent has a consistent orientation toward a particular construct. It is important to ask multiple questions to examine the same concept to address this. For example, Duke University (2018, para. 18) provides the example of questions related to a free market: "If the concept of interest is free market ideology, ask about two separate, specific issues that raise the questions related to the free market." Discriminant validity tests whether concepts or measures that are not supposed to be related are truly unrelated (Beamer, 2002). Questions can be asked that help eliminate possibilities and target the construct to enhance discriminant validity (Beamer, 2002).

Sample Development

Whom to interview, or the sample, is important in designing an elite interview. Elite interviews involve interviewing specific knowledgeable people on a particular subject (Patton & Sawicki, 1993). Therefore, this research method involves the careful selection of people who have expertise that will help address the construct. This is much different from other research methods where unbiased samples are the goal. For example, Schofer et al. (2006) used elite interviews to understand how data and resulting performance information are important for transportation systems. They tried to find interviewees that were thoughtful and mindful of their role in transportation, as well as articulate. Therefore, there was bias in their selection of interviewees, but they chose people they knew they could access and who would be able to provide the perspective of someone in a leadership role who also truly understood the processes for decision-making. Zeemering (2014) recommended that even within elite interviews, where people with a certain expertise are needed, it is still important to aim for a diversity of respondents to ensure that you get a comprehensive set of responses for your question.

Interviews begin once the sample of interviewees, the type of interview (unstructured or structured), as well as the relevant questions were prepared and determined. There is much advice from previous research that focus on interview logistics and careful planning. First, interview requests should be made well in advance with time and flexibility for the respondents. Second, it is important to consider how the interview will be recorded. For example, the researcher should determine if it will be recorded or transcribed. As reported in Beamer (2002), recording can help accuracy of the interview but may also inhibit a respondent from providing a candid response (Beamer, 2002). Permission to record should either be written or recorded before the interview, and confidentiality or anonymity should be discussed beforehand (Beamer, 2002;Duke University, 2018.

Interview Procedure

To conduct the interview, a common technique is to begin with general questions and then get more specific (Duke University, 2018; Beamer, 2002). This allows the interviewee to offer his/her perception and speak candidly but also allows the interviewer the ability to ask probing questions for specific information. Some interviews do start with specific questions, which can be helpful if it is important for the interviewer to make the interviewee aware of his or her level of understanding and avoid a large range of responses (Beamer, 2002). The format depends on the careful development of the construct, questions and research plan.

For the interview, there are some high-level limitations to consider. First, an interviewee's perception and interpretation of the questions and definitions of the subject matter limit the analysis (Dexter L. , 1970; Berry, 2002). Additionally, there are objectivity issues in that interviewees may attempt to paint their organization in a particular, often positive light (Berry, 2002). These issues should be documented. The researcher can corroborate respondent claims by investigating articles, documents or other materials that provide backup to any information provided by the respondent (Beamer, 2002;Berry, 2002). This supports the validity of the research.

Second, elite interviewing helps provide qualitative information but may not provide much that can actually be translated into descriptive statistics. Though theme identification and coding can be used, the overall goal of elite interviews is to aid in understanding theoretical position, as well as of the interviewee, their perceptions (Richards, 1996).

Third, the process is often transactional and dependent on the quality of the interviewer's skills (Peabody, 1990). Preparation and interview techniques are important in the research design (Patton & Sawicki, 1993).

Fourth, the researcher should aim to obtain the same results or information from each interview, but doing this may require variations of the questions and could introduce some bias to the process (Berry, 2002). For example, Schofer et al. (2018) used an agreed upon list of questions that included iterative questions to get reliable responses on data and information factors affecting decision-making. The interviews were conducted by multiple interviewers so that they would have multiple people taking notes and able to cross-check for validity (Schofer J. L., 2018).

Fifth, Zeemering (2014) found that generalizations could not be made based on any one interview. Instead, it is important to use the interviews to gather information and highlight points of consensus or areas of common concern and disagreement (Zeemering, 2014).

Analyzing Responses

Analyzing responses requires careful assessment. One of the first tasks recommended for elite interviews is to identify bias for individual interviews such as respondent motives and self-promotion, censored responses, interviewer bias, and interruptions) (Beamer, 2002). In addition, the interviews should be assessed to identify if a respondent perceived variables in different ways (Kingdon, 1989).

Coding of information is a method for assessing responses. It helps identify key themes from interview responses. Frankfort-Nachmias and Nachmias (1996) describe establishing coding notes as an important aspect of data analysis during data collection. This is a process of developing simple categories based on the observations such as classifying interviewees into groups depending on role or classifying responses into categories (Frankfort-Nachmias & Nachmias, 1996).

In coding for qualitative analysis, the researcher organizes the derived data into categories or variables. This begins with the development of a coding scheme or a system that uses numbers for each type of observation in order to categorize it. They may be arbitrary, ordinal or interval variables. The number is a code. This code must be consistent across cases for the same conditions. A codebook should be developed to capture what each code means (Frankfort-Nachmias & Nachmias, 1996).

There are several rules for coding according to Frankfort-Nachmias and Nachmias (1996). First, the numbers assigned in coding must make intuitive sense. For example, if coding a population range, a higher code number should accompany a higher population (e.g., 5 represents an urban area with 1M population or more). Second, if a ranking is not appropriate, categories should be coded sequentially. The purpose of these standards is to reduce miscoding and confusion in data analysis when editing or cleaning the data. Third, the researchers should examine theory or previous research to have an understanding of the types of categories they can or should expect. Fourth, the coding categories should be mutually exclusive. Each case must be coded into one category of the variable. Fifth, the number of categories should be exhausted meaning "that the enumeration of categories is sufficient to exhaust all the relevant categories expected of respondents" (Frankfort-Nachmias & Nachmias, 1996, p. 337). For example, each response can be classified without a substantial number being classified as other. Finally, the detail of categories should be carefully considered. It is better to have additional categories to define responses and collapse later than to have many categorized as other. Also, using theory and judgment the categories should make sense to or be divided into ranges or sections that fit the subject matter (Frankfort-Nachmias & Nachmias, 1996).

There are two types of coding, deductive and inductive. Deductive allows the researcher to rely on theory and subject matter expertise to create coding categories before the interviews. These can be pretested on a small group of respondents to ensure that the categories fit the research. Alternatively, researchers can use inductive coding, in which coding schemes are created by a representative sample of interviewees after the first interviews and then used for the remaining sample (Frankfort-Nachmias & Nachmias, 1996).

Coding can be challenging and put researchers in a position where they are evolving the coding scheme until the categories best fit the responses and the study. A benefit to using the inductive approach is that it provides research flexibility and allows the ability to generate explanations or categories from findings instead of having categories prescribed at the outset. The downside to using inductive coding is that it can consume the researcher in details and over-coding and worrying about observations that are more trivial and could be eliminated (Frankfort-Nachmias & Nachmias, 1996).

Corroboration is another mechanism for assessing responses. It involves confirming respondent information with external sources. This helps with validity in that it can be used to verify responses. Beamer (2002) recommends using news sources, articles, publications, or other materials that document or back up the claims of the respondents.

To reduce bias of the interviewer in interpreting the results, it is helpful to have someone review the interpretations or coding and findings to ensure that there is reliability and validity by the researcher in interpreting the results (Duke University, 2018;Beamer, 2002). This helps ensure that responses are accurately reflected in the research findings reported. Having recorded the interviews also helps with the accuracy of the information, but as stated earlier, it may present some challenges if the respondents are reserved in their responses.

Methodology Approach

The construct I analyze is the use of freight measurement and policy influence. I modeled my process after Zeemering (2014) by attempting to interview a range of public sector policy actors in the urban transportation arena that I identified as having a level of influence or success in freight policy. Similar to Zeemering, I used a semi-structured interview style that relied on a set of questions adjusted to complement the interviews as they took place. Zeemering found this type of approach to work well with complex, multi-faceted topics, and a diversity of stakeholders.

I describe the construct development, sampling, interview and analysis process below.

Construct and Question Development

I developed the construct for this research in concert with the overall hypothesis of this dissertation. This question explores if FPM measures are affecting urban policy and how. The goal was to ask questions in an unstructured way to allow freedom of responses, but to also be prepared to navigate interviewees back to the topic. The questions I developed as a guide for the interviews included the following:

1. In what ways do you use performance information? By performance measures, I mean measures and findings related to freight whether it is congestion, economic (tonnage and value moving), environmental or other.
2. How is it used to make a policy or investment decision? What are the outcomes?
3. If you do not see performance information used to make a policy or investment decision, why do you think this is? What information seems most important or used?
4. What performance measures matter to you for your role or the job you do in the urban region?
5. How do you use the information in your role?

6. What are the major issues in the urban area that impact you? By issues, I mean cost of doing business, delayed goods movement, congestion, and land use challenges.
7. How does performance measurement get used to address these issues?
8. Are there things you need to know or want to know but cannot measure?
9. What are the challenges you have with measurement? What are the opportunities?
10. If policy was affected, what was the catalyst?
11. How well do you think that the information helps you in your role (e.g. business planner making routing decisions, transportation planner prioritizing investments)? Is it worthwhile?
12. Do you pay for data and performance information? If so, what are the costs? If costs are not specifically known, is there an order of magnitude or perception of effort level?

I developed these questions to address validity. For example, I attempted to ask the question about use of performance information in several different ways. Being able to ask too many questions or ask them exactly as I designed is a limitation of elite interview research, especially if it is unstructured and allows respondents to interpret questions and expand on ideas. I used these questions as a guide, and on the occasion where a respondent deviated from the foundation that the questions set, I was able to guide him back to the discussion with the follow-up questions as needed.

Sampling Procedure

In my initial research proposal, I hoped to contact four MPO regions active in FPM and interview people representing a mix of public and private sectors. I also planned to consult trusted third-party staff from the Transportation Research Board (TRB) and FHWA as a means of reducing any favoritism in my selection of interviews. As I completed my research plan, and in identifying potential interviews especially from the private sector, the selection became challenging due to trouble finding private sector interviewees who were active enough in metropolitan freight groups to contribute to my research, as well as metropolitan public experts who wanted me to talk to private sector representatives in their region. Another course of action was needed.

TRB colleagues suggested consulting some of the public sector staff from state DOTs and MPOs who participate in urban freight activities at TRB. I used lists of TRB committee members from TRB's freight committees and task forces that focus on urban issues (TRB, 2018b; TRB, 2018c). This does present much bias. These people are all involved in TRB and are active in researching freight issues and freight data, so they are all people active in using freight information in the public sector in various ways. However, given the purpose of my research question and the elite interview research plan I developed, this suggestion resulted in the best pool of interviewees who could expound on the topic and help me explore the multi-faceted nature of freight. I knew that selecting these individuals could present some challenges that are frequently experienced in qualitative research interviews, such as bias of my selection of them, self-promotion or even overpowering the interview to guide it their way (Beamer, 2002; Dexter, 1970; Richards, 1996). Ultimately, I felt that this group was a strong and diverse group of people who have the battle wounds and medals, the perspective, to help me get to a deeper level of understanding for this topic.

The approach I chose for sampling was similar to another study completed for the Transportation Research Board (TRB). I consulted this work to provide the context for elite interviews. This work, a needs assessment of transportation information as an asset, focused on how data and resulting performance information are important for transportation systems because of the role in decision-making. While not focused on freight specifically, this work looked at the relationship between data and if the resulting processed performance information was useful in supporting decisions. It also considered the value of information in specific decisions (Schofer, Lomax, Palmerlee, & Zmud, 2006). This work used structured interviews with eight senior transportation managers and former managers (Schofer et al., 2006). The interviewees were chosen specifically for the expertise and ability to provide the appropriate level of insight for the analysis.

I modeled my sampling process after this work because like Schofer et al. (2006), I also needed to choose people that I could access and who I knew could provide the perspective to address the questions I had for this topic area. The TRB committee lists provided a limited but diverse group of people representing different geographic locations, sizes of urban areas and freight issues.

I targeted the public sector staff from the TRB lists and sent invitations for interviews. I requested interviews with the eleven individuals from TRB. In addition, I selected Baltimore since my other research questions focused on freight in the Baltimore urban area.

Of the eleven, I was able to interview seven from the lists, who in two cases included additional personnel involved in freight issues for the urban area in the interview (without asking). I did not deny them because I decided that they were value added to the discussion and could enhance the perspective, and in some cases, serve as a check and balance to the original interviewee. Several of my interviewees have served freight-related roles in several metropolitan areas, which helped provide broader perspective than just one region.

I received permission to use names in this research; however, due to sensitivities in some of the responses and observations, I used pseudonyms in this work. The urban locations respondents represented are listed below.

- **Participant I and II: New York City/New Jersey Metro Area**
- **Participant III and IV: Baltimore Washington Metro Area**
- **Participant V: Chicago Metro Area**
- **Participant VI: Seattle Metro Area**
- **Participant VII: Washington D.C./Houston, Texas**
- **Participant VIII: Atlanta Metropolitan Region**
- **Participant IX: Louisville, Kentucky Metro Area/ Texas Metro Areas**

In total, I interviewed nine experts representing perspectives for eight specific urban areas spread across the country with some interviewees speaking to a few additional locations based on their experiences in multiple places. While there are thousands of urban areas in the nation, not all are active in freight issues. In recent analysis by the Federal Highway Administration, there were less than ten MPOs that were highly active in freight planning beyond basic federal requirements (FHWA, 2018b). Though limited in number, my interviewees represented a range of geographic characteristics and sizes and are key experts who have information that I believe help comprehensively answer my research. Most of my interviewees were or had been with an MPO organization. However, in some locations, state personnel are policy actors in the urban freight environment, so several of my interviewees represent (or very recently represented) state organizations. I believe that the mix of locations and roles helps to bring diversity in responses important for my research and aligned with recommendations in Zeemering's (2014) recommendations for interview selection as well as Schofer et al. (2018) in seeking people who could provide a level of perspective that I needed.

Figure 3 depicts the geographic diversity of interviewees who represented regions across the U.S. Figure 4 is the number of organization types by affiliation meaning MPO or municipality.

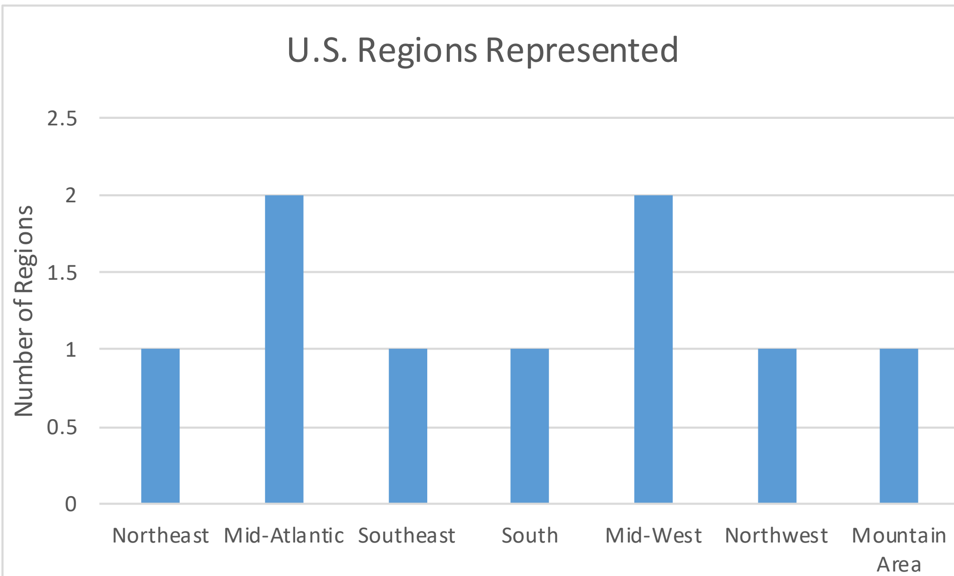

Figure 3: U.S. Regions Represented

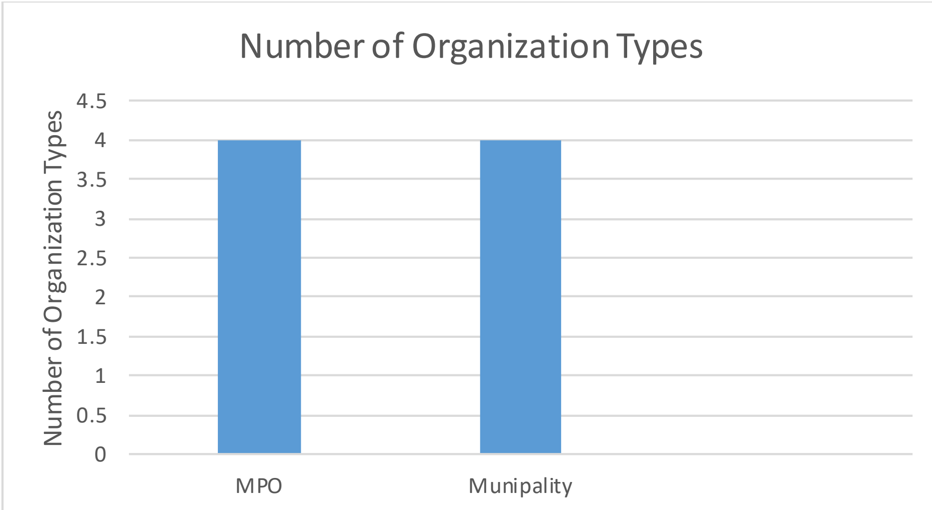

Figure 4: Organization Affiliations of Interviewees

Figure 5 shows the population range of the specific locations that interviewees represented.

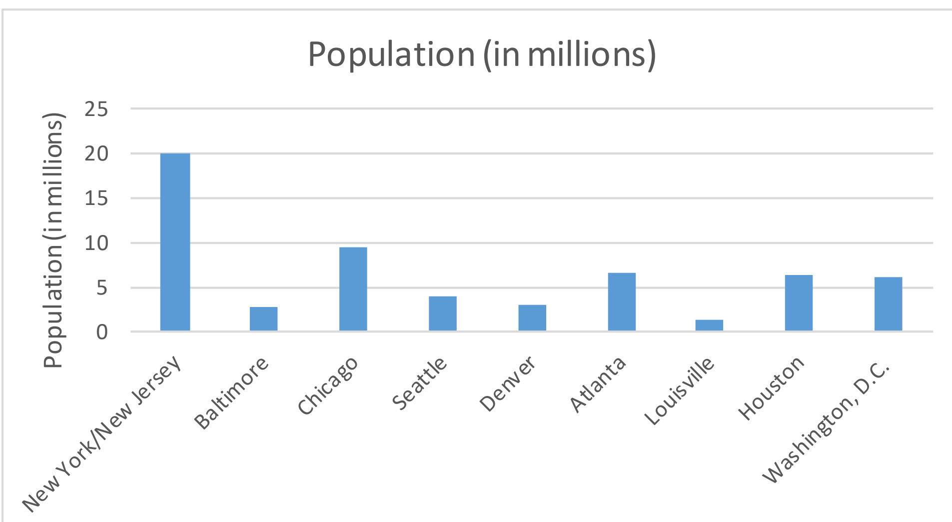

Figure 5: Population of Specific Locations Represented

Interview Logistics

I invited people by e-mail, asking them for a bit of their time to help me with my research. I conducted each interview using the Cisco WebEx platform because most participants lived far away. This also allowed me to record the conversation so that I have records and could go back to take proper notes and correct any questions I had.

I let each interviewee know that I would be recording the conversation for my own benefit and promised not to make the recordings available or publish them directly. I also offered anonymity if needed. None of my interviewees was concerned about the recording or anonymity.

I scheduled each interview according to their schedule and the interview logistics worked well. There were no issues in conducting the interviews that might have had an impact on the discussion. After the interviews were held, I went back to the recording and developed notes of the key points from interviewees that I could use to code responses and develop my research. I was careful to transcribe what I heard and then develop notes.

Analysis

For this research, I used an inductive coding technique for organizing responses and keywords. Though I could rely on literature review and personal expertise and training on the subject matter to develop coding categories upfront for deductive coding, I wanted to let the data I collect in the interviews drive the categories. I believe this helped reduce personal bias by fitting data into categories I think exist. I describe the results of this work in a section later on titled Main Themes but provide the methodology for coding below.

Coding Development

I developed the coding by listening to the interviews and inductively ready transcripts. I did not attempt to develop categories for coding ahead of the interviews (deductive coding) to reduce bias by injecting my own ideas as to what the results would be, but I did use the questions I asked as framework for organizing information. I first listened to the interview recordings, making notes of key points raised and common words or activities and listed these by question. Then, I read the transcripts and checked my notes to ensure I did not miss data.

I used notes I made on key words, activities, or thoughts to develop codes. Interviewees spent most of their time on the policy impacts, and many responses were in this category. I used the notes to make codes for each way in which they used freight performance measures. I used a color to highlight parts of the interviews that pertained to different ways in which they used measures. The results of the coding are presented first in the results section.

To enhance the reliability of my research and the validity of my findings, I had a non-freight expert colleague review my original transcriptions and notes, as well as my findings to document any missed or false information recorded. While there may be error in my transcription of the audio recordings, the review helped to reduce error in my work between the transcription and the notes I developed, as well as the findings. The review noted no major issues with my notes and no differences related to findings. I did go back and review the audio recordings a second time to attempt to capture any missed information or misinterpreted information after this review. In addition, for all respondents, I corroborated any claims with looking for external sources of information in news articles, state and local jurisdictional reports, or MPO area studies.

Limitations

There are limitations to my methodology for this question that are important to address. First, my selection of interviewees presents bias, which I addressed earlier. However, this type of design requires experts who can discuss the topic area with a level of knowledge that not all representatives of an urban area or those active in urban issues can. For example, there are over 400 MPOs in the nation and thousands of urbanized areas. Of these areas, not all are doing anything for freight performance measures except very basic requirements based on federal surface transportation requirements. By interviewing a limited number of people representing a limited number of urban regions, I know that is not enough to represent an appropriate sample size to make assumptions that responses will represent the population of these areas. I do believe, however, that my findings will help advance research in this area and could be replicated to include other regions in the future.

Second, I recognize that elite interviews, especially those selected from a list of people involved in TRB may present bias. Some bias may be introduced depending on the individual and their motivations and position. Their responses may be self-serving per Berry (2002). Aiming for a geographically diverse group as I did from the list of people I had used may help to reduce bias in their selection, but there still may be issues related to both their selection and self-perceptions. I carefully monitored the interviews in the transcription to document any concerns related to bias. Despite the limitations, interviewing these representatives is a necessary step in my research. It provides a foundation or baseline otherwise not available of ideas and perceptions related to urban performance measure use in freight policy and investment.

Third, my own familiarity of the subject matter and interviewees may present bias. To reduce bias, I used inductive coding of the interview responses to help identify the response categories. I also engaged an independent review, as previously described, to help validate results.

Results

I conducted the interviews with the subject matter experts over three months beginning September 2018 and ending in November 2018. Using the research plan and prepared logistics, interviews went as planned with no major issues. The results of my interviews are presented below beginning with coding and the case descriptions for each interviewee or interviewees. This is followed by interpretation of results. Detailed summaries of the interviews are in Appendix A.

Coding Results

This section details the results of the coding, which was useful in organizing results. The processed used for coding is depicted in Figure 6. It began with organization of interview notes and then coding the uses of measures. Then, coding was used to identify the way the measures had an influence on urban policy. Further coding captured some of the characteristics of FPM use in relation to the interviewees such as commonalities or unique observations, as well as comments on data needs to improve FPM.

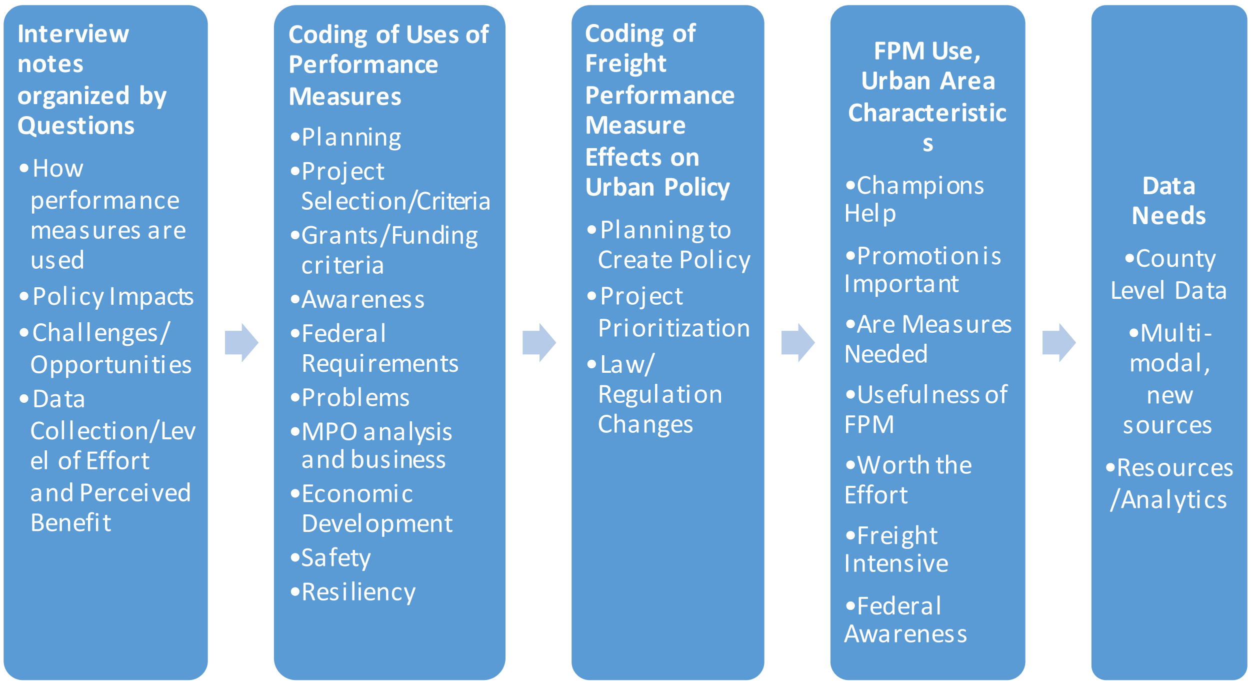

Figure 6: Coding Development to Analyze Responses

After organizing the interview transcripts and notes by questions, I first coded the transcripts of the interviews in the ways in which interviewees discussed using FPM. I chose this as a first step because I found that interviewees would start by explaining the ways in which they used measures before they talked about specific policy action. Coding the interviews for FPM use resulted in the following nine categories:

1. Planning – use of measures to develop freight plans, transportation plans, or other related plans by defining the characteristics of freight.

2. Project Selection/Criteria – use of measures to help prioritize funding and project selection for transportation budgets.

3. Grants/Funding criteria – use of measures to develop funding or grant award criteria for projects.

4. Awareness – use of measures to inform and to engage stakeholders or the public on freight issues.

5. Federal Requirements – Specifically, MPO and state use of federally required performance measures for MAP-21 and FAST Act reporting.

6. Problems – use of measures to assess specific problems like delivery space issues or truck parking.

7. MPO analysis and business – use of measures to analyze traffic, workforce transportation and other traffic studies or modeling to support planning efforts.

8. Economic Development – use of measures to engage industry on specific economic development and to identify opportunity and to make transportation networks more efficient.

9. Safety – use of measures to analyze crashes, high crash rate locations and incidents involving freight vehicles.

10. Resilience- use of measures to identify infrastructure assets and condition, availability of assets to support freight movement..

Figure 7 illustrates the responses that helped establish the coding and the magnitude of each (number of urban areas engaging FPM by the coded category).

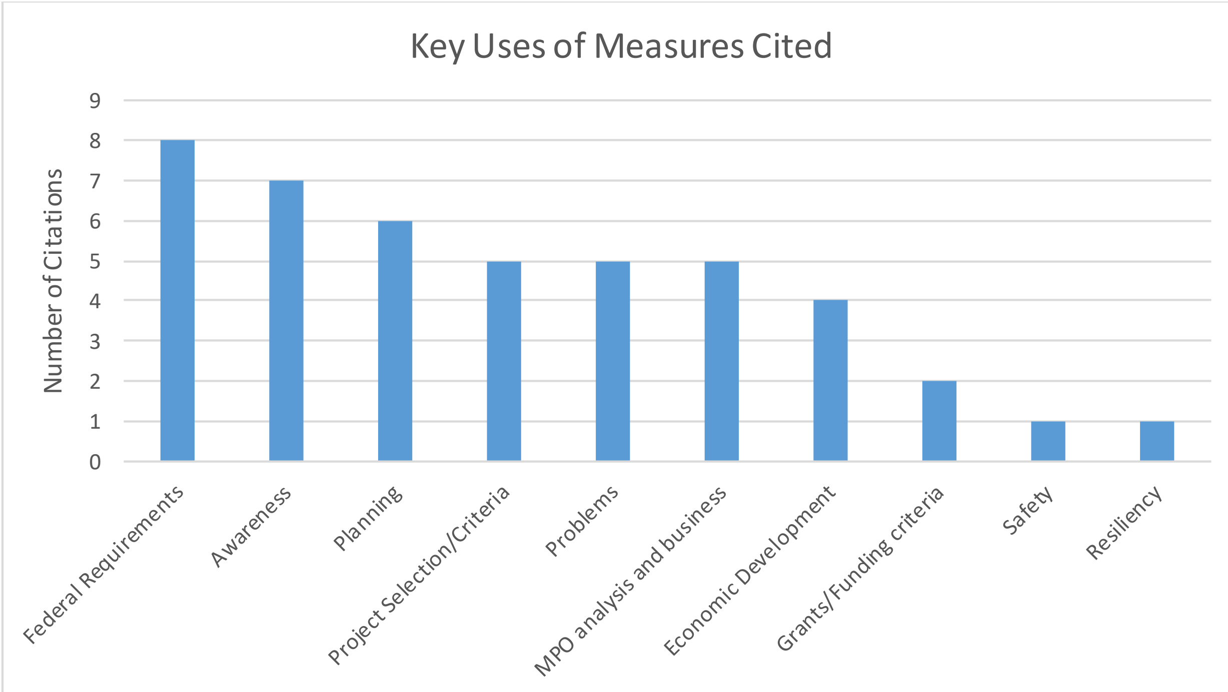

Figure 7: Key Uses of FPM Measures Cited by Interviewees

In addition to the methods experts said they utilized for measures, I coded the types of measures used. Figure 8 shows the types of measures and level of magnitude based on the citation by region for nine types of measures coded.

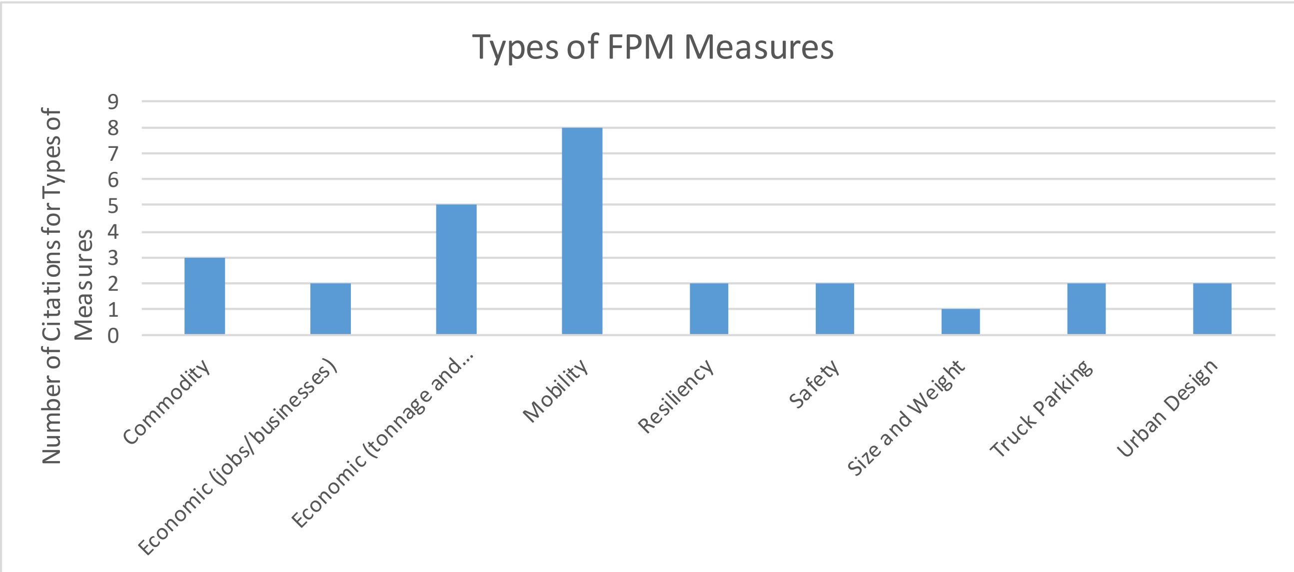

Figure 8: Types of FPM Measures and Number of Citations

The nine measures as described by the experts include:

1. Commodity measures – use of sources like the Freight Analysis Framework (FAF) and other tools such as TRANSEARCH to know what types of commodities move in the region and their origins and destinations. This only provides information on what is moving and how much but not how well.
2. Economic Measures – the use of Census and or direct reports for the numbers of establishments and jobs and any revenue estimates or economic impact that can be calculated, perhaps using economic analysis tools like IMPLAN.
3. Economic Tonnage and Value – measures of tonnage for commodities and modes, likely derived from FAF or TRANSEARCH, as well as Census and Commodity Flow Survey information.

4. Mobility – use of probe data or related information to assess mobility including congestion and reliability, speeds, etc. Only highway mobility measurement was cited.
5. Resiliency – use of measures that helped identify issues related to resiliency such as asset conditions and routing challenges. These were not well defined, but the indication was that the region identified routing with resiliency challenges and possibly ranked infrastructure based on resiliency risks, as well as noted asset condition measures like pavement scores or bridge condition in relation to freight movement...
6. Safety – use of truck incident and crash data to identify area of safety problems or high crash rates.
7. Size and Weight – measuring limitations related to weights and routing in an urban area, assessing proper truck routes and measuring impacts of truck size and weight related to urban traffic.
8. Truck Parking – measures of need for truck parking or areas of illegal truck parking and or residential conflicts.
9. Asset Management – measuring issues related to delivery space, accommodating deliveries and delivery times for the central cities, condition, and availability.

I then derived from the use of measures the ways in which they were reported to affect urban policy. I made notes while reviewing the responses under the ten performance measure codes of the specific policy changes or policy actions that occurred specifically because of information from FPM. When reviewing these notes, I found that they fell into three categories:

1. Planning leading to policy change.
2. Project prioritization to determine what was funded.
3. Specific Problems leading to law or regulatory changes.

Figure 9 shows the three categories and level of policy action that emerged from the coding. For example, respondents described three locations where were FPM are used in prioritization and investment of funds, two for strategic planning, and one for a change in statute or regulation.

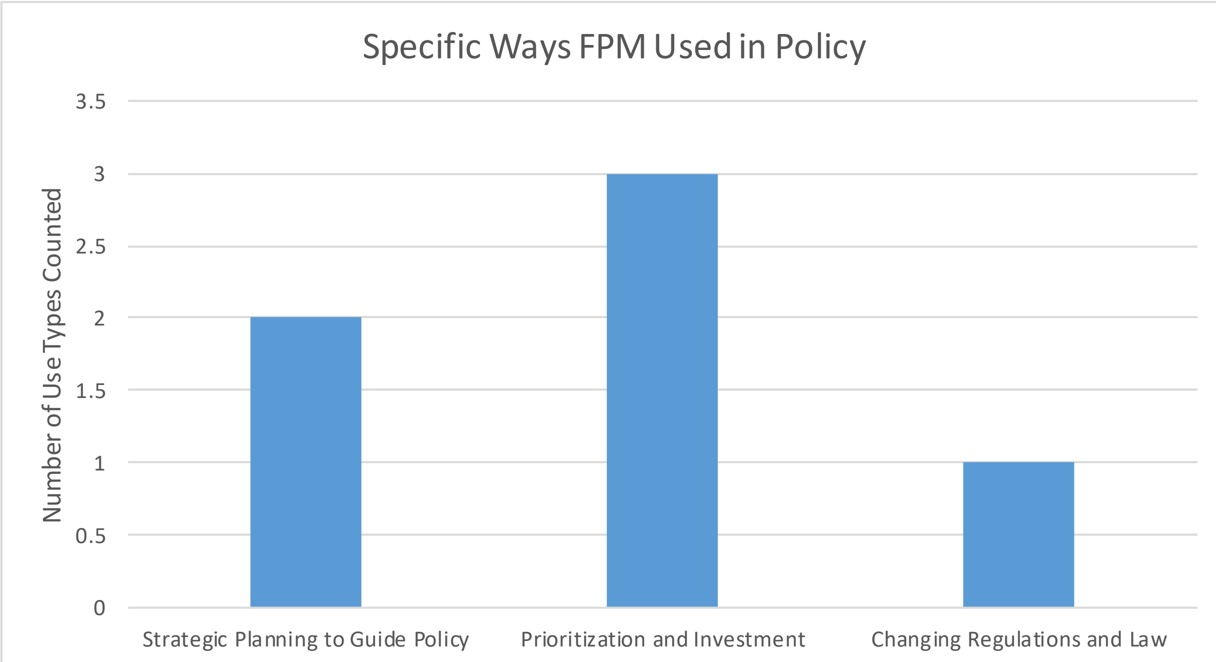

Figure 9: Specific FPM Uses in Urban Policy

After coding for the above categories, I looked at the characteristics that emerged about the ways policy changed and the characteristics of the organization, which helped explain some of the "why" in policy changes. I looked at what the regions had in common and if there was something unique. I found that some key themes came up frequently that I could code. These included:

- Ways in which FPMs helped engage policy champions who helped drive policy change.
- How stakeholders repeatedly promoted or marketed the FPM information to lead policy change.
- The number of interviewees who believed FPM is necessary.
- The number who perceived FPM as useful or valuable.

- The number who believed that despite challenges, FPM was worth the effort.
- The freight intensity or metro area activity of regions with most FPM and policy activity.
- The number of entities that cited federal mandates and use of FPM to respond to federal measures.

Figure 10 depicts the coding derived and magnitude (number of responses) that helped derive further coding for key themes.

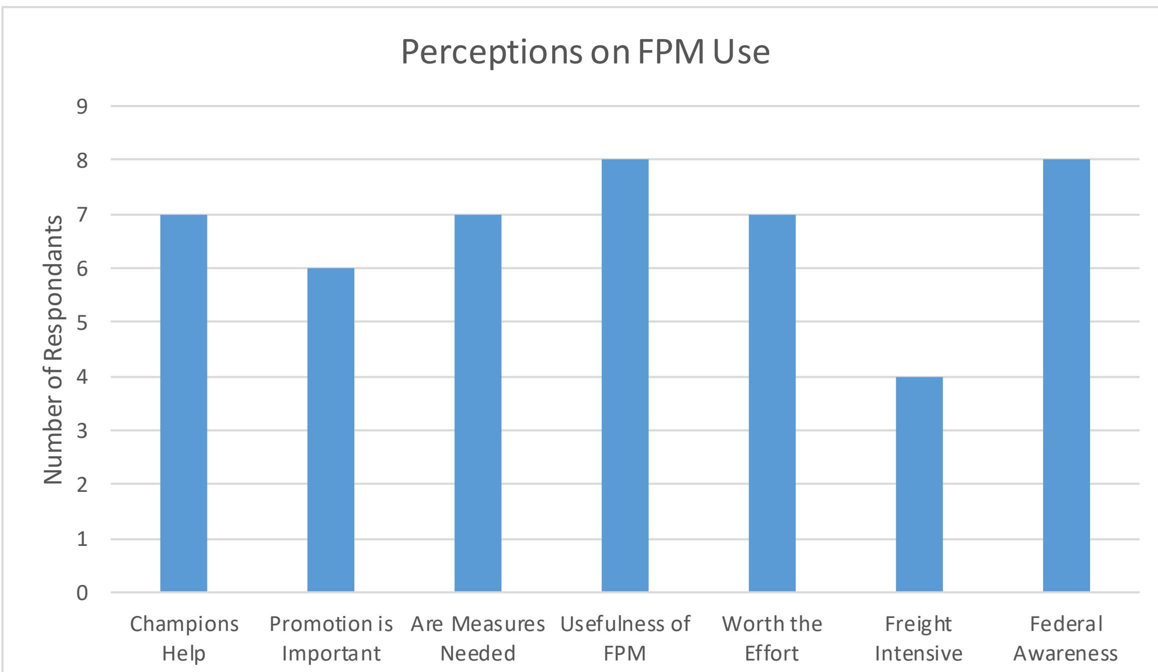

Figure 10: Perceptions of FPM Use

I also created coding for citations of challenges and opportunities for FPM data. These included needing county-level, multi-modal, commodity, and origin/destination (O/D) data, as well as better access and analysis tools for data mining. Several interviewees described the emerging Connected and Automated Vehicle (CAV) technology and opportunities to stream data from information exchanges for CAV that could aid in FPM analysis. Figure 11 depicts the magnitude of responses for this.

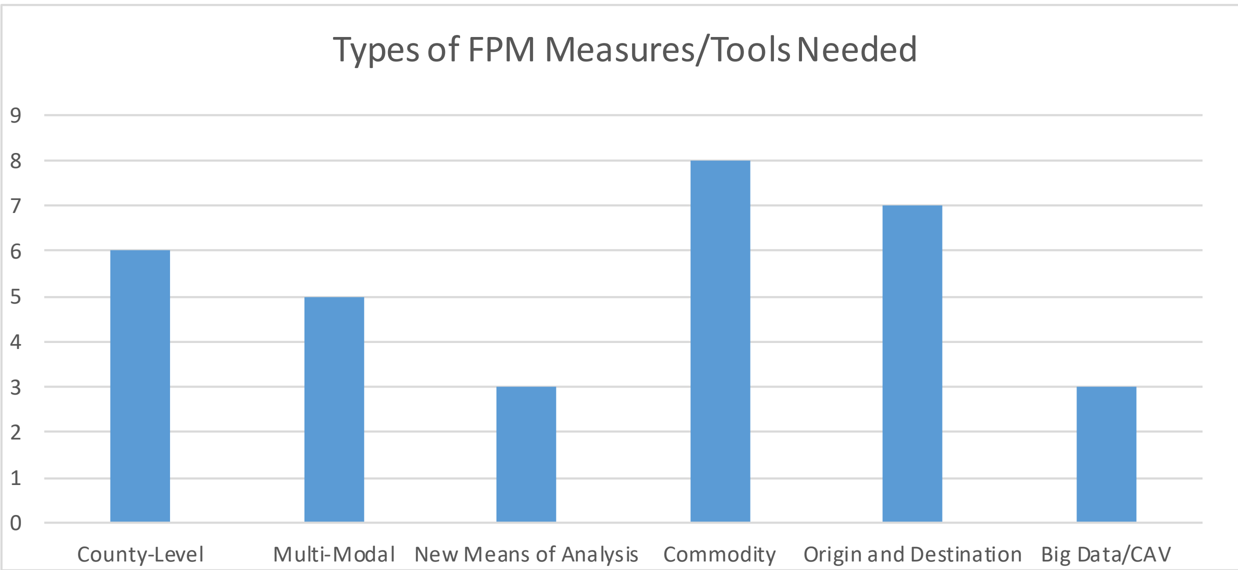

Figure 11: Types of FPM Measures and Tools Needed

Below I interpret my findings and provide detail on each of the key themes I found in the interviews.

Interpretation of Interview Results

The information I received from the elite interviews helped demonstrate the ways in which measures are used and affecting urban public policy. In general, I heard from each interviewee that they are engaged in FPM in some way. Use of FPM to specifically influence policy was less common. However, all interviewees said that they viewed FPM as useful, value-added, and important for policy. They did describe that it would be important to get local, city/county-level, granular and last mile data to measure mobility in urban areas and identify bottlenecks.

Before discussing these findings in detail, there were some key observations about the characteristics of the interviewees and regions they represent worth noting for context. These include federal awareness, urban character, freight champions, and promotion.

First, a major finding in terms of FPM use was awareness and responsiveness to federal mandates for FPM. All interviewees regardless of organization referenced the federal laws, both MAP-21 and the FAST Act, that require freight planning and performance measures at the state and MPO level. This might be because there were a number of MPO representatives or former MPO leaders in the sample, but even state-level interviewees were keen to acknowledge the federal FPMFPM requirements. They all were aware of what was required in terms of states needing to coordinate with the MPOs and MPOs needing to develop performance measures. For all of the interviewees, except Baltimore, this was mentioned quickly and they moved on to discuss ways in which they have used measures for planning, project prioritization, or to address problems. The Baltimore MPO representatives I interviewed were quite focused on the federal requirements and mentioned that their work plan and use of measures deviated little from the federal requirements. This may be due to a partnership that they said they had with the Maryland Department of Transportation (MDOT) to participate in freight planning, modeling, and other activities that I review later. Although, they did mention that they felt there needed to be more data sharing and collaboration. It seemed that maybe on freight planning, there is more collaboration than perhaps on other issues, which drove their perspective. As they approached this topic, I noted if these federal mandates drove policy or not. Adhering to the MAP-21 measures was described as more of an exercise and they did not relate it to policy effects.

Though several of the interviewees were active in FPM and freight planning prior to the federal mandates, the mandates may be an important catalyst for FPM use. The collaboration described by the interviewees may be a result of mandates pushing them into new territory for freight analysis.

Second, interviewees from major freight generating areas like New York/New Jersey, urban entities in Texas and the Atlanta metropolitan region cited more policy impacts from FPM use, suggesting that a freight intensive urban area had more freight policy activity. This is likely due to the massive number of stakeholders and freight-related activity in these areas and their sophisticated awareness of freight issues. I was not surprised, for example, at the number of efforts and programs underway at NJTPA or the types of activities underway at ARC. These are major freight crossroads and locations of global importance for freight movement, so it makes sense that they would have numerous relationships, inventories, or analyses and freight plans in place. Texas is another freight intensive state with metro areas that are critical freight nodes and locations of international trade, so their focus on data and analytics, as well as valuing freight in the prioritization process was not surprising. However, all locations exhibited different ways in which measures affected policy. Future research may investigate different types of cities and the types of policies based on different city characteristics such as freight facilities, industries, size, etc.

Third, champions of freight also appeared as a major factor for influencing policy. What all regions seemed to have in common was a champion – someone or a group of people who cared about the subject matter, understood it, “drank the Kool-Aid” as they say, and did something about freight that got attention. The champion or champions were those in addition to or different from the interviewees who latched on to FPM information. Interviewees mentioned that once they were able to convince a champion to take up the freight cause after seeing the FPM outputs, these champions were effective in carrying the message forward to affect policy.

For example, in Seattle, Participant V was able to reach out to city council members directly and brief them on new research from the Urban Freight Lab. In doing this, she found a council member who “got it,” and described her experience now with the City Council in Seattle as a Golden Era where these policy actors with understand well the impacts of freight in the urban setting and are interested in including it in policy. Their projects focus on resolving urban freight conflicts like delivery space and less on traffic congestion and throughput. However, this focus has helped Participant V to advance other positively viewed, freight-related research, such as working with UPS on E-bike deliveries and other types of methods that delivery companies seek to improve their own efficiency. Additionally, Participant V was the only interviewee to cite specific law changes and changes in building codes from these efforts.

In Chicago, FPM results influenced the Governor to champion the relief of a specific, nationally identified bottleneck that was constantly on the ATRI Top Truck Bottlenecks list. His interest in reducing the media scrutiny on this problem resulted in attention to the project. Therefore, while the interviewees cited success in policy outcomes from FPM, it appears that the policy actor component is important.

Fourth, there is also an element of self-promotion that seems related to FPM and policy influence. Interviewees were eager to describe ways they have used measures and any successes leading to policy impacts. There can be issues with elite interviews with bias and self-promotion, and most all of the people I interviewed were proud of their accomplishments. It led me to contemplate the elite interview research design. On one hand, I want to balance and ensure a rigorous research design that though qualitative, adheres to a high standard of research methods and practices to limit bias. On the other hand, the success of the interviewees and the benefits of their work may be because they sold their ideas and themselves and were excellent promoters that helped push their ideas forward.

My work is not focused on the social psychological aspects of power building, but I find it important to recognize that most of the interviewees I talked to have spent a great deal of time promoting their findings and their work. Performance measures gave them something to promote or talk about. In Jeffery Pfeffer's book on power, he writes that something powerful and influential people have in common is the ability to make their supervisors or leadership know what they are accomplishing. Additionally, repeated exposure of information and ideas increases positive acceptance of them (Pfeffer, 2010).

This dissertation is not a project related to psychology and behavior aspects of policy actors, but I did notice Pfeffer's qualities of power involving self-promotion in the success stories told by interviewees. I find that it may be an important catalyst in affecting urban policy. For example, Participant V in Seattle spent years promoting freight performance and planning for the Washington Department of Transportation (WSDOT). The WSDOT has a culture of performance measurement outside of freight. This participant found ways to incorporate freight into WSDOT's performance measurement program, which has been a major promoter of their findings, best practices, and policies throughout the nation. She has received significant praise for her work and has been labeled an expert and as someone with great influence. It is not difficult to see how this promotion of WSDOT's freight work and the attention it received helped increase the focus on freight in Seattle and elsewhere throughout the state. In her new role, her position and ability to promote was influential in gaining the attention of key city council leaders, as well as the mayor.

Similarly, in Washington, D.C., Participant IV said he came from a consulting background with an appreciation for data-driven decision-making. Subsequently, his promotion of ideas helped changed perceptions. He told his story about coming into the public sector and seeing a culture of decision-making without proper data and analytics. He described the ways in which he showed others at DDOT how to collect and use freight data to improve awareness of freight for the problem they were trying to solve, which at the time was how to deal with oversize and overweight trucks. His attention to data and ability to tell the story, he said, helped leadership understand the issues and to balance the need for regulations with the need to support commerce and its flow of goods.

Participant III also described needing to promote, market, educate, and translate well the "takeaways" for leadership. Participant III described his constant presentations, marketing, education, and repeated messages in front of MPO leadership, who are were all local elected officials. In promoting the measures and findings, he found it was most effective to learn ways to tell the story and give these elected officials the "takeaways" or to find ways to make things relevant to their constituents. Many elected officials cared about what they heard from constituents, so by using freight measures to mitigate constituent complaints, for example the residential and industrial conflicts in the Atlanta region, Participant III was able to advance policies and get funding for local freight projects.

Types and Uses of FPM

Interviewees discussed numerous ways in which they use measures and the types of FPMs as presented in the coding section. In terms of the type of measures used, the findings are that mobility was by far the most used and most cited use of highway mobility data, especially related to federal mandates for MPO performance measurement. Experts from Chicago, New York, and Kentucky (Louisville) described use for project prioritization or planning purposes. Despite the widespread use of mobility measures, they were applied only to highways, since other modal data was unavailable.

Additionally, economic information such as evaluating tonnage and value, as well as any information on commodities in the region was mentioned frequently. Most of the experts described their use of measures to explain what is moving, how much, and how well.

Some of the more freight intensive areas had robust use of measures for other areas such as safety or resiliency. Some had specific types of measures such as Seattle and Washington, D.C., both of which use measures to resolve urban delivery issues.

The use of these measures supported numerous urban public sector activities. It was not surprising that there was a heavy use of FPM for federal requirements and planning. MPOs are required to respond to the federal government for FPM and non-MPO representatives would likely be aware of these federal mandates and become involved in some of the federal freight requirements for planning.

In addition to the federal requirements, use of FPM for awareness was the second highest use category. It appears that urban areas are at least exploring FPMs and understanding freight characteristics in some ways. Freight intensive areas seemed to do this more than others. Many interviewees cited using FPM to assess freight flows, bottlenecks, and other issues. They then used this information in planning documents or strategic plans, the third highest activity.

Planning, project selection, addressing specific problems and MPO organization analyses (often to analyze an urban problem or transportation need) were all cited for FPM use but not as much as federal requirements and awareness. It seems among these activities, there is quite a range of FPM use and application. However, these categories also seemed to generate most policy interest and activity.

Additionally, economic information such as tonnage and value, as well as any information on commodities, were mentioned frequently. Many experts described their use of measures to explain what is moving, how much, and how well.

Some of the more freight intensive areas had robust use of measures meaning that they measure beyond mobility to include topics such as safety or resiliency. Some, such as Seattle and Washington, D.C., used specific types of measures to resolve urban delivery issues such as parking conflicts created when trucks are serving urban buildings or identifying where urban design should incorporate truck delivery space.

Direct Influence on Policy

As mentioned in the coding section, specific influence on policy from FPM fell into three major categories when coded.

1) Planning that identifies policies and new programs.

2) Prioritization of investments for funding.

3) Addressing urban problems leading to law or regulation changes.

In addition to these categories, FPM influenced urban policy in several indirect ways. The direct and indirect policy impacts are described below.

Planning Leading to Policy Initiatives

For most of the interviewees, use of measures to create plans that listed freight strategies or project needs was a primary activity and drove the ways in which measures had a relationship with policy. I wanted to know the type of planning and if FPM helped them create strategic plans with policy directives for government action and use of resources or smaller, project specific plans.

NJTPA, for example, described some of the most robust planning ranging from master plans and major urban area strategic plans to smaller project plans. This approach included use of performance measures to identify strategies that translated into funding and policy actions. These planning efforts, combined with an advisory committee of regional elected officials, drove the development of strategies and study needs, which NJTPA carried out. For example, NJTPA was instrumental in the New Jersey Department of Transportation (NJDOT) development of the Local Freight Impact Fund, which in turn uses performance measures to determine investments. In addition, NJTPA's freight planning efforts helped develop their programs for identifying and tracking freight assets, the Freight Rail Industrial Opportunity Program (FRIO), and related asset tracking and commodity analysis to understand what is moving through the region. The planning work has also helped support the Port Authority of New York and New Jersey to identify opportunities and needed investments, that the MPO cites as helping the Port to be ready for the new Post Panamax ships.

The Atlanta Regional Commission (ARC) provides another example of planning efforts using FPM outputs that led to strategies and policy changes. ARC identified a need to engage stakeholders on freight issues in the Atlanta Region. They knew they had issues related to industrial growth and needed to talk about solutions. The inaugural plan completed in 2008 relied on data collection, inventory, and analysis to establish numerous recommendations. Some of the performance measures they used included measures of mobility for routes based on origin and destination of goods movements in the region, identifying freight bottlenecks, and economic assessments of freight flows. These measures combined with stakeholder accounts, identified transportation and land use needs led to the development of policy strategies. Some of the strategies include incorporating freight-specific measures into project prioritization procedures, establishing a Freight Corridor Traffic Signalization Improvement Program for signal timing practices and a focus on changing land uses policies to help preserve freight-related districts.

In the ARC 2016 plan, new initiatives focused on actions such as addressing truck parking and developing truck-friendly highway lanes in addition to land use, resiliency, alternative delivery, and policies for connected and automated vehicles. What seemed to help propel more policy engagement was the focus on truck parking. As Participant III mentioned, the first freight plan helped to incorporate freight more in the MPO process, but it was this focus on truck parking that came directly out of the plan that got the attention of elected officials. It resonated with them because they were hearing it from their constituents. Constituents were not reaching out in a pro-freight way. They were complaining about residential impacts from freight and too many trucks in the region, especially as the Atlanta industrial base boomed in recent years.

Measures Used for Project Prioritization and Investment

A second major way interviewees reported measure effects for policy is in project prioritization. Interviewees reported how they have used freight measures in the overall transportation project prioritization process when developing budgets or capital programs. For example, the Kentucky Transportation Cabinet (KYTC) and the Governor's injection of measures including FPM into the project prioritization process to combat the Kentucky legislature's traditional control of project funding changed how Kentucky's road projects are planned and funded. While the way in which KYTC and the Governor were able to put pressure on the legislature was not all about freight, freight measures helped tell the story of transportation projects and to relate them to jobs and the economy. Doing this put scores on pet projects of members of the legislature and exposed them or justified them in public ways. The measures used for freight are not sophisticated and are basic mobility, tonnage, and value elements, but it was enough to influence overall budget and capital program through exposure of projects and their potential benefits.

The Chicago MPO set another example for the use of freight measures in project prioritization. They invested in truck probe data that allows them to assess bottlenecks in the region for freight. The MPO used passenger probe data to assess projects in the past and then invested in truck probe data to assess projects through a freight lens. This data was useful, for example, in remedying one of the nation's worst bottlenecks. They used this data to identify issues and develop solutions to improve it. They also used the data to convince Illinois Department of Transportation (IDOT) to re-engineer projects that as designed would not help freight flow. The MPO was able to demonstrate the freight impacts of proposed highway engineering projects and show that the project as designed would miss the opportunity to improve a bottleneck. The project design was improved and funded appropriately. One outcome of this is that highway project engineers at IDOT reportedly work with the MPOs and consult the freight data during project design phases.

An interesting take on using freight measures for project prioritization work is led by the TxDOT. For years, TxDOT commissioned assessments of the top bottlenecks in the region, Texas 100. In recent years as freight performance information became available, they developed the Texas 50 for freight bottlenecks. Though many of the top 50 freight bottlenecks show up in the Texas 100, the findings are that the bottlenecks and severity are different. This information influenced activities at TxDOT to use freight information in addition to all traffic information to feed the project prioritization process. There does not seem to be a formal algorithm, but it is used in project selection. As Participant IX mentioned, it improves a project's chances in Texas. Both Participant IX and Participant IV described Texas as a freight-centric place, whether in the MPO regions or statewide.

TxDOT has taken additional steps to assess mobility measures of speed and travel time for congestion in relation to economic measures of commodity flows. This freight fluidity concept, originally developed for Canada, was adopted and applied in Texas. According to Participant IX, the fluidity analysis provides a basis for Texas to understand how freight performance and projects or policies affect the economy and business, and to learn what to prioritize from a freight perspective that will best sustain and grow the Texas economy.

Participant IX indicated that Texas' interest in this is so great that data purchase is not a problem. They have access to an abundance of data sources; whereas, in his experience in Kentucky, they mostly used publicly available data and purchased data one time to support freight analysis. He explained that KYTC had less funding for data and analytical tools. Texas has more resources. He described this to explain TxDOT's belief and focus in performance analysis that drives their policies and programs.

Measures Used to Address Urban Problems and Change Policy

A third way that urban areas were using measures to affect policy was in addressing key problems that then prompted specific policy action. In Seattle, a large department store complained of sharing delivery space with a competitor, which prompted the city to consider freight parking and how it was a problem throughout the city. The Urban Freight Lab's work in finding how urban buildings used public space, coupled with Participant V's engagement of city council members, helped drive a policy change. It influenced Seattle's building code, which was changed to require new buildings to provide their own delivery space, perhaps by having a delivery area in the parking garage or elsewhere that reduced the burden to public street spaces.

In Atlanta, issues related to oversize and overweight trucks moving goods in the city were resolved by using freight data to understand the value of those goods. Using freight performance information, decision-makers were able to balance the need to charge for oversize and overweight permits with an appreciation and understanding of what and how much is moving through the city to help support business and freight flow but still charge an appropriate amount for the city.

Indirect but Influential Uses of Measures

There were some other ways that the respondents reported using measures though their direct influence on policy decisions was less clear. These uses included economic development activities, environmental initiatives, assessment, and analysis.

BRTB representatives discussed how they have used measures to support economic development initiatives. Participant VIII and Participant VII described how the City of Baltimore was looking to support an economic development project that would redevelop a large industrial property left behind when the Bethlehem Steel company closed. This project, called Tradepoint Atlantic, was envisioned to fully redevelop the site and include new uses for a port area, connection to rail and industrial uses. BRTB was asked to measure freight movement, specifically the mobility aspects, to determine if the city infrastructure could support the added truck activity.

CMAP uses freight measures to provide comments on plans and engineering for transportation projects, which may affect whether they are funded or the breadth of the project. Participant VI felt that a very telling benefit of freight measures was in their use to change the parameters of projects that Illinois Department of Transportation or Chicago Department of Transportation were planning.

In Seattle, the Mayor is seeking environmentally friendly policies and programs as part of her agenda, and a recent partnership with UPS and their e-bike effort used performance measures to assess freight delivery methods to provide an environmental benefit. Though this is a pilot assessment or demonstration, Participant V described that they can measure the benefit of new freight delivery activities and show environmental benefits that fit with the Mayor's agenda, which may advance policy ideas and programs.

Finally, BRTB has a long history of analytics and travel forecasting, considering they were partner with FHWA and MDOT for many years in the development of transportation models and programs. These models and programs helped identify project priorities and other strategies. The Strategic Highway Research Program 2 (SHRP2) C20 project is an example of their efforts to develop analytical tools and resources to improve freight measurement to improve planning and project prioritization (FHWA, 2018c). They also hope to use this model to support new efforts for Transportation Systems Management and Operations (TSMO) so that the model can support real time decisions for operating the highway network.

Measurement Needs to Improve Use in Policy

I asked each respondent if the effort to measure freight performance provided value, and overwhelmingly, the answer was yes. Most of all respondents indicated that they would like more data and more capacity to analyze it. Participant VI at CMAP said that they have expended enormous effort in analyzing truck probe data, weeks and months. However, he found the results of using FPM mobility data and measures to be valuable and provided information they could not have collected from other sources. , and months. However, Participant VI further said that the freight performance measures are invaluable and worth the cost and effort to analyze because of the information such as freight bottlenecks it provides.

Most respondents said that they would like more information on origins and destinations to describe the mobility of freight moving through the urban region. They also discussed a need for economic data such as commodity information so that they could show impacts to particular goods, as well as jobs from congestion. They hoped to illustrate this information so that local elected officials would understand the importance of their roadways to business supply chains and possibly the number of jobs impacted by freight bottlenecks. They wanted information that would help elected officials identify a connection to their districts.

In addition, several spoke about the need to get county-level or local jurisdictional data and performance measures to better identify performance for last mile roadways and connections with local businesses. With many MPO boards comprised of local elected officials, using measures, and then turning them into "takeaways" as Participant III described, seemed necessary to grab their attention. Most respondents seemed to struggle with last-mile, local, or county-level awareness of information to tell the freight story.

In addition to the type of information they sought, they also wanted easier and cheaper ways to digest and analyze the data. Many expressed that it took a lot of funding and a huge level of effort to obtain and analyze freight data. Participant III and Participant IX mentioned that they mostly used free sources of information. Expensive sources of information like TranSearch were purchased one time and factored as much as possible to use it for several years. Typically, growth rates would be applied to factor the data and extend its use. In data-rich regions like

Texas, they are still expending millions of dollars in resources to purchase data and analyze it. Their view as reported in this research is that the price is worth it to tell the story. In places, like Kentucky, Baltimore, and other regions, interviewees discussed data cost and reliance on free or state and federal resources and partnerships as much as possible. They have not been accustomed to paying for data, so it is not prioritized in the budgets. For example, in Baltimore, the BRTB has a good relationship with the state for sharing highway, although apparently not other modal information, and they (city and state) both are represented in the I-95 Corridor Coalition partnership where they can access vehicle probe data and now origin and destination data for all traffic and trucks. However, this recent development is only a few years old.

Going forward, several respondents described the need to look at a rapidly changing data future. Participant VII brought up the use of data from connected and automated vehicles that are quickly emerging on the market. Both Participant VII and Participant I remarked that there seems to be great opportunity in this data or the concept of big data, which may change the way urban regions get access to and analyze data. They wondered if there could be efficiencies in a new data-rich environment where everything is connected.

Discussion

This question asks if performance measures affect urban policy through an example of freight transportation. I explored this question to learn if and how policy actors used freight performance measures and to know the ways they perceived and FPM influence on policy. To do this, I interviewed experts representing urban areas throughout the nation.

This work focuses on a specific group of experts. I specifically tapped people who represented urban areas and had some known activity in measuring freight performance and in planning and implementing freight programs and projects in their region. This is a limited sample group of people and urban areas with a known level of activity for freight. There are thousands of urban areas in the U.S., and there is likely a range of activity and use of measures. For this work, I wanted to focus on that part of the distribution that could speak to their use of measures and whether or not there was an influence on policy. If so, how, why, and by whom?

The main finding of this work is that FPMs are influencing urban policy, but this is occurring in limited ways. When asking if the measures affect urban policy (as defined earlier by laws and regulations, actions, and allocation of resources/funding), I found that these measures support policy in three ways.

First, experts used measures to develop policies in the form of actions taken for stakeholder engagement, economic development, funding specific projects or even solving traditionally non-freight issues that impact freight. For example, measures informed development of plans for ameliorating residential encroachment on industries and vice versa or incorporating freight deliveries in the urban landscape.

Second, measures are involved in prioritizing and funding projects, primarily mobility measures to define which projects should be funded. In some cases, measures of bottlenecks help to score priorities.

Third, measures helped address urban problems leading to law and regulation change. Though the planning process described above captures some of the strategies to solve problems, I found that for several of the urban areas, there was a particular issue requiring resolution. Measuring urban delivery problems, bottlenecks, issues with freight activity and non-freight impacts, and using that information to solve for freight challenges helped to spark legislative or regulatory changes.

Key characteristics emerged among the experts and the policy activities. First, there seemed to be a relationship between areas of major freight activity, such as around New York, Chicago, and Atlanta, and the amount of FPM use and success in influence on policy. This makes sense since these areas have nationally and globally significant freight infrastructure and industries. In some cases, like in Atlanta, they were solving problems related to increased freight activity in addition to trying to improve economic development. In other cases, like Chicago, they found value in freight performance analysis and considered themselves freight-centric. These areas seemed to have the most activity related to planning, outreach and freight programs and the most success in freight-related policies including investments.

Self-promotion and champions also had a relation with urban policy impacts. I found those who were strong self-promoters of their freight analyses seemed to have the most effect in influencing policy. It may also be that causality worked the other way and a success led to pride and promotion, which helped to gain further success. All of the experts I interviewed talked about champions in addition to what they did to promote their findings. Many spoke of people who “got it” or the raised eyebrows of politicians and constituents who latched on to the FPM story or visualization. Engaging these people seemed to help increase the focus of freight in funding or policy programs.

Despite the touted successes by almost all experts, they all talked about wanting more data and the challenges with getting freight data and performing FPM. This speaks to the challenges highlighted in the literature review, especially those collected by groups such as the TRB Task Force for Freight Fluidity and the myriad of freight committees, as well as NCHRP reports on the challenges of measuring freight and using proprietary freight data. These challenges include not having great data to measure freight, needing multi-modal data to better tell the freight story and desiring more granular county-level origin and destination data. Many spoke about the hardships of getting the data they thought would help them tell the story. There were many comments such as “if only” and “why can’t we.”

They also talked about needing to translate the measures for leadership and the public while painting the picture of “so what.” This idea of translation, or putting things in quick terms or economic terms that politicians or agency leadership and citizens understand, was described as the most important and necessary aspect. Many interviewees eschewed the “math” and said FPM is critical, but messaging is key. They needed to find resources that could help them analyze data and express it better than they can today.

Even with the challenges in measuring freight, I heard words such as invaluable, critical, much needed, and worth the effort. Experts reported that they wanted to know more about the origins and destinations of freight, the takeaways for local governments or last-mile movements that are harder to measure and multi-modal data to show performance of freight trips across different modes such as a port to factory trip from ship to rail to truck. They advocated for improved mobility information to help tell the freight story and relate it especially to local governments.

Chapter 6: Did FPM Measures Influence Urban Investment Decisions?

Introduction

This research provides a quantitative and retrospective assessment to answer the question, do performance measures influence urban transportation investments? My measure of transportation investment is funding decisions for project candidates listed in the 2009 Maryland Statewide Freight Plan (MSFP) for the Baltimore urban region. My measure of performance are the Freight Performance Measure (FPM) results. The hypothesis I test is that funded projects are those with the highest FPM results, meaning those that are more likely to be associated with predicted freight performance benefits.

I modeled this work after studies that used statistical analyses such as regression models to dissect what information was relevant in decisions. Homan, Adams, and Marach (2013) provided the framework since they analyzed the relationship of Benefit Cost Analysis (BCA) results for transportation projects and federal funding decisions. This is similar to my hypothesis in that I examine if higher FPM scores related to project funding.

I use data from the MSFP for the Baltimore urban area. The Baltimore metropolitan region consists of seven local jurisdictions including Baltimore City. Of the seven jurisdictions, the plan included highway projects for only six of them (Baltimore City, Anne Arundel County, Baltimore County, Harford County, Howard County, and Queen Anne’s County).

I only used highway projects in this research because public agencies have the most control over highway funding and related policy as opposed to rail, marine and air cargo. Additionally, data are not available to analyze other modal projects at this time. This is a limitation documented for FPM in the literature review.

I ran a series of statistical analyses (descriptive statistics, correlation, independent samples t-test, and regression) to explore the relationship between FPM and projects funded over the past decade. I also considered what other data and measures decision-makers likely had available to them. The following sections detail the methodology, results of the four statistical tests, and the discussion.

Methodology

The resulting methodology of this research is a binary logistic regression analysis to study the determinants of highway investment decisions. The dependent variable is project funding, whether a project was funded or not. A series of variables serve as independent variables to analyze association with funding.

Such a methodology requires framing of the problem, data gathering, preliminary statistical analysis, and finally, the regression analysis in which I test for significance of various FPM measures. To frame the analysis and review methods, I searched for quantitative studies that related freight performance information to policy and or investment outcomes. I could not find a study that focused on this precisely. Instead, I found examples of how metropolitan areas are using measures and ways to assess the value of delay to freight, as well as costs of delay as described in the literature review. Though this information is helpful and points to the benefit of using freight performance information, it did not capture a relationship in quantified terms.

Although freight specific studies were not available, I did find studies that used statistical analyses such as regression models to dissect what was important in decisions for federal awards and government sales. These studies provided a model for analyzing information drivers and decisions for use with my data.

Homan et al., (2013), sponsored by the United States Department of Transportation (USDOT), examined the relationship of benefit cost analysis (BCA) to grant decisions for Transportation Investment Generating Economic Recovery (TIGER) for surface transportation infrastructure projects. TIGER grants were awarded over several years for transportation projects and USDOT requirements emphasized the need to demonstrate a positive BCA for any project.

Homan et al. used an analysis of variance (ANOVA) and logistic regression model to assess the relationship of BCA quality and outcomes to those applications approved for funding. They hypothesized that if the quality of the BCA and higher net social benefits were important for awarding a TIGER grant there would be a positive relationship between grants and the quality and net benefit of applications.

They compared the average BCA-Usefulness and Probability of Net Benefits of the awards to the non-awards to see if there were any significant differences. Their first step was an analysis of variance (ANOVA) to determine the variability between the groups of funded and unfunded projects and identify systematic biases between the two groups of projects. Then they used logistic regression to determine and test how important the BCA and the likelihood that the benefits exceeded the costs were in selecting grant applications for funding.

They found that positive BCA and net benefit outcomes did not matter significantly in the overall funding of the TIGER grants despite being listed a major requirement to receive a grant. For earlier rounds of TIGER, there was a higher likelihood of a positive BCA and net benefits for awarded grants and that the difference between awardees and non-awardees was significant. However, the influence of BCA and net benefits and was not significant in all later rounds. They were also not significant when all rounds were considered, as there were a large number of projects funded with lower quality BCA.

I also reviewed research by Hoagland and Farrow (1996) for an additional application exploring the determinants of complex federal action. They investigated the political, scientific, and organizational factors that contributed to decisions to lease resources in offshore oil and gas lands. Like freight issues, this situation involved a diversity of stakeholders such as political interest groups, bureaucrats, scientists, citizens, and businesses. These stakeholders had different positions such as environmental concerns and endangered species protection to business and profit.

This study used regression analysis to understand what factors ultimately determined actual lease sales. It illustrated the dynamics of federal planning in attempting to inject a rational process for decisions along with industry, interest groups and scientific information. Results showed that despite what the federal government planned to do and the process it created, the political relationship of competing interests influenced what actually occurred. Industry was able to get sales where they most wanted them, but political opposition was also able to influence the outcome. This is similar to the Homan et al. findings in a context where the stated intent was to base decisions on BCA results and a rational approach to awarding federal funds. However, over time, the decisions moved away from this protocol set by the federal government toward other influences.

Design

The research design for this question adapts the Homan et al. method by using the MSFP 49 Baltimore urban area highway freight projects as the subjects and analyzing a series of variables in relation to projects that were funded. These variables capture much information about the 49 projects, but a limitation is that it is unknown what decision-makers actually consulted or knew that informed their decision.

Four statistical analyses including descriptive statistics, correlation, independent samples t-tests, and regression analyzed relationship. For all of these statistical analyses, the dependent variable or grouping (for descriptive and t-tests) is funding, whether or not the project was funded. Specific information on the methods for each of these and all of the variables is provided later.

Figure 12 depicts the process.

Figure 12: Methodology Process

I organized the analysis in the following way:

1. **Relationship of Funding to FPM measures in the MSFP**: For this, I used the four statistical analyses to assess the relationship of MSFP FPM scores with funded projects. These scores will be described later, but they include an aggregated score and scores for categories such as mobility and safety. I assess them all but am most interested in the mobility scores as part of the MSFP FPM scores.

2. **Relationship of Funding to Measures Decision-Makers had**: I considered what decision-makers might have had to influence their decision and relationships with funded projects. This includes data such as information from other plans, demographics, and traffic volumes.

3. **Effect of New FPM Mobility Data**: Over the past decade, state Departments of Transportation (DOTs) and Metropolitan Planning Organizations (MPOs) started using

vehicle probe data based on Global Positioning System (GPS) pings to analyze mobility performance on roadways. Truck probe data has been a growing source over the years, but a more robust, publicly available resource has only been available to DOTs and MPOs in recent years. Whether decision-makers used this data in some form for all traffic and or truck traffic when it was available is unknown. There were some reports on mobility (described later) that MDOT analysts produced. However, I tested the relationship of this newer mobility data as a proxy of all traffic and, especially, freight mobility information and awareness as a way to compare with the MSFP FPM scores and to assess what might be influencing decisions.

This design required an upfront assessment of several aspects of transportation funding decisions in the Baltimore region. These include the decision-making process, the MSFP, and use of data in decision-making. Each is described below.

Transportation Decision-Making Process

The Maryland Department of Transportation (MDOT) and the Baltimore City Department of Transportation (BCDOT) make funding decisions for the urban area. MDOT is primarily responsible for funding in greater Baltimore metropolitan region except in Baltimore City where BCDOT makes the decisions. To determine if MDOT or BCDOT funded a project, I reviewed and documented funded projects from the MSFP from their transportation capital programs over the past ten years.

Maryland Statewide Freight Plan

The MSFP includes an assessment of freight issues and performance for all modes (highway, rail, air, and marine), as well as a list of projects that were needed for each mode (MDOT, 2009). The projects were developed by selecting from the list of projects that MDOT had in plans and other studies and inputs from public and private stakeholders all over Maryland, including MPO and local government stakeholders. Part of this work involved the establishment of the MDOT Freight Advisory Committee (FSAC), which is a working group of public and private freight stakeholders. Private freight stakeholders include representatives of trucking companies, shippers, port businesses, railroads, and industry organizations throughout the state. Stakeholders contributed projects to the list along with those collected by MDOT and MPOs. When the plan was published, there were over $35 billion in project candidates for freight in Maryland (MDOT, 2009). MDOT has typically funded its total transportation program (highways, transit, airport, etc.) at an average of $13.9 billion per year over the past ten years. The total requests per year for funding are much greater than the ability to fund, and most of the funding goes toward system preservation and not new projects. Freight projects compete amidst many other priorities (MDOT, 2019).

The MSFP includes freight performance measures for each of the listed project needs. The plan includes an Overall Score and performance information for five categories. The scores are a mix of expected benefit such and known performance such as crash rates or mobility issues.

An independent consultant firm collected data and developed the scores as adapted from MDOT (2009):

1. Quality of Service: Potential for the project to reduce delay and increase reliability.
2. Safety and Security: Potential for the project to provide a safer operating environment and reduce opportunities to compromise the supply chain.
3. Environmental Stewardship/Development Plan Goals: Potential for the project to reinforce the development of freight-related land uses within existing freight activity centers or direct new development to Priority Funding Areas and sites with adequate infrastructure.
4. Connectivity for Freight Mobility: Potential for the project to enhance connectivity between freight modes and/or improve access to clusters of freight-intensive industries.
5. Coordination: Potential for the project to fulfill the plans, programs or goals of multiple agencies.

The five categories above provide both quantitative and qualitative performance information, but the scores are presented in the plan as ordinal indicators of high, medium, and low related to freight benefit. For example, Quality of Service was based on known areas of freight congestion at the time and Safety and Security accounted for known crashes and incidents in the project area.

Since I am most interested in FPM mobility measures for this dissertation, I note that items 1 and 4 above are the types of performance information that incorporate freight mobility information as defined in the MSFP. These include measures of mobility and congestion along with measures that attempt to capture connectivity and accessibility or enhancements to the freight network.

MDOT weighted each category, with Quality of Service, Safety and Connectivity receiving the highest weights. There was also an Overall Score category. The scores were presented as full, half, or empty circles so as to not rank each project. MDOT did retain individual rankings for each project, but what is publicly available is a score of high, medium, and low for each project (MDOT, 2009)[6]. A confounding issue is that useful information is hidden in this scoring process.

Data Available to Decision-Makers

In addition to the MFSP, decision-makers had several informational resources available to them over the past decade. These include information on other plans and local jurisdiction requests and limited mobility information. They also likely had demographic information such as population and number of business entities. They were aware of projects in other plans and prioritized lists, as well as operational characteristics. They may have also been aware of political relationships and priorities.

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[6] The independent consultant team that drafted the MFSP compiled data for each category and developed a type of score for the data inputs that they could then use to create a score of 1, 2, or 3 with three being the highest. The circles were developed by MDOT in an attempt to avoid easy ranking of projects. However, to use the scores in this project, I translated the circles back to scores of 1, 2, and 3.

For example, MDOT stated publicly that it uses several plans in its decision-making, as well as priorities as expressed by local jurisdictions including Baltimore City and the Baltimore urban area counties. MDOT's decision-making process includes (MDOT, 2017):

1. Consulting the Maryland Transportation Plan (MTP), which is a five-year plan that includes goals and objectives for MDOT based on public input and agency priorities. It does not include specific project, just goals. Economic improvement and freight are included in the goals.
2. The MPO Long Range Transportation Plans for the MPOs within Maryland.
3. County/City Priority Letters where local jurisdiction leadership informs MDOT of what it would like MDOT to fund or prioritize as a policy. These are submitted yearly.
4. The Highway Needs Inventory, a list of highway needs put together by the State Highway Administration (SHA) every year to inform FHWA of what MDOT's highway priorities are since MDOT uses mostly federal highway funding for system preservation.
5. Modal plans, what each of MDOT's modal administrations needs for its infrastructure (e.g. port berths or ramps to support a new port area).
6. Authority projects, needs of the Maryland Transportation Authority and the Washington Metropolitan Area Transit Authority.
7. The MDOT Attainment Report, which is a document that reports on performance measures.

Performance information such as the Freight Plan and the Mobility Report are supposed to inform the MTP, the MPO plans, the Highway Needs Inventory and Modal Plans. The variables tested in this research pulled information available from the above list of decision material.

In addition to the above plans and reports, every year, MDOT requests priority letters from local governments as to which projects should receive funding. MDOT travels to each jurisdiction and MPO to present on its ideas for policies and investments. Then, they use this information to develop the CTP and designate funding decisions statewide using federal and state highway funds. Local governments also make decisions using local funds, or in the case of Baltimore City, direct federal funds. There are currently no private funds involved in highway investments in Maryland (MDOT, 2017).

If decision-makers used mobility data and measures, it was limited to all traffic data and mostly measures on Interstates and major routes. Every year or so since 2012, MDOT State Highway Administration (SHA) published a mobility report that included some corridor-level all traffic probe data purchased from INRIX. This report started to include truck data only recently with improved truck probe data availability. The information in the report is high-level and mostly Interstate or corridor-focused. It is not part of a formal, decision-making review or project prioritization process unlike how some of the interviewees from the elite interviews use mobility information (MDOT, 2018a). This research assumes that decision-makers did not have mobility data and measures. Thought they might have had some reports from all traffic information, especially since 2012, this is not likely. Mobility measures from probe data are included in this research as a proxy for awareness or expertise for mobility in relation to funding.

Data Development

The data for the 49 projects came from multiple sources including the MSFP, public documents and a publicly available tool that provides access to vehicle probe data.

I collected data in the following categories:

- **MSFP Data**: Data directly from the MSFP for freight included an overall score and five FPM categories.
- **Data Available**: Data that decision-makers had available to them over the past ten years for decision-making. Whether they were used or not is unknown, but they were available.
- **Mobility Data**: This includes all traffic mobility data that decision-makers may have had at some level of awareness and new freight mobility data assumed unavailable or used by decision-makers.

Similar to Hoagland and Farrow (1996), I grouped variables into categories and created a suite of variables that I could use to assess relationship.

1. Freight Performance Measures (FPM) Information available in the freight plan: Variables in this category include Overall Score and five categories of freight measures based on criteria outlined in the plan for each project.
2. Funding information: Variables in this category describe stage of funding and year funded, as well as if the project seemed to be put on hold.
3. Political: These variables describe political affiliation of county and city leadership at the time of funding and whether the project was included in a jurisdictional funding request letter.
4. Operational/Planning: These variables include information from other plans that are used in decision-making related to the 49 projects such as the Highway Needs inventory and Annual Average Daily Traffic.
5. Demographic: These variables capture population and employment, which are drivers of freight activity.
6. Mobility and Congestion: These measures capture the mobility information for all traffic and freight while providing information on speed, congestion, and reliability.

There are some variables I collected or attempted to collect that I either use in a limited way or chose to omit for reasons related to data quality. For example, I collected data on the year funding began and if the project was put on hold. For the year funding began, many projects were either already funded for planning in 2010, and it was difficult to determine which year they were actually funded prior to 2010 due to lack of records. I have this information and used it to build the variable Political Relationship to Governor When Funded, but due to the unknown year of funding before 2010, I did not include it except in descriptive statistics. Additionally, it was difficult to determine if a project was on hold. There were some funding issues related to federal highway funding and the American Recovery and Reinvestment Act (ARRA) that appear to have affected projects showing up in the budget after 2010. There is a two-year gap around the time of ARRA where no MSFP projects were funded.

For the variable Political Relationship to Governor When Funded, I use this in a limited way. This variable is based on the ambiguous year of funding variable, so it was somewhat difficult to determine when a project came online prior to 2010, and a project needs to be funded to count in this variable. I describe the use of this variable later on, but I discuss it here to illustrate some of the data challenges involved in collecting data for these projects and including them in my analysis.

Another characteristic of the data used is that many of the important variables I chose to analyze are ordinal and require the use of dummy variables. Dummy variables are used often to represent a variable that has two or more distinct variables. Regression analysis is used with numerical variables. For ordinal variables to be used, the interpretation of the order must mean that it is a specific number or unit such as a 2 meaning twice as much of something than a 1. 3 would be three times and so forth. (Princeton University Library, 2019). Often, especially in the social sciences, researchers will need to work with categorical or ordinal variables that do not have a real numerical relationship. The solution is to recode these into dummy variables, which are variables with only two values, usually zero and one. This creates a binary variable that can be used in statistical analyses like regression. Additionally, it is possible to recode a categorical variable with multiple levels. For example, in this research, the MSFP variables are high, medium and low or 3, 2, and 1. The solution is to create N-1 dummy variables. In this case, there are three categorical results, 3, 2, or 1. N is 3 and the number of dummy variables needed is 2. When these are analyzed the result for category 1 is included in the intercept result (Princeton University Library, 2019).

I use dummy variables as described below in this report. Table 2 describes all of the variables, and then each variable aside from the nominal name, jurisdiction, and year funded is detailed after Table 2.

Table 2: Variables

Variable Name	**Coding**	**Type of Variable**
Name of Project	None	Nominal
Jurisdiction	1=Anne Arundel; 2=Baltimore City; 3=Baltimore County; 4=Harford County; 5=Howard County; 6=Queen Anne's County	Nominal
Year Funded	1=2010; 2=2011; 3=2012; 4=2013; 5=2014; 6=2015; 7=2016; 8=2017; 9=2019	Nominal
Funding Information		
Funded Project	0=No; 1=Yes	Binary
Stage of Funding	0=Not Funded; 1= PE(Planning and or Engineering); 2=Construction	Nominal

Completion	0=Not complete or funded; 1=Complete	Nominal
Political Information		
Political Relationship to Governor When Funded	0=Not Funded; 1=Opposite 2=Same Party	Nominal
Priority Letter	0=No; 1=Yes	Binary
Freight Plan Scores		
Overall Score	1=Low; 2= Medium; 3= High	Ordinal
• Overall Score Dummy Variable, Medium	0=all other scores; 1=FPM score of 2	Binary
• Overall Score Dummy Variable, High	0=all other scores; 1=FPM score of 3	Binary
Quality of Service (QOS)	1=Low; 2= Medium; 3= High	Ordinal
• QOS Dummy Variable, Medium	0=all other scores; 1=FPM score of 2	Binary
• QOS Dummy Variable, High	0=all other scores; 1=FMP score of 3	Binary
Safety and Security (SS)	1=Low; 2= Medium; 3= FPM of 3	Ordinal
• SS Dummy Variable, Medium	0=all other scores; 1=FPM score of 2	Binary
• SS Dummy Variable, High	0=all other scores; 1=FPM score of 3	Binary
Environmental Stewardship (ES)	1=Low; 2= Medium; 3= High	Ordinal
• ES Dummy Variable, Medium	0=all other scores; 1=FPM score of 2	Binary
• ES Dummy Variable, High	0=all other scores; 1=FPM score of 3	Binary
Connectivity for Freight Mobility (CFM)	1=Low; 2= Medium; 3= High	Ordinal
• CFM Dummy Variable, Medium	0=all other scores; 1=score of 2	Binary
• CFM Dummy Variable, High	0=all other scores; 1=score of 3	Binary
Coordination	1=Low; 2= Medium; 3= High	Ordinal

• Coordination Dummy Variable, Medium	0=all other scores; 1=scores of 2	Binary
• Coordination Dummy Variable, High	0=all other scores; 1=scores of 3	Binary
Planning/Operational Information		
Included in Highway Needs Inventory (HNI)	0=No; 1=Yes	Binary
HNI Cost in 000s	None	Scale
Annual Average Daily Traffic (AADT)	1=Low; 2= Medium; 3= High; 4=Very High	Nominal
• AADT Dummy Variable, medium	0=all other scores; 1=2 or medium	Binary
• AADT Dummy Variable, high	0=all other scores; 1=3 or high	Binary
• AADT Dummy Variable, very high	0=all other scores; 1=4 or high	Binary
Mobility Information		
All Traffic Speed in mph	None	Scale
All Traffic Delta in mph	None	Scale
All Traffic Buffer Time in Minutes	None	Scale
All Traffic Buffer Index	None	Scale
All Traffic Planning Time in Minutes	None	Scale
All Traffic Planning Time Index	None	Scale
All Traffic Travel Time in Minutes	None	Scale
All Traffic Travel Time Index	None	Scale
Truck Speed in mph	None	Scale
Truck Delta from 55 mph	None	Scale
Truck Buffer Time in Minutes	None	Scale
Truck Buffer Time Index	None	Scale
Truck Planning Time in Minutes	None	Scale
Truck Planning Time Index	None	Scale
Truck Travel Time in Minutes	None	Scale

Truck Travel Time Index	None	Scale
Demographic Information		
Population	None	Scale
Ratio to State Population	None	Scale
Total Employer Establishments	None	Scale
Ratio to State for Employer Establishments	None	Scale
Total Employment	None	Scale
Ratio to State Total Employment	None	Scale
Population per Square Mile	None	Scale
Ratio to State Population per Square Mile	None	Scale

The following are detailed descriptions of the variables, including variable type, grouped by the categories I developed.

Funding

Funded Project, Binary: This variable describes whether a candidate project was funded or not in either MDOT or BCDOT's capital program.

Stage of Funding, Nominal: The Stage of Funding defines whether the project was funded for planning engineering (PE), construction, or both. One challenge with analyzing the stage of funding is that many projects stay in a state of perpetual PE over a long period until construction funding comes available. In fact, there were 18 funded projects and of those, two advanced to construction and only one was completed. The rest of the 16 projects are still in a stage of planning or engineering and possibly on hold (on. On hold may indicate it was not a priority. This variable is included to attempt to illustrate if a project advanced toward construction funding or not. Often, projects can be funded for planning for years without advancing and then falling off the list of funding.

Completion, Binary: This variable captures whether the project was completed or not. A challenge with this variable is that it takes years to complete major transportation projects. Though my data reaches back to 2010, ten years may not be long enough to capture completion. Only one project out of the 18 is complete and one other is in construction. The rest, as mentioned above, are in planning.

Political

Political Affiliation when Funding Began, Nominal: This variable captures the relationship between the local government and the state government leadership by defining whether the jurisdiction was Republican or Democrat at the outset of the funding. Until 2014, the state leadership was Democratic and then a Republican governor was elected. This variable was developed in an attempt to capture some of the political relationship. However, the change in gubernatorial dynamics and even county-level party affiliations makes it challenging to assess this accurately. It is used for descriptive purposes only.

Priority Letter, Binary: This variable denotes if a project was requested formally by a county or Baltimore City. Every year as MDOT develops the capital program, it requests jurisdictions to provide letters detailing their transportation priorities. Counties and Baltimore

City provide a letter describing their desired projects, which range in mode and type. They are not all highway projects. MDOT considers this in the development of the investments.

Freight Plan Scores

Freight Plan Scores, Nominal: The SFP included scores developed by both qualitative expert judgments and quantitative information such as for safety, traffic and congestion, environmental issues such as air quality, and accessibility to freight facilities. These variables represent expected improvement from the project candidate. There was an overall score and then scores for the following elements. The following is adapted from the SFP (MDOT, 2009, p. 8-3).

> ***Quality of Service:*** Quality of Service refers to the "potential for the project to reduce delay and increase reliability." Issues such as congestion and bottlenecks were considered as part of this measure. It was weighted in the overall score at 30 percent.
>
> ***Safety and Security:*** Safety and Security is the "potential for the project to provide a safer operating environment and reduce opportunities to compromise the supply chain." It was weighted in the overall score at 25 percent.
>
> ***Environmental Stewardship***: Environmental Stewardship is the "potential for the project to reinforce the development of freight-related land uses within existing freight activity centers or direct new developments to" Priority Funding Areas (PFAs) "and sites with adequate infrastructure." It was weighted in the overall score at 10 percent.

Connectivity for Freight Mobility: This score is the "potential for the project to enhance connectivity between freight modes and/or improve access to clusters of freight-intensive industries." Whether or not the project could improve connections from one mode to another or reduce the route of goods was considered for this measure. It was weighted in the overall score at 25 percent.

Coordination: This score is the "potential for the project to fulfill the plans, programs or goals of multiple agencies." It was weighted in the overall score at 10 percent.

As mentioned earlier, I use dummy variables to assess these categories. The dummy variables created are shown in Table 2. These variables are binary.

<u>Operational and Planning</u>

Included in the Highway Needs Inventory (HNI), Binary: The HNI is a yearly collection of highway projects developed by the MDOT SHA as it prepares funding for projects. It is a long-term planning tool that is not fiscally constrained and identifies highway improvements important for the state (MDOT, 2018b). The Transportation Article 8 of the Annotated Code of Maryland (MDOT, 2018b) requires its development. The HNI serves as the source document for the highway project selection for the CTP (MDOT, 2018b). An issue with this variable, however, is that it does not include Baltimore City, and historical information is easily available. The HNI changes little each year, and it is assumed for this work that the projects in the data that are listed in the HNI have been in the HNI for some time.

HNI Cost, Continuous: This variable is the cost if listed in the HNI in millions.

Annual Average Daily Traffic (AADT), Nominal: AADT captures magnitude of traffic volume. In Maryland, it is based on sample counts from Automated Traffic Reader (ATR) devices in major state roads. As it is a sample, it is not a perfect count, but the state is required by FHWA to provide this information every year to the federal government, and the state believes it to be a good representation of traffic volume. It is a ranking in this dataset as the state provides this information to the public in ranked, color-coded format (MDOT, 2018c).

Since AADT is nominal in nature, I recoded this variable with dummy variables as shown in Table 2. This created three binary variables.

Mobility Measures

An important activity for many DOTs is measuring mobility to identify congestion. The literature review provided an overview of how this developed over time as the data to do this grew over the years. Today, states have access to robust probe data for all traffic and a growing but less robust source for truck probes. States do not have mobility measures for other freight modes.

Mobility analysis in the form of probe data assessment as practiced today was not part of the MSFP development or accounted for in the HNI. I wanted to include this data in some way in my research because. MDOT had a Mobility Report based on all traffic data beginning in 2012. I included it as a proxy for all traffic and freight mobility awareness.

An issue, however, is that the best dataset to capture this is the National Performance Management Research Data Set (NPMRDS) made available by the Federal Highway Administration (FHWA). This dataset provides the ability to reach back to previous years for data, but previous versions did not have the same number of trucks providing information to the dataset. While it is possible that highways with congestion change over time, the Texas A&M Transportation Institute (TTI) has found that congestion ranking changes little over time in its work on FHWA's Urban Congestion Report and for the Texas 100 bottlenecks TTI generates every year (Schrank, 2018); (FHWA, 2018a). For my dataset, I use a more recent year of NPMRDS, choosing 2017 because it will likely reflect the magnitude of congestion accurately and it includes better coverage for all traffic and trucks than previous versions of the NPMRDS.

This presents a temporal problem, and it would be best to have a congestion ranking for the year the project was funded. I make the assumption for this research that the magnitude of congestion that the NPMRDS reflected is likely the same despite changes to the transportation network that may have occurred. This is based on information showing that congestion changes little over time. Maryland's mobility reporting shows the same segments with the same magnitude of congestion for the past several years in addition to similar findings from TTI's work in Texas (MDOT, 2018a). Additionally, most of the projects were funded in 2010 or prior, so this information would not have been available. As mentioned earlier, it can be a proxy for some level of mobility/congestion awareness that MDOT may have had.

Developing the Mobility Measures

Developing the Mobility Measures required the use of the UMD RITIS tool. RITIS allows a user to select segments of the highway and compute aggregated mobility performance metrics for the selected area. I used RITIS to identify the roadway segments that correspond with every freight highway need listed in the 2009 Statewide Freight Plan for the Baltimore metropolitan area and to calculate measures of congestion and reliability for this variable. I used 2017 data initially since the NPMRDS version 2 began in 2017 and prior years had a less robust sample of trucks.

The RITIS tool creates measures of speed, buffer times, planning times, travel times and related indices from the NPMRDS. The measures are based on a distribution of travel times over a determined period such as a quarter or year. Most of the measures assess the relationship between the worst travel times and free flow speeds (no traffic) or an average or median speed (University of Maryland Center for Advanced Transportation Technology Laboratory (UMDCATT, 2017).

The following define the measures provided by RITIS (as adapted from UMDCATT (2017) and TTI (2018):

Speed: RITIS provides speed data and average speed data for selected time-periods and segments. This is based on the NPMRDS data.

Buffer Time (BT): The extra time that one must add to the average travel time to ensure on-time arrival, usually calculated as 95th percentile travel time minus the average travel time.

Buffer Index (BT): The Buffer Index shows the Buffer Time's percentage value of Average Travel Time. The value of the index increases as reliability worsens.

The Buffer Index is calculated as:

$$\text{Buffer Index (\%)} = \frac{(95^{th}\ \text{Percentile Travel Time} - \text{Average Travel Time})}{\text{Average Travel Time}} \quad \textbf{(Eq. 1)}$$

Planning Time (PT): Planning time is the total time one should plan for a trip to ensure being on time. This is usually the 95^{th} percentile travel time.

Planning Time Index (PTI): Planning Time Index refers to the total travel time when a buffer is included. It compares the worst travel time to travel time in free flow conditions. It differs from Buffer Index as it includes typical and unexpected delay. It is usually calculated as the ratio of the 95^{th} percentile travel time and free flow travel.

The Planning Time Index is calculated as:

$$Planning\ Time\ Index_{time\,period} = \frac{95th\ Percentile\ Travel Time_{time\ period}}{Reference\ Travel\ Time} \quad \textbf{(Eq. 2)}$$

Travel Time (TT): Travel Time is the actual travel time for a particular trip over a segment of road. It can be averaged over a period of time (such as a year) or over multiple road segments (corridor versus a specific location).

Travel Time Index (TTI): TTI is the ratio of the average travel time over the free flow travel time. Unlike the BI and PTI, the TTI is more of a measure of congestion than reliability. BI and PTI are looking at the variability of travel time. For example, it asks whether a road experiences spikes of congestion where you never know what the travel time is going to be like. The TTI tells you if a roadway is reliably congested meaning that you know you are going to sit in traffic, and you can expect that you will regularly. The TT is calculated as the average travel time for a trip.

The TTI is calculated as:

$$Travel\ Time\ Index_{time\ period} = \frac{Average\ Travel\ Time_{time\ period}}{Reference Travel Time} \qquad \textbf{(Eq. 3)}$$

Planning Time Index and Buffer Index provide an understanding of unreliability. This means that it helps identify the variance. A road segment with a high index is unreliable in that it can present difficulties for travelers to know what to expect. Alternatively, the Travel Time Index helps assess congestion. A road segment may be congested but be reliably congested, so one can expect that their travel time will not vary as much as a segment that is unreliable (TTI, 2018).

RITIS is limited to the Buffer, Planning and Travel Times, and Indices, but each one provides a different lens. The Maryland Mobility report includes TTI and PTI among others not included in RITIS (MDOT, 2018a). It includes the BI, TTI, and PTI but prioritizes hours of delay not included in RITIS.

The mobility measures provided are among the most popular measures used by transportation agencies (as described in the literature review) and are typically reported to leadership and decision-makers, as well as the public. These measures are also important to the freight community because they value on time, reliable deliveries for customers and use reliability in their own route planning (Katsikides et al., 2017).

Picking one mobility measure for use in the regression later on presented difficulties. I used all available all traffic and truck mobility measures provided by RITIS for the descriptive statistics, correlation and independent samples t-tests in order to assess which ones have a relationship with funded projects. For the regression, only one is used since these measures are inter-correlated. More on this selection is in the regression section of this research after the mobility measures are analyzed in the sections below.

Demographic

The final measure category is for demographic measures to capture any relationship on population, employment, and employment establishments.

I used Census data for the following:

- Population
- Total Employer Establishments
- Total Employment
- Population per Square Mile

To relate these variables to the statewide levels, I also assessed the ratio of each to the statewide numbers.

Statistical Analyses

The methodology began with a broad analysis of all variables and moved toward identifying the variables that appear as predictors of funding. Starting out with descriptive statistics and assessments of scatter plots and then assessing correlation and sample means helped to reduce the relevant variables. It also helped to answer questions by providing an indication of whether MSFP FPM variables appear related, whether other variables are related, and the relationship of newer FPM mobility data to whether they hold something meaningful there.

Methods for each statistical analysis are described below. To conduct them, I generally used SPSS software to perform statistical tests and scatterplots. I also used Excel to organize and visualize data results. The methods for each of the four analyses is detailed below.

Descriptive Statistics

Descriptive statistics helped identify relationships of funded projects and unfunded projects, which was useful in the following statistical analyses. Specifically with scatterplots, I assessed linearity and relationship based on the trend line. Then, I organized the variables from low to high in terms of relationship with funding. This helped provide some context and comparison for correlation calculations below.

Correlation

For this work, the Pearson's correlation measured strength and direction of a linear relationship between variables (Schweigert, 1994). This correlation calculation requires that variables be measured on a continuous scale, that they are paired, and that there is a linear relationship between the variables.

Since the Pearson correlation coefficient represents strength and direction of a linear relationship among variables, the null hypothesis is that there will be no relationship among the variables or that the correlation coefficient is equal to zero. The alternative hypothesis is that the correlation coefficient is not equal to zero.

Technically, since some of the variables are binary or were recoded into binary dummy variables, the application of the correlation is considered a point-biserial correlation. A point-biserial correlation is appropriate when a data set involves one interval type data and a binary or dichotomous variable and the calculation is the same as Pearson but uses an alternative notation when calculated (Schweigert, 1994).

I applied the Pearson correlation/point-biserial correlation to the binary and continuous variables.

Independent Samples T-Tests

Another way to differentiate what might be driving decisions is to look at differences between funded projects and unfunded projects. Using Independent Samples T-Tests, I tested for differences between means of the independent variables for funded projects and unfunded projects. This helped explore which independent variables might be important in relation to funding. Although some differences can be seen in the descriptive statistics, the t-test helps highlight if the difference is significant.

The Homan et al. (2013) research used an ANOVA test, but since I have two groups (funded and unfunded), I used independent sample t-tests to compare means. To use this type of t-test, there is an assumption that there is one dependent variable measured at the continuous level or one independent variable consisting of two categorical, independent groups such as a dichotomous variable. Also, independence of observations is important meaning. Meaning that there is not a relationship between the observations of the independent variable or between the groups (Schweigert, 1994).

For independent samples t-tests, the null hypothesis is that the means of the two groups are equal. The alternative hypothesis is that the means are not equal. I tested numerous variables and assessed each result based on the null and alternative hypothesis.

Binary Logistic Regression

The regression calculation produces a model to predict the probability of an event happening that can be used to test relationship of variables to outcomes. It examines the relationship of a binary or dichotomous outcome and predictors that are either categorical or continuous.

For this analysis, the dependent variable is whether a 2009 Freight Plan Highway Project was funded or not. The null hypothesis is that there is no effect or relationship of the FPM variables on funding, and the alternative hypothesis is the probability that there is an effect for the FPM variables.

The formula for the logistic regression is:

$$\ln\left(\frac{\mu_i}{1-\mu i}\right) = x_i b = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \dots \beta_p x_{ip}$$

Where:

μ_i = linear predictor

β_x = a term indicating the value of a predictor, x, and its coefficient, β.

$\ln\left(\frac{\mu_i}{1-\mu i}\right)$ = link function upon which the fitted or predicted value of the logistic model is based.

μ = the probability that the response value y is equal to 1.

$\mu/(1-\mu)$ = the formula for the odds, probability of its success is divided by the probability of its failure or absence.

Xb = *linear predictor*

X = *independent variables* ***(eq. 4)***

It is common for statistical literature to provide an interpretation of the coefficients produced in this regression as the odds ratio instead of probability (Cameron & Trivedi, 2005). In this case, the formula for expressing probability in terms of the odds ratio is:

$$p = \frac{\exp(x'\beta)}{1} + \exp(x^1\beta)$$

$$\rightarrow \frac{p}{1-p} = \exp(x'B)$$

$$\rightarrow \ln\left(\frac{p}{1-p}\right) = x^\beta \qquad \textbf{(eq. 5)}$$

In eq. 5, p is the probability that a project was funded, y=1. (1-p) is the probably that a project was not funded, y=0. The expression p/(1-p) represents the odds of funding. The expression $\exp(x'B)$, is the odds ratio. This is often used to describe the results as it is more intuitive than discussing the odds. The odds ratio is a multiplier meaning that a one-unit increase in the regressor multiplies the initial odds ratio by the value of $\exp(x'B)$. For example, if $\exp(x'B)$ is 2, this is interpreted and two times more likely to occur (Cameron & Trivedi, 2005).

There are several expectations important for the use of binary logistic regression. First, it is important to consider the predictor variables to include in the model. It is conventional to first run correlations and use variables that show significance in the model when compared to the dependent variable. However, consideration needs to be given to whether the results of the correlation and the inputs into the model in general make sense in terms of the association (Ranganathan, Pramesh, & Aggarwal, 2017).

Second, the number of predictor variables is important for the model. Including too many predictor variables may dilute associations and lead to increased standard errors with imprecise confidence intervals. Alternatively, they may identify false associations. A rule of thumb is one independent variable per 15 events or observations. Peduzzi, Concato, Kemper, Holford, and Feinstein (1996) recommend at least ten events for each variable entered. This rule has been questioned by Vittinghoff and McCulloch (2007) who found that fewer events are needed per independent variable (Ranganathan, Pramesh, & Aggarwal, 2017). This research includes 49 observations or events; therefore, the number of independent variables should be around three to four.

Third, a linear relationship between the continuous independent variables and the logit of the dependent variable should exist (Osbourne, 2017). I test this using the Box-Tidwell approach, which tests for linearity by calculating the cross-product of the independent variable by its natural logarithm or [(X) ln(X)]. This approach tests for an interaction between the two. If there is a significant product, there is not linearity in the logit. I transformed my continuous variables for into the natural log. I then created interaction terms for both of the variables. I tested the interaction and found that the tests did not reveal that the interaction terms were statistically significant. This means they are linearly related to the logit of the dependent variable and have passed the test for assumption of linearity required for the regression.

Fourth, data must not show multi-collinearity (Osbourne, 2017). The previous statistical analyses helped to identify collinearity among variables and aided in the development of the regression model presented below.[7] I found moderate to high levels of collinearity among several of the variables. Among the FPM measures, these show some collinearity with each other that made it difficult to assess them in the model. For example, Connectivity for Freight Mobility is correlated with Safety and Security.

Fifth, there should be no significant outliers (Osbourne, 2017). To check, case-wise diagnostics added to the regression outputs helped to show whether or not there were outliers and if they posed a risk to the model.

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[7] Appendix B provides the table showing collinearity among FPM measures.

Overall Methodology Limitations

This research has several general limitations important to recognize. First, there are many elements of the decision-making process for transportation not captured in the data or able to be analyzed in the four methods above. The transportation investment process is not straightforward. It is a collection of actions and is not always based on data, criteria or even most need. Many actions are political and can occur 'under the table.' These may be impossible to capture in data because they are unknown. It may also be that political deals have the most impact, but without data, this will not be discovered. Of all the variables I collected, none of them capture the political elements of public sector decision-making specifically. Unfortunately, politics may be one of the most influential aspects of decision-making, but this research does not capture it.

Second, this research lacks information on what data and measures, if any, decision-makers actually used. I list the information that the decision-makers should have had. However, it is not possible to know exactly if performance information was specifically consulted for each project. Since the 2009 Statewide Freight Plan and yearly performance reports like SHA's Mobility Report that includes freight bottlenecks are produced by OPCP and modal planning agencies, one may expect that this information would be reviewed by OPCP staff. The MSFP was presented to a range of MDOT and Baltimore area decision-makers such as OPCP staff, MPO staff and local government leaders and planners. Since the Freight Plan described over $35 billion in freight project needs, it received much media attention. However, there is no indicator that the plan or other freight performance information was consulted when the CTP was crafted.

Third, there are data quality challenges that exist and need to be recognized when considering the results. For example, the MFSP FPM scores were to be based on both qualitative and quantitative data, but it is unknown as to the level of each that contributed to the score. The scores were vetted and created with and by internal MDOT and external stakeholder input. However, some of these scores may well be arbitrary. There is no other plan for MDOT that ranks and prioritizes freight projects in any other way. One issue with this is that perhaps the score does not actually reflect what the measure was supposed to measure. Another is that the weighting of scores to produce an Overall Score was arbitrary. Issues like these make it challenging to say definitively that a score for Connectivity or Safety and Security, for example, is valid.

Fourth, the MSFP projects were derived from numerous sources including internal and external stakeholders, as well as resources like. Since they are highway projects and MDOT relied on the Highway Needs Inventory and existing plans and programs. They may not, however, be the most important roadway segments for freight. In other words, they may be areas of known congestion or bottlenecks but if all roadway segments were considered equally, these segments in the MSFP may not be the highest-ranking segments when assessed for freight congestion or unreliability. There is significant bias already in the project list, as well as the data from the MSFP FPM scores.

Another challenge with the MSFP is that most of the projects listed were those already partially funded for planning prior to 2010. This points to MDOT contributing known projects they already had underway or in the pipeline into the plan without an analysis of perhaps what should be in the plan that an unbiased project selection process would produce.

Fifth, this analysis ignores economic benefit of projects or indicators such as impact of commodities or key industries in the Baltimore region that may be driving investments. Data to determine these relationships for the project in the plan do not exist. It would be helpful to know a CBA result or economic benefit estimation for jobs for each project, as well as the commodities affected and any relationship of commodity flow performance to investment decisions. This is an economic influence missing from this analysis that requires additional exploration.

Finally, the mobility data present a temporal issue for the analysis. 2017 probe data from the NPMRDS was used because it was the most robust version available for the timing of this research. Though studies show little change in congestion information year to year and it is likely that there has not been much change among congested highway segments and levels of congestion over the past ten years, a stronger analysis would rely on data for each year if it could be produced. There is little likelihood that segments changed much since only one project of all the freight projects were completed. However, other projects not listed as freight projects may have had an impact that 2017 probe data would not show. In time, future research could rely on yearly versions of the NPMRDS that were not available for this research.

These limitations along with the individual measure or analytical limitations present challenges for this type of research. I considered these limitations and report on where they may be a challenge in the results analysis presented later.

Results

The results of each statistical analysis are presented in appropriate sections below. Findings for each test are discussed at the end of the presentation of results. A discussion chapter following the results section presents overall findings for this question.

Descriptive Statistics

A first step in analyzing characteristics and relationships of funded projects was to explore the data. This was done using descriptive statistics and visualization in the form of tables and graphs. Table 3 provides the results of descriptive analysis followed by discussion.

Table 3: Descriptive Statistics

Variables	N	Range	Minimum	Maximum	Mean	Std. Error	Std. Deviation
Funding							
Funded (Y/N)	49	1	0	1	0.37	0.07	0.49
PE or Construction	49	2	0	2	0.43	0.09	0.61
Completion	49	1	0	1	0.02	0.02	0.14
Political							
Priority Letter	49	1	0	1	0.55	0.07	0.50
Political Relationship to Governor	49	2	0	2	0.63	0.13	0.88
Freight Plan Variables							
Overall Score	49	2	1	3	2.27	0.10	0.70
Quality of Service	49	2	1	3	2.51	0.10	0.71
Safety and Security	49	2	1	3	2.24	0.08	0.56
Environmental Stewardship	49	2	1	3	2.57	0.11	0.76
Connectivity for Freight Mobility	49	2	1	3	1.98	0.14	1.01
Coordination	49	2	1	3	2.02	0.07	0.52
Planning							
AADT	49	2	2	4	3.65	0.10	0.69
Included in HNI (2017)	49	1	0	1	0.67	0.07	0.47
HNI Cost (000s)	34	1,132,100	33,100	1,165,200	307,607	50,471	294,296
Travel Measures							
AT Speed (mph)	49	50.25	14.34	64.59	50.89	1.76	12.33
AT Delta from 55 mph	49	50.25	-9.59	40.66	4.11	1.76	12.33
AT Buffer time (minutes)	49	24.36	0.32	24.68	5.92	0.81	5.65
AT Buffer index	49	1.20	0.10	1.30	0.45	0.04	0.28
AT Planning time (minutes)	49	52.37	3.14	55.51	19.02	1.97	13.81
AT Planning time index	49	4.26	1.22	5.48	1.97	0.12	0.85
AT Travel time (minutes)	49	38.56	2.49	41.05	13.13	1.33	9.28
AT Travel time index	49	1.38	1.10	2.48	1.32	0.04	0.29
TR Speed (mph)	49	50.73	11.28	62.01	48.23	1.75	12.25
Truck Delta from 55 mph	49	50.73	-7.01	43.72	6.77	1.75	12.25
TR Buffer time (minutes)	49	30.15	0.42	30.57	7.75	1.00	7.03
TR Buffer index	49	1.93	0.13	2.06	0.60	0.06	0.41
TR Planning time (minutes)	49	58.32	3.35	61.67	20.87	2.14	14.98
TR Planning time index	49	6.10	1.14	7.24	2.20	0.17	1.18
TR Travel time (minutes)	49	39.66	2.52	42.18	13.89	1.37	9.61
TR Travel time index	49	2.16	1.14	3.30	1.42	0.06	0.42
Demographic							
Population	49	757,231	47,798	805,029	594,285	29,307	205,147
Ratio to State Population	49	0.13	0.01	0.13	0.10	0.00	0.03
Total Employer Establishments	49	18,508	1,387	19,895	14,760	658	4,608
Ratio to State for Employer Establishements	49	0.13	0.01	0.14	0.11	0.00	0.03
Total Employment	49	312,131	11,808	323,939	261,690	10,202	71,415
Ratio to State Total Employment	49	0.14	0.01	0.14	0.11	0.00	0.03
Population per Square mile	49	7,543	129	7,672	2,422	361	2,524
Ratio to State Population per Square Mile	49	12.68	0.22	12.90	4.07	0.61	4.24

Descriptive Results Discussion

There are several descriptive results that are important to note. A primary observation was that of the 49 projects, 37 percent were funded (18 were funded and 31 were not). 15 of the 18 were funded for planning and engineering (PE) and three were funded for construction. Baltimore County led with the most projects funded, followed by Howard County and Anne Arundel. Table 4 shows the distribution of projects listed in the MSFP.

Table 4: Projects by Jurisdiction

Jurisdiction	Number of Projects Listed in the MSFP	Number of Funded Projects
Anne Arundel	12	3
Baltimore City	9	2
Baltimore County	18	8
Harford County	1	1
Howard County	8	3
Queen Anne’s County	1	1

Additionally, of the projects in the MFSP, 55 percent were included in a priority letter by the county or Baltimore City. 63 percent of them were funded when the local jurisdiction was of the same political party as the governor.

Projects in the MSFP had varying scores related to the FPM variables included in the MSFP. The results suggest that they were irrelevant or their importance not revealed through the descriptive statistics. For example, the mean Overall Score was 2.27, indicating a lean toward medium and high scoring projects overall. The average score for Environmental Stewardship was highest of the variables at 2.57 followed by Quality of Service, which is supposed to reflect mobility or congestion issues. Surprisingly in the MSFP, projects had an average score of 1.98 for Connectivity for Freight Mobility, the lowest of the averages for the FPM variables.

Most of the projects in the MSFP were those that scored as “very high” for traffic volumes by AADT. This average was 3.65 and the range was 1 to 4. Additionally 67 percent of the projects were included in the Highway Needs Inventory, and of those projects, the average cost was $308 million.

Mobility Measures as included in this research were not available when the bulk of the projects were initially funded for planning or engineering. However, they serve as a proxy for congestion awareness. The findings show that the average speeds for all traffic and truck were below free flow or posted speeds of 55 and 65 miles per hour depending on location. Truck speeds were lower than all traffic speeds by approximately 2 miles per hour. For measures of reliability and congestion, the projects exhibit higher levels of congestion on average. PTI, a measure of total time needed to ensure an on time arrival for a trip based on the ratio of the 95th percentile for all traffic, shows showed an average ratio of 1.97. This means that on average, the project segments in the MSFP take twice as long to traverse and have high unreliability. For trucks, these same segments are even worse as the average PTI ratio is 2.20. The higher the ratio, the worse the reliability. The descriptive results also reveal that the truck experience is worse than the all traffic experience as the mobility measure averages reflect worse times and indices of reliability and congestion than all traffic.

In terms of demographics, the average population is close to 600,000 people with an average of approximately 15,000 employer establishments and 262,000 employees. However, the range of population is from 48,000 to 805,000 as the metropolitan region includes lower populated jurisdictions in addition to more populated areas like Baltimore City and Baltimore County.

The next section analyzes the descriptive results by groupings of funded and unfunded projects.

Relationship of Funded versus Unfunded Projects to Freight Plan FPM Scores

Central to the hypothesis is whether there is a relationship between high MSFP FPM scores in the freight plan and funding. Figure 13 depicts the relationship of funded versus unfunded projects and freight plan scores. The bars on the left are for funded projects and the bars on the right for unfunded projects by FPM score. The column marked Average is the Average for each jurisdiction.

On average, funded projects had a higher score for two of the MSFP scoring categories, Quality of Service and Safety and Security. Coordination was also higher for funded projects. The Overall Scores from MSFP for both funded and unfunded were almost the same.

Environmental Stewardship scores were higher for unfunded projects as were, surprisingly, scores for Connectivity for Freight Mobility.

For funded projects in Anne Arundel County, Quality of Service, Environmental Stewardship, Safety, and Security were higher than unfunded project scores. In Baltimore City, the Overall Score, Quality of Service, Environmental Stewardship, and Connectivity for Freight Mobility were highest. However, Baltimore City only had two funded projects, and these projects individually scored high in these categories. Harford County's one project had high scores for Quality of Service as well as Safety and Security. Howard County's few funded projects had high scores for Quality of Service, Safety and Security, and Coordination. Queen Anne's County's only funded project was high in Quality of Service, Safety and Security, and Coordination. In general, only Anne Arundel County and Howard County had an Overall Score for freight that was higher for unfunded projects.

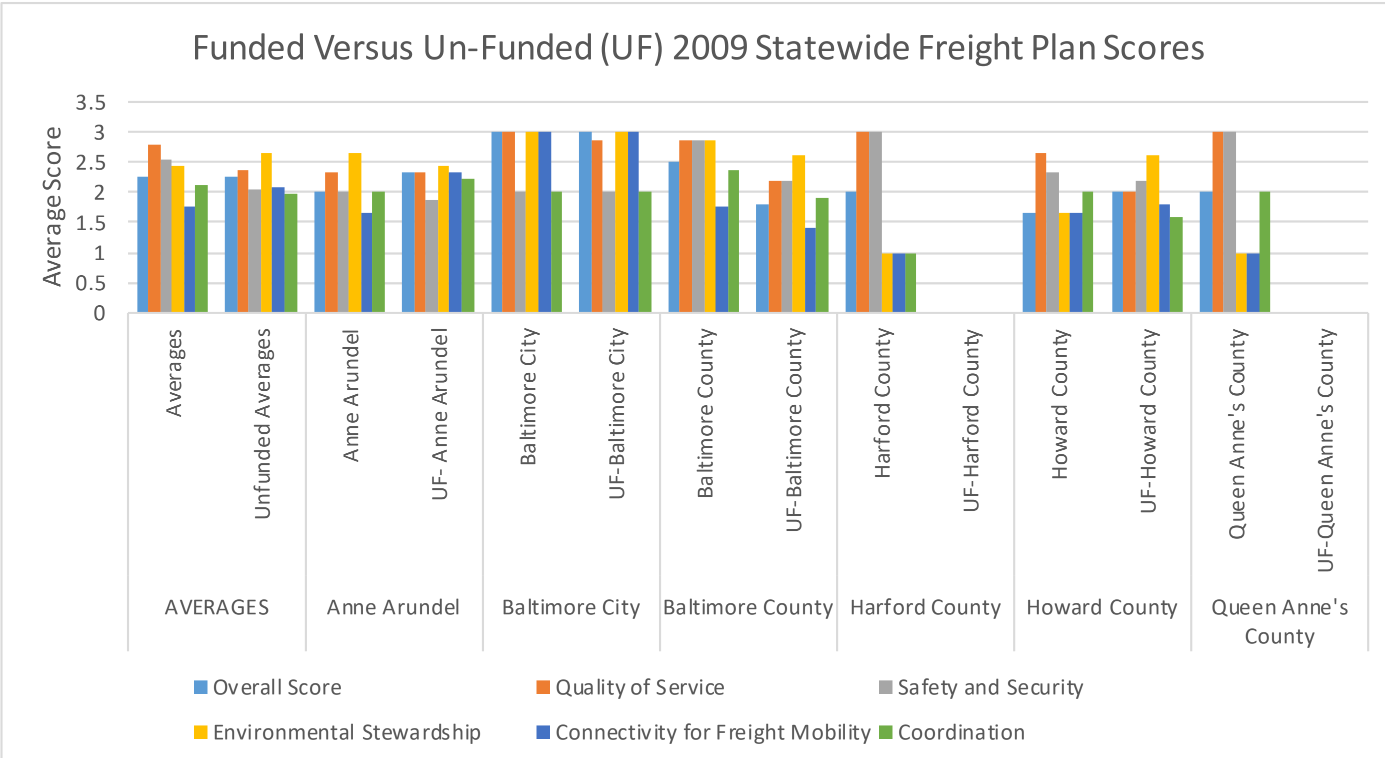

Figure 13: Funded vs. Unfunded FPM Scores

<u>Relationship to Other Data and Measures Available to Decision-Makers</u>

After assessing FPM information from the freight plan, the next area of focus is on the relationship of data and measures decision-makers likely had when making funding decisions. The measures illustrated in this section are Inclusion in the HNI, known county-level priorities as set in a county Priority Letter, and AADT.

Inclusion in the HNI was higher for funded projects (see Figure 14). This is especially so for Anne Arundel County, Howard County, and Queen Anne's County. However, for Baltimore County, unfunded projects were included in the HNI more than funded projects. As stated earlier, the HNI is a difficult variable to consider. There is not historical information to match the HNI with the year and does not include Baltimore City.

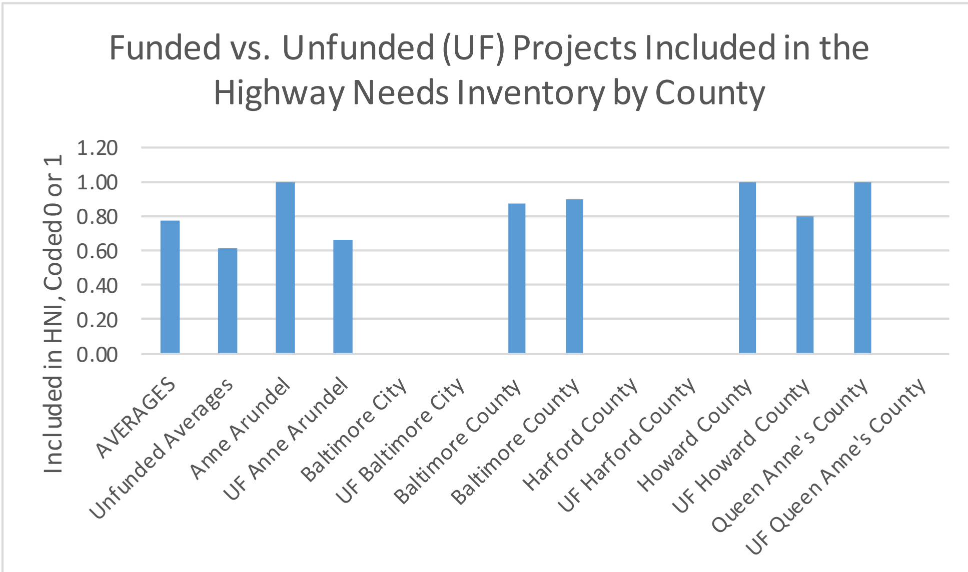

Figure 14: Funded vs. Unfunded (UF) Projects in the HNI

In all counties except Howard County, funded projects had a higher AADT. Howard County was about even as all projects in Howard County scored with the highest amount of AADT and Harford and Queen Anne's County did not have an unfunded project for comparison. Figure 15 shows the relationships for AADT.

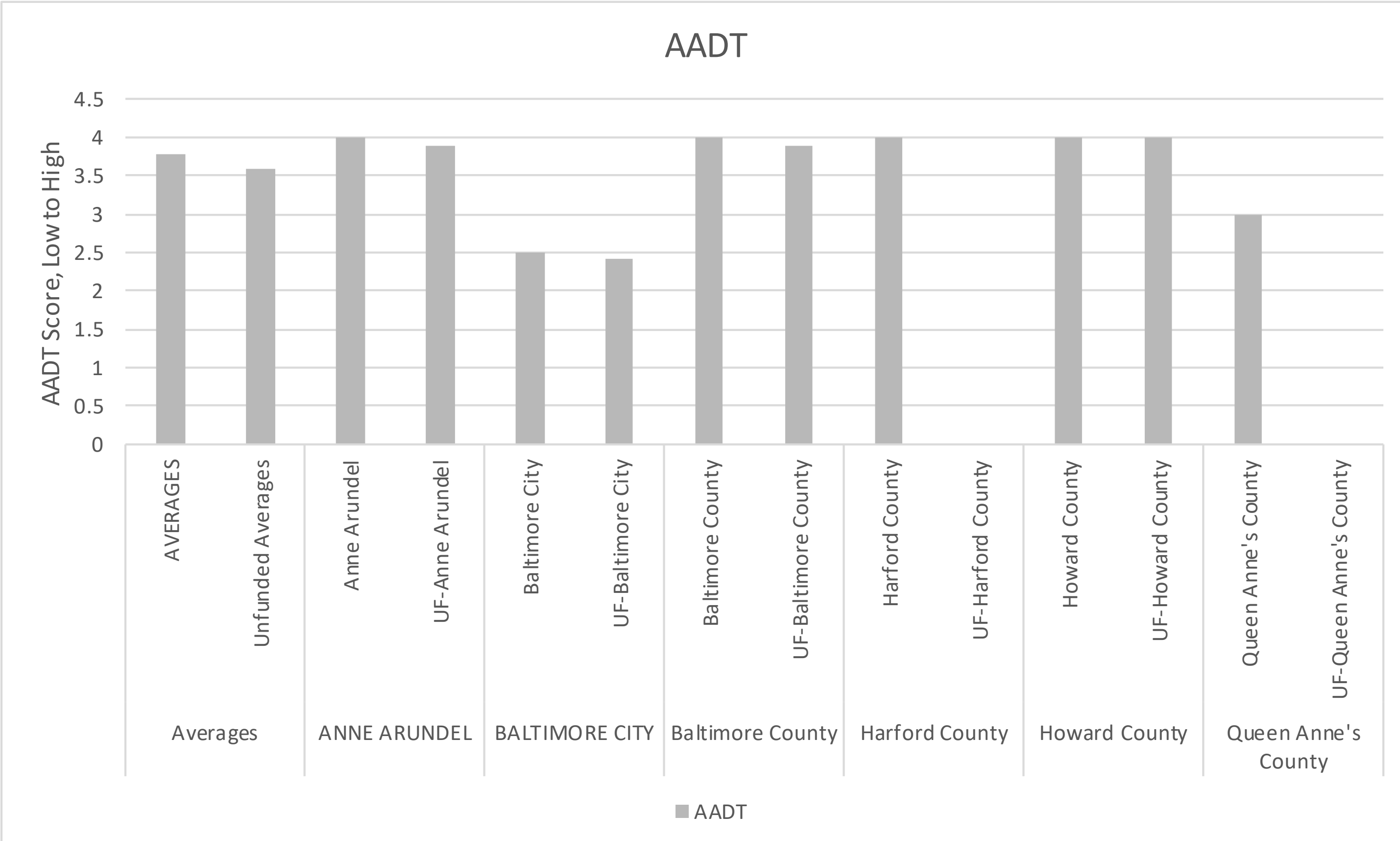

Figure 15: Funded vs. Unfunded (UF) Project Average AADT

On average, funded projects were more frequently listed in priority letters than unfunded projects (See Figure 16). Most of the results are from Anne Arundel County and Baltimore County. Baltimore City did not have any unfunded projects requested in the Priority Letter and Baltimore City sets its own budget. Neither funded nor unfunded projects were requested by Harford County. Howard County is the only jurisdiction that had more unfunded freight projects requested in a priority letter. Queen Anne's County's only project was included in the priority letter.

Figure 16: Funded vs. Unfunded Project Inclusion in a Priority Letter by County

Baltimore County and Baltimore City were the two jurisdictions with leadership in the same political party as the governor at the time of funding. Baltimore County notably has many projects funded in 2014's budget that would have been put in the budget at the end of 2013 before the political parties changed in the 2014 gubernatorial election. It also, as described earlier, has limitations as a measurable data point.

Relationship to Mobility Measures

Though decision-makers may have had some level of mobility data, especially in later years, particularly in later years, they likely did not have the freight mobility information that has come online in recent years. Assessed in relation to funded projects, probe-based mobility information for all traffic and truck traffic shows that mobility measures were worse for funded projects than unfunded projects except in Howard County. This suggest that there was a mobility issue in all jurisdictions except Howard County (See Figure 17). In Howard County, funded and unfunded projects are approximately the same. Harford and Queen Anne's County had no unfunded projects.

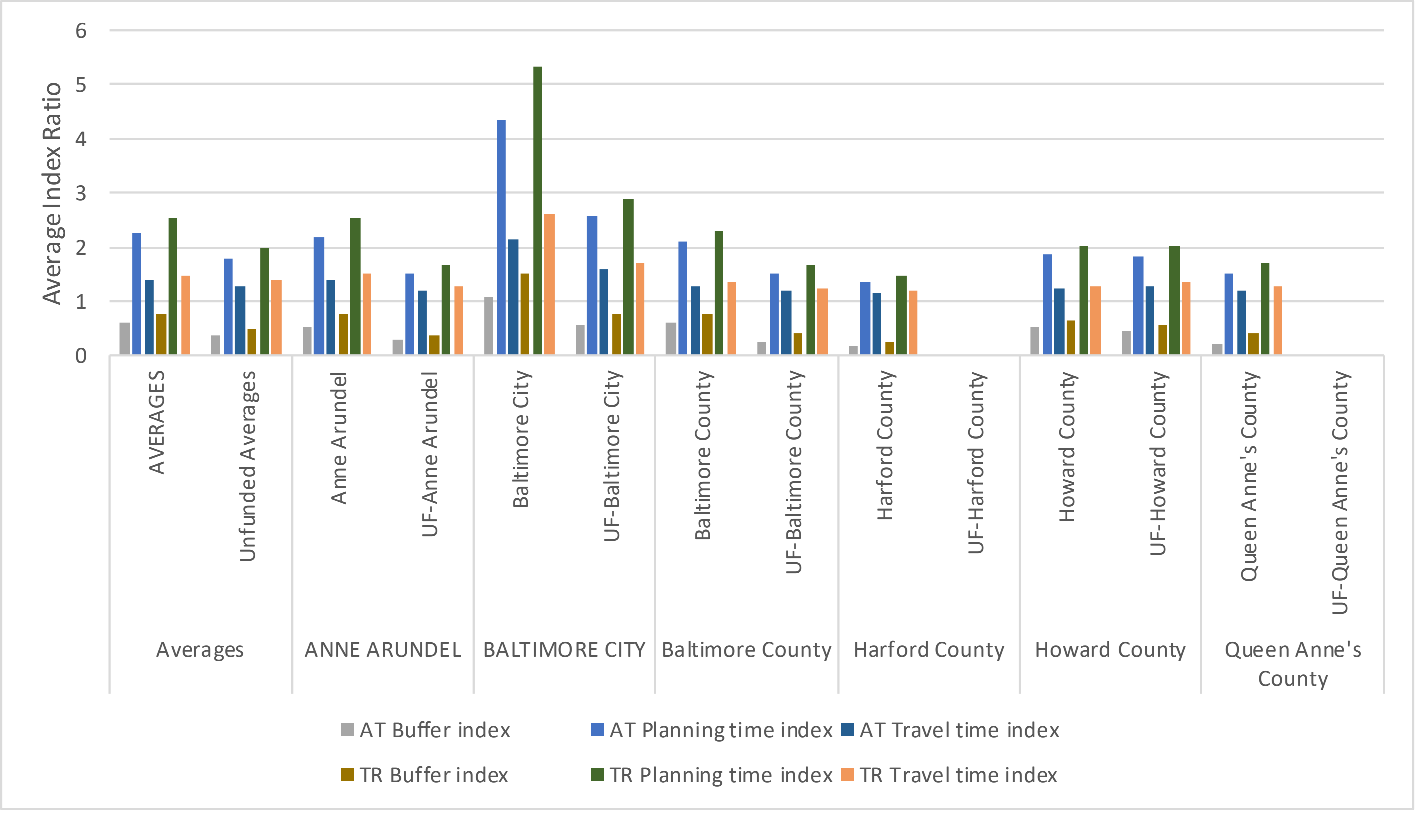

Figure 17: Comparison of Mobility Measures

Scatterplot and Linearity Assessment

In addition to the visualization provided above, I created scatterplots and trend lines to assess relationship and linearity, which provided. These provide useful information for future statistical analysis. A summary is provided below in Table 5 and the scatterplots are in Appendix B.

These scatterplots show that the relationship to funding is positive and highest for FPM variables of Quality of Service, but only when the Quality of Service score is high. When the

Quality of Service score is medium or low, the relationship is negative. Similarly, a high score for Safety and Security is positively related, a low or medium score is unrelated. This suggests that only high scores may matter for funding.

The relationship is less strong for other FPM measures. Some FPM measures show a negative relationship, meaning they are inversely related. In addition to the FPM results, there appears an upward relationship between funding and HNI inclusion and cost, mobility measures for all traffic and trucks, and inclusion in a County's Priority Letter.

Table 5: Scatterplot and Trend Line Relationship

Stronger, Positive	**Moderate, Positive**	**Moderate, Negative**	**Strong, Negative**
All Traffic Buffer Time	All Traffic Travel Time Index	All Traffic Speed	Safety and Security (Medium)
All Traffic Planning Time	Connectivity for Freight Mobility Low	Truck Speed	
All Traffic Travel Time	Coordination (Total)	Safety and Security (Low)	
All Traffic Buffer Time Index	Environmental Stewardship (Low)	Coordination (Low)	
All Traffic Planning Time Index	Environmental Stewardship (High)	Overall Score (High)	
Truck Buffer Time	Overall Score (Total)	Quality of Service (Medium)	
Truck Planning Time Index	AADT	Overall Score (Low)	
Truck Buffer Time Index	Included in the HNI	Overall Score (Medium)	
Truck Planning Time Index		Environmental Stewardship (High)	
Safety and Security (High)		Coordination (Medium)	
Quality of Service (Total)		Environmental Stewardship (Total)	
Quality of Service (High)		Connectivity for Freight Mobility (Total)	
Priority Letter		Connectivity for Freight Mobility (High)	
HNI Cost		Coordination (High)	
		Quality of Service (Low)	

Like the visualizations shown above, the scatterplot and trend line assessment show a positive and higher relationship between funding and high scores for Quality of Service and Safety and Security, HNI Cost, inclusion in a priority letter and measures of mobility. The relationship with the other FPM measures is much lower.

Discussion of Results

While the descriptive statistics show that variables like the MSFP FPM scores, traffic volumes and congestion levels (mobility) are generally higher for funded projects, the trend lines reveal a more refined view of the relationship. For example, of the MSFP FPM scores, both Safety and Security and Quality of Service appear to be highly related along with the mobility measures, and inclusion in the Priority Letter. Surprisingly, AADT, a measure of traffic volume, is only moderately related to funding. Scores for Connectivity for Freight Mobility were negatively related.

These results mostly confirm intuition as transportation agencies focus on congestion and safety issues. Notably, Quality of Service is an MSFP FPM measure that refers to mobility. Therefore, funded freight projects appear to be those that had higher MSFP FPM scores related to mobility that as measured by Quality of Service. However, high scores for Connectivity for Freight Mobility was negatively related. This appears to be a clue that there might be some challenges related to the definition of this measure and what is captured by it in the freight plan, especially since it is not in line with the proxy mobility measures.

Correlations

The Pearson's correlation analysis yields the results as presented in Table 6. These results reject the null hypothesis for a number of variables, indicating they have significant correlations with funding. Positive relationships indicate a higher number or score relative to funding, while whereas lower numbers or scores means a project is less likely to be funded. Though they have positive, significant relationships, these are moderate and not high correlations. There are also two inverse correlations, discussed below.

Table 6: Correlation Results

	Funding
FPM	
Safety and Security (High)	.504**
Safety and Security (Medium)	-.473**
Quality of Service (Low)	-.285*
Mobility Measures	
All Traffic Buffer Time	.509**
Truck Buffer Time	.503**
Truck Planning Time	.497**
All Traffic Planning Time	.492**
Truck Travel Time	.431**
All Traffic Planning Time Index	.423**
All Traffic Buffer Time Index	.390**
Truck Buffer Time Index	.331*
Priority Letter Inclusion	.347*
HNI Cost	.498**
Note. * = p < .05, **= p < 01. N=49	

These results show that of the FPM measures, only Safety and Security has a significant correlation with funding if the score was high in the MSFP. If the score was medium, it was less likely to be funded. Additionally, a low score for Quality of Service in the MSFP, one of the

FPM categories related to mobility, had a significant, negative correlation with funding meaning that lower scoring projects for this factor were less likely to be funded.

Additionally, Priority Letter is significantly correlated with funding, and both Safety and Security and Priority Letter were variables revealed as having a positive relationship with funding in the descriptive and scatterplot analyses.

Otherwise, the remaining significance is among the mobility variables both for all traffic and truck. Surprisingly, two of the highest correlations are with Truck Buffer Time and Truck Planning Time. This indicates that the information is more correlated with funding decisions than much of the information in the MSFP and that decision-makers likely had available to them. This may be the result of several possibilities such as that decision-makers had some awareness of congestion issues that was accurate or even that the measures or information they actually used would achieve the same results as the newer proxy mobility measures that this research hypothesizes as useful.

HNI cost was also significantly correlated with funding. A challenge with this variable is that unless a project is in the HNI, there is no cost information, so the data is incomplete. Without knowing the potential cost of the non-HNI projects, funded projects included in the HNI were generally those with higher dollar figures.

AADT was not significantly correlated with funding. I expected that funded projects have the highest AADT, and planners and decision makers would know this information and rely on it. While most funded projects did have high AADT, there were two projects in Baltimore City where AADT was lower, as well as a project in less urban Queen Anne's County that had 'high' volume but not 'very high' like the remaining projects.

Discussion of Results

The results of the correlation analysis performed helped identify several variables that emerge as predictors for funding, but they also show that FPM measures were generally less correlated with funding. It seems that only projects with high Safety and Security scores were significantly correlated with funding, followed by a high but not significant correlation for a high Quality of Service score. For example, Safety and Security, Priority Letter and mobility measures emerged in this analysis as candidates to consider for the regression model.

However, these variables exhibit correlation with each other. The A high score for Safety and Security is significantly correlated with All Traffic Buffer Time, Planning Time and Travel Time, as well as Truck Buffer Time, Planning Time and Travel Time. Inclusion in a Priority Letter was not significantly correlated with either a high score for Safety and Security or any of the Safety and Security scores or mobility measures. It did have some interesting correlations though. Notably, it was highly correlated with a moderate score for AADT, meaning that projects requested by counties that were also included in the MSFP may not have been projects with high traffic volumes. Similarly, they were significantly correlated with projects that only received a medium score for Quality of Service in the MSFP, one of the FPMs tied to freight mobility. However, these projects were likely to be in the HNI and, surprisingly, they were significantly correlated with projects scoring high for Connectivity for Freight Mobility. It is interesting that a project listed in a priority letter would be associated so significantly with some of the variables that were only moderately or least related to funding in both the descriptive and correlation analyses.

FPM measures for Quality of Service and Connectivity for Freight Mobility are supposed to represent a project's potential to improve mobility and efficiency. However, higher scores for both of these were not necessarily correlated with mobility measures or traffic volume (AADT). For example, Quality of Service was not correlated with mobility measures in a way that would suggest the two are related. Also, it had a significant relationship with moderate AADT, meaning that the projects in the MSFP scoring highest for mobility and addressing truck volumes actually had lower traffic volumes. Similarly, Connectivity for Freight Mobility (CFM) is also significantly correlated with moderate AADT, meaning that the projects in the MSFP with high Connectivity for Freight Mobility were not those that addressed high traffic and likely high truck volumes.

Further, high scores for Connectivity for Freight Mobility present some interesting correlations in addition to the moderate correlation with AADT. A high score for Connectivity for Freight Mobility is significantly and positively correlated with the indices for mobility measures for all traffic and truck. However, high scores are significantly and negatively correlated with All Traffic Travel Time and Truck Travel Time. They were also less likely to be included in a priority letter.

Overall, these correlations show that in looking at the information drivers of funded projects, variables related to safety, congestion and county priorities appear most important in the funding decisions. Additional assessment of means can help to compare the group of funded projects and unfunded projects and any significant differences into the results found in correlations and the previous descriptive analyses. However, challenges with the data, especially the MSFP FPM scores that mask the underlying data, may be problematic to reveal strong and logical correlations in addition to uncaptured influences such as political elements that might have an effect.

Independent Samples T-Test

Another way to differentiate what might be driving decisions is to look at differences between funded projects and unfunded projects. Using Independent Samples T-Tests, I tested for differences between means of the independent variables for funded projects and unfunded projects.

The independent sample t-tests validate what the descriptive statistics and the correlations imply. As shown in Table 7, Highway projects with high congestion scores and inclusion in priority letters are more likely to be funded. HNI cost was also significant, but this is a challenging variable in that there are no costs for projects unless the project is listed in the HNI. I include it in my results, and they indicate that funded projects had higher HNI costs than unfunded projects, but without cost estimates for all the project needs it is difficult to assess this further properly. I cannot use it in the regression. I included it through to the t-tests because it appeared related to funding in the previous analyses and this t-test.

For the FPM variables, like the correlation analysis, a high score for Safety and Security is noteworthy for funded projects. However, a medium score relates to unfunded projects, as does a low score for Quality of Service. No other FPM variable means were significantly different for funded or unfunded projects.

Table 7 describes all of the variables with statistically significant differences in means. A negative t score means that the variable favors funded projects.

Table 7: Independent Sample T-Tests

	t	df	Sig. (two-tailed). p<.05=*, p<.01**
FPM Measures			
Quality of Service (Low)	2.036	47	0.047*
Safety and Security (Medium)	3.682	47	0.001**
Safety and Security (High)	-4.003	47	0.000**
HNICost000s	-3.252	32	0.003**
Priority Letter	-2.540	47	0.014*
Mobility Measures			
All Traffic Buffer Time	-4.054	47	0.000**
All Traffic Buffer Index	-2.903	47	0.006**
All Traffic Planning Time	-3.869	47	0.000**
All Traffic Planning Time Index	-1.804	47	0.078*
All Traffic Travel Time	-3.196	47	0.002**
Truck Buffer Time	-3.986	47	0.000**
Truck Buffer Index	-2.402	47	0.020*
Truck Planning Time	-3.931	47	0.000**
Truck Travel Time	-3.276	47	0.002**

Discussion of Results

The t-tests do not provide new clues as to what drives funding of the MSFP projects. Like the correlation and descriptive results, variables such as safety, congestion, and local government priorities differentiate funded and unfunded projects. However, understanding this difference provides added information about the strength of the dominant measures.

Binary Logistic Regression

The previous analyses helped identify the variables that appear theoretically reasonable and statistically correlated with funding decisions, which serves to identify variables that seem to be good predictors of funding. The most promising variable categories appeared to be the mobility measures, the score for Safety and Security, and inclusion in county Priority Letters. A high score for Quality of Service does not appear as strong as Safety and Security, but it is among the top most related to funding in the previous analyses.

For this regression, I considered these results and designed three regression versions.

Version 1 (Plan Scores): Model of project funding as a function of FPM measures from the MSFP.

Version 2 (Related Variables): Model of project funding as a function of measures decision-makers had available to them.

Version 3 (New Mobility Data): Model of the relationship between project funding and mobility measures, especially for freight. This includes the previous model but adds in the mobility information not available at the time to see if this improves the model. It includes all traffic, but the interest here is specifically on the freight mobility measures as part of this research.

Modeling in this way provides the opportunity to consider the freight elements and the freight mobility data in addition to what information was available and appear related.

The first version has two models. Model 1 analyzes a project's overall freight score in the MSFP and, as described earlier, is based on the five inputs: Quality of Service, Safety and Security, Connectivity for Freight Mobility, Environmental Stewardship, and Coordination. I assumed that a decision-maker with limited time might look at a project's overall score and consider those that are scored highest.

Model 2 explores the MSFP FPM score variables of Quality of Service and Connectivity for Freight Mobility further, since these are the measures most related to freight mobility, the primary focus of FPM in this dissertation. It is difficult to explore all of the FPM measures together because there is a high degree of collinearity among them. For example, Connectivity for Freight Mobility is significantly correlated with Environmental Stewardship. Quality of Service is significantly correlated with a low score for Safety and Security. These relationships make it challenging to use the variables in the model as it creates a statistical error. Exploring the two FPM mobility-related variables allows a way to focus on the freight mobility aspects of the MSFP FPM measures and their relationship to funding.

Additionally, I found that the dummy variable Quality of Service (Medium), meaning those projects that scored as medium for this in the MSFP, created a statistical effect known as a separation problem and produced a strange coefficient result. In researching this further, I found that this might be due to the low sample size and the dichotomous coding. Researchers recommend dealing with this issue by removing the variable from the model (University of

California Los Angeles Institute for Digital Research and Education(UCLA IDRE), 2019). Removing Quality of Service (Medium) appeared to resolve the problem. This is a limitation of the model, and as such there are statistical issues that may need further exploration.

Version 2 considered the information that decision-makers had available to them and relied on the previous statistical analyses and the predictor variables that emerged. This version included the FPM Safety and Security variable, since it was most prominent, and a high score for Safety and Security was the only FPM variable to be in the upper ranks of significant correlation to funding. It also includes Priority Letter, since this was also another, highly correlated variable that was available to decision-makers and is part of the transportation decision-making process.

Version 3 included two models. This model was used to explore if this new freight mobility data not available to the decision-maker adds to the explanation or had a relationship. The first adds All Traffic Buffer Index to the model in Version 3 to determine if the all traffic mobility data added to the explanation of funding. The second model replaces All Traffic Buffer Index with the Truck Buffer Index.

Buffer Index was chosen as it was the only mobility measure that was both highly correlated with funding but did not create a problem of collinearity with the other variables. For example, most all the other mobility variables highly correlate with Safety and Security. These measures are different versions of assessing travel time, and Buffer Index is a measure of reliability, which is an important measure used by many public and sector analysts. Therefore, given its lack of collinearity, as assessed in this research, and its prominence, as well as its high correlation to funding, it appears to be the best option to represent the mobility measures.

Figure 18 defines the versions.

Version 1: Plan Scores - Using only MSFP Measures

- Model 1: Overall Freight score in the MSFP
- Model 2: FPM Measures related to Mobility (Quality of Service and Connectivity for Freight Mobility)

Version 2: Related Variables - Includes variables appearing to have a relationship with funding, other available information.

- Model 3: Safety and Security and Priority Letter

Version 3: New Mobility Data - Includes freight information not available to the decision-maker.

- Model 4: Safety and Security, Priority Letter and All Traffic Buffer Index
- Model 5: Safety and Security, Priority Letter and Truck Buffer Index

Figure 18: Regression Versions and Models

The results of all the models are provided in Table 8. The B coefficient for the derivative of the log of the odds, the p-value for significance and the transformed odds ratio, exp (B), are provided. Significance is noted in the table. Additionally, tests of the model fit and predicted value classification are provided below. The Nagelkerke R Square helps understand how much variation in the dependent variable can be explained by the model. This is equivalent to the R^2 in multiple regression. This information shows whether addition or deletion of a variable improves the model. The predicted value classification measures the predicted percent correct for both the funded and not funded outcomes as a percent of the total number of observations. Though I am mainly interested in testing association, the predicted classification value is important for forecasting and provides a sense of how accurate the model might be in predicting funding results as it assesses s the effectiveness of the predicted classification against the actual classification. Improvement in the predicted classification value indicates improvement in the model at predicting the dependent variable accurately.

Table 8: Regression Results

Variable	Model 1 (Overall Score)		Model 2 (MSFP FPM Mobility)		Model 3 (Highly Related, Available Information)		Model 4 (w/All Traffic Mobility Proxy)		Model 5 (w/ Freight Mobility Proxy)	
Constant	-.916	(.27)	-.964	(.11)	-2.05	(.16)	-3.10	(.05)*	-3.059	(.06)*
	.400		.382		.129		.045		.047	
Overall Score (M)	.549	(.56)								
	1.731									
Overall Score (H)	.297	(.76)								
	1.346									
Connectivity (M)			N/A							
Connectivity (H)			-.873	(.17)						
			.42							
Quality of Service (M)			N/A							
Quality of Service (H)			1.240	(.078)*						
			3.46							
Safety and Security (M)					-.084	(.96)	-.078	(.96)	-.005	(.99)
					.92		.93		.99	
Safety and Security (H)					2.141	(.13)	2.012	(.16)	2.22	(.12)
					8.51		7.51		9.21	
Priority Letter					1.36	(.078)*	1.24	(.12)	1.28	(.11)
					3.88		3.45		3.60	
All Traffic Buffer Index							2.54	(.06)*		
							12.62			
Truck Buffer index									1.59	(.07)*
									4.92	
Classification Score	63.3		67.3		77.6		75.5		75.5	
Naglekerke R Square	0.011		0.123		0.381		0.45		0.45	

Note. B coefficient and p-value are listed in first row for the variable, exp(B) is provided in second row for each variable; *=p is significant at the .10 level.

Discussion of Results

The following details the results for each of the models.

Version 1: Plan Scores – Overall Score

FPM measures aggregated into one score does not appear to explain funding decisions for freight projects in the MSFP. Overall Score was not significant for any of the levels, high, medium, or low. Analysis of model fit determined it to be a poor model. Additionally, it did not improve on classification from the base classification analysis.

Version 2: Related/Predictor Variables – Quality of Service, Connectivity for Freight Mobility

When considering the FPM measures most aligned with mobility, only high value of Quality of Service was significant at the .10 level ($p=.078$). This indicates that for every unit increase in Quality of Service score or, in this case when a project is scored as high or 3, the odds of a project being funded is 3.46 times greater than if not scored high.

As mentioned earlier, the Quality of Service variable created some statistical challenges that did not work out when run in SPSS. The original run of this model included the dummy variables for high, medium, and low for Quality of Service. The model returned extraordinarily high odds ratio (exp(B)) values. This indicates the condition of separation and perfect prediction and is a problem when samples are low and with dichotomous variables. As noted earlier, I only used Quality of Service (high) in this regression as recommended by guidance on this condition.

Quality of Service (high) was not significant in the correlation analysis like Safety and Security (high), but it was the second highest correlated FPM measure.

Despite the statistical limitations of this model, it did improve the classification by 4 percent. It improved the explanation of variation slightly.

Version 3/New Mobility Data – Safety and Security, Priority Letter

This model included variables based on two characteristics. First, it included information that decision-makers had available to them other than freight. Second, it included variables of this information that appeared to be predictors of funding based on the previous analyses. Safety and Security was not significant, although a high score was almost at the .10 level. Alternatively, a medium score for Safety and Security had a negative coefficient. This is in line with previous findings that a high score is significantly correlated, but a medium to low score is not. Priority Letter was significant at the .10 level (p=.078). Coincidental to Model 2, the results show that for every unit increase in Priority Letter, or being included in a Priority Letter, the odds of a project as funded are 3.88 times greater than a project not included.

This model improved the predicted classification value by 10 percent and improved the explanation of variation as well. Based on the Cox & Snell R Square and the Naglekerke R Square, it appears that this model explains between 33 and 45 percent of the variation, which is an improvement over the previous models.

Version 4 – Safety and Security, Priority Letter, All Traffic Buffer Index

This model included Model 3 but added a variable to capture the all traffic mobility data in the form of the All Traffic Buffer Index not available at the time. Safety and Security (Medium) and Priority Letter are not significant. A high score for Safety and Security and Priority Letter have p-values that are near the .10 level threshold, indicating strong relationship to funding and large changes in odds. The All Traffic Buffer Index is (p=.06). This means that for every unit increase in Buffer Index (which would mean increase congestion and unreliability on the road network), the odds of a project being funded are 12.62 times greater.

There are two notable elements of this model. First, the significance of the All Traffic Buffer Time means that these mobility measures are better predictors of the funding decisions that were made than the information decision-makers had for FPM in the MSFP. This may indicate that these are more in line with their decision-making process or perspective, which appeared to prioritize congestion reduction and safety.

Version 5 – Safety and Security, Priority Letter and Truck Buffer Index

Model 5 adds the Truck Buffer Index to Model 3 to determine if the freight mobility information now available has a relationship with the funded projects. Like Model 4, the results for a high score for Safety and Security and Priority Letter demonstrate strong relationships to funding with p-values near the p<.10 level threshold. However, only Truck Buffer Index is significant (p=.07). It is almost identical to the p-value of All Traffic Buffer Index in this model.

The result means that for every one-unit increase in the Truck Buffer Index, the odds of a project as associated as funded are 4.92 times greater.

Like Model 4, there appears to be some statistical interaction when this variable is added in with Safety and Security and Priority Letter as the predicted value classification decreases slightly. It could be an effect related to sample size and collinearity. However, like Model 4, the policy takeaway is that this freight mobility measure appears important and influential. Future research could explore these variables further.

Key Conclusions

The regression shows that for the most part, there does not appear to be a strong relationship between the FPM measures from the MSFP and funding decisions. The exception is for both a high score on Safety and Security and Quality of Service, which is a measure of mobility.

When the Safety and Security and inclusion in a priority letter were included in the model, this combination had the highest predicted value and explanation of variation. This is in-line with the results of the correlation and other statistical tests. Repeatedly, Safety and Security and Priority Letter stood out as important, so it makes sense that they would create a strong model.

Additionally, not unlike the previous statistical analyses, the Buffer Index was also important in the model and more important than the MSFP FPM measures except perhaps Safety and Security. This means that the mobility measures are more related to the decisions made than the MSFP FPM scores for projects, in general.

Exploration of Regression Results

Two additional analyses help to explore the regression results further. These include an analysis of the predictions by the model and the variable Priority Letter, since it emerged as so important in the relationship of funded projects.

First, the classification tables generated when the models were run provide the opportunity to assess what the model predicted incorrectly and to investigate if the errors provide useful insight. They provided an output of projects that were predicted as unfunded when they were funded or as funded when they were actually unfunded.

The classification tables from the strongest model, Model 3, were analyzed to determine the characteristics of the projects that were predicted incorrectly. The table is provided in Appendix D. The results for projects funded but predicted unfunded and not funded but predicted funded were compared using descriptive statistics and independent sample t-tests. Seven projects in this model were classified incorrectly as unfunded when funded and four were classified as funded when unfunded.

For projects that were funded but predicted as unfunded, these projects had lower MSFP Safety and Security scores, higher scores for MSFP Coordination, a lower overall MSFP FPM score and greater population per square mile. For projects that were predicted as funded but the projects were unfunded, these projects had higher Safety and Security scores, lower scores for Environmental Stewardship and higher travel times for all traffic and freight.

These results show that for both sets of projects predicted incorrectly, scores for Safety and Security and mobility scores appear to align with the group of incorrect classification. For example, projects predicted as unfunded but actually funded had safety characteristics more like unfunded projects, but perhaps other characteristics caused the project to be selected for funding. Alternatively, for projects predicted as funded when actually unfunded, these projects aligned with the safety and mobility scores of funded projects but were not actually selected for funding. For both sets of projects, the model seemed sensitive to the scores for Safety and Security and mobility in this example.

Second, exploration into the Priority Letter variable helps to provide additional context for its relationship with project funding. Using Pearson correlations, the variables most related to Priority Letter other than funding included high AADT, a low score for Connectivity for Freight Mobility and a medium score for Quality of Service. This means that AADT, which explains areas of high traffic volumes, was highly related to Priority Letter and had a level of influence in the relationship of Priority Letter to project funding even though AADT was not significantly related to funding in the correlations. Priority Letter was statistically significantly, inversely related to some of the variables such as lower scores with safety or AADT meaning that projects not listed in priority letters had lower scores for these variables and lower AADT. Table 9 shows the significant correlations with Priority Letter.

Table 9: Significant Correlations with Priority Letter

Positive Correlation	
Funded	0.347*
CFM Low score	0.347*
Quality of Service Medium Score	0.323*
High AADT	0.301*
Inverse Correlation	
Medium AADT	-0.414**
Safety and Security Medium	-0.347*
CFM High	-0.347*
Overall Score High	-0.336*
Quality of Service Low	-0.289*
*. Correlation is significant at the 0.05 level (2-tailed).	
**. Correlation is significant at the 0.01 level (2-tailed).	

The results of exploring Priority Letter provide an indication that AADT traffic volumes may have influenced the funding result in some way through the Priority Letter variable. As mentioned earlier, AADT was surprisingly not highly correlated with funding. It was expected to be correlated due to its representation of high volume areas or highway use. The results related to the MSFP FPM scores align somewhat with findings demonstrated later on in the regression, as well as findings from the descriptive statistics and correlations that funded projects had higher Safety and Security and Quality of Service scores and lower Connectivity for Freight Mobility Scores. Perhaps projects listed in priority letters are those that have high traffic volumes in each jurisdiction. This combined with the county's formal request for project funding as captured in the Priority Letter might mean that volumes and local priorities are highly important in funding decisions.

Concluding Discussion

This research found that the MSFP FPM scores as presented were not statistically significantly related to project funding unless scores were high for safety and one of the FPM scores related to mobility. I first tested the MSFP FPM scores by analyzing Overall Score. I assumed perhaps a decision-maker might use that score since it aggregates all the MSFP FPM scores and provides a single data point on which to consider freight benefits for a project. This score was not significant in the regression, and it also had a lower relationship than other variables in the other analyses.

Then, I tested the scores for the two variables in the MSFP related to mobility, Quality of Service and Connectivity for Freight Mobility. A high score for Quality of Service was significant, but the regression model was not strong. Surprisingly, the MSFP FPM variable Connectivity for Freight Mobility, which one might assume would be a critical decision driver for funding, was not related to funding.

Considering the predictors of funding revealed from the descriptive, correlation and t-test analyzes, local jurisdiction priority letters and the FPM score for Safety and Security were tested in the model. Only inclusion in a priority letter was statistically significant, but Safety and Security was close to being significant at the .10 level. This model had a high-predicted value score along with higher explanations of variation. This was not surprising, based on the strength of their relation that appeared in every test. Safety and Security was tested alone but not listed as a model itself. It was statistically significant overall when Priority Letter is not present. It was statistically significant in the correlations and higher than Quality of Service and the Priority Letter variables.

The proxy mobility scores, however, were significant for all traffic, and freight Buffer Index in the regression and most all of the mobility measures were among the most related to funding in the other tests. Though they were significant when included with Safety and Security and Priority Letter, the predicted value of the model was slightly less than that of testing just Safety and Security and Priority Letters. The explanation of variation did not appear to change. These measures are based on newer data, but this information related more to funding and could better predict funding than the FPM scores from the plan. Another observation about the mobility measure results is that all traffic appeared to improve the odds more than freight traffic; although, both were statistically significant in the model. There may be several reasons for these results.

One explanation is that whether they used all traffic mobility data or had a keen awareness of congestion, decision-makers were able to use whatever information they did have to target congestion. Since the proxy mobility measures provide the state of the practice in accuracy for congestion analysis and since congestion does not change much over time, these measures would be expected to also illustrate congestion in the same way.

Another explanation may also be a combination of the above and that perhaps projects in the MSFP were highway projects in congested areas that MDOT had already targeted. During the MSFP development, it is possible that these projects were put forth and stakeholders agreed they were problems for freight due to congestion. Under this thinking, these were added to the plan.

A problem with this, however, is that it is unknown whether the highway segments of these projects were actually the most congested for freight. The Texas 100 work on bottlenecks in Texas has found that the freight experience on a highway may be quite different from the all traffic or passenger vehicle experience. Though congested segments of a highway for all traffic certainly would have an impact for freight movements, there may be other freight bottlenecks in the region more problematic for freight flow that should be in the plan (TTI, 2017).

The freight mobility measures could be used to assess highway segments in relation to all traffic in the future to assess which segments are worse for freight and should be in a freight plan. Decision-makers could use this information as an added lens or criterion when prioritizing projects. Then, future research of this type could be used in an evaluative way to determine if the worst freight segments were actually funded.

Overall, the mobility measures appeared to be in line with the position of decision-makers who clearly prioritized congestion. Despite some of the construct issues related to the MSFP and how projects even made it on the list, if decision-makers care that much about congestion, then improvement and advancement of FPM seems important and the more freight mobility information available to decision-makers to improve their awareness of congestion related to freight, the more it may result in freight funding. Alternatively, the all traffic congestion measures were similar and appeared in this research to produce the same results. Again, whether or not the segments in the plan are truly the worst for freight is unknown.

This research links to the elite interviews in that the interviewees discussed use of FPM to highlight bottlenecks and to show the congestion picture to leadership. This was especially true in Chicago, Atlanta, New York and New Jersey, and Kentucky. In these places, the new freight mobility measures based on probe data are being used to inform leadership on where freight bottlenecks are occurring. There have been reported successes for highway improvements based on these efforts.

However, these successes are overshadowed by the lack of multimodal mobility data. Elites listed their success with FPM, but they said they needed the full freight picture and multi-modal data to illustrate it. Similarly, this research was limited because only highway data could be obtained. It would improve on the research design if multimodal data were available and the freight projects for other modes were included.

Since inclusion in a priority letter was so significant, this may be an indication that a worthwhile activity for the freight community would be to get FPM data in the hands of local decision-makers who could then advocate for these projects and engage constituents in understanding any benefits or impacts of freight projects. This is echoed by the results of the elite interviews, where the respondents said that more granular, county-level information would be useful in order to engage local governments and that it could help them relate freight to constituents. Respondents said that any information should be in a digestible format for decision-makers and relate things like safety and congestion that concern constituents.

In terms of freight planning, the findings of this analysis raise a question about the usefulness of the MSFP. The MSFP FPM measures for congestion and safety stand out, but that is to be expected for a public agency that prioritizes such factors. The other measures do not stand out at all. The MSFP was a major agency effort, and it was costly, but the statistical dependence on it to make decisions as analyzed here is absent. It may be that the MSFP had value in other ways or helped influence projects or programs at MDOT that cannot be determined by this type of analysis. However, in looking at what decision-makers seemed to care about, given the research approach presented here, the MSFP FPM measures did not rise to the top unless they were safety and congestion related. If future planning could use the mobility data in ways that differentiate the freight projects from all traffic and demonstrate freight differently than passenger projects, the result might be different for freight plans and decision-making outcomes.

Additionally, this research did not include measures of economic benefit explicitly, such as BCA results for the project candidates or predictions of jobs created because the information did not exist. However, the elites mentioned economic development often. Having this type of information for each project might have improved on this analysis and provided more depth on what information was related to decisions.

Chapter 7: Perceptions of Usefulness of Freight Performance Measures; Are they Worthwhile?

This question seeks elite, decision-maker feedback on the initial research findings from the previous questions by asking them their perceptions of freight performance measures (FPM) effort and value. I assess this using a focus group of public sector, transportation decision-makers from the Baltimore region and their feedback to a preliminary review of research findings from the elite interviews and analysis of freight project funding completed earlier. This focus group is a form of back-talk qualitative research, which is a new method in qualitative design where subjects and other stakeholders weigh in on findings of initial research questions. The key findings is the existence of perceived usefulness in measuring and understanding freight. This helps to validate findings, but it also helps to reduce researcher bias.

Introduction and Background

In a recent study for the National Cooperative Highway Research Program (NCHRP), researchers developed a Freight Research Roadmap and took a similar approach to the methodology I used in Chapter 5 for elite interviews (Zmud, Morgan, Eisele, Geiselbrecht, Kruse, Rutter, Simek, Villa, Ivanov, Goodchild, McCormack, & Atherton, 2019). They employed the use of elite or subject matter interviews but then they used a series of focus group workshops to elicit feedback from stakeholders on the findings of the interviews and literature in developing a roadmap for freight research. This allowed researchers to validate what they heard from elite interviews.

I use this same research approach of a feedback loop in this chapter, a feedback loop to contemplate the topic of the usefulness and perceived value or benefit of using freight measurement and the level of effort. The hypothesis tested is if there is usefulness in using freight performance measurement for urban policy.

I developed the construct of usefulness of freight measures that I evaluate in this question based on work related to attempts to derive the value of information. In other words, I was interested to determine a value of measuring freight performance.

The original concept for this analysis was to quantify a value of information, capture the benefit of FPM. There are some emerging formal techniques for quantifying value. For example, Obersteiner, Rydzak, Fritz, and McCallum (2012) tested the use of earth observation data and improvements in information technology and data infrastructures. They assessed data in a model to determine outcomes of a set of scenarios related to changes in sustainability. They set a baseline and then modeled several scenarios in order to assess the differences between baseline conditions and the model outputs. They found they could quantify the delta between baseline and scenarios and were able to then quantify the economic value of investing in and using the earth observation data (Obersteiner et al. 2012).

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After considering this type of approach and reviewing literature in this area, data and methods to apply the methodology similarly presented challenges. Instead, I applied a qualitative approach from perceived values of the information instead. I term this as perceptions of usefulness.

I explored some of the decision analysis tools like decision trees to attempt to visualize this concept of value of information. A decision tree provides a visual and computational method for risk and expected value. They provide a mechanism for visualizing payoffs, probabilities and decision alternatives such that the expected value of decisions can be compared and chosen based on the analysis and visual (Treeplan, 2018). I adapted the decision-tree approach to illustrate the hypothesis. In doing so, it is less a decision-tree and more a flow of information, but I use Figure 19 to describe the information flow and the question of if added freight information is useful or adds value to decision-making.

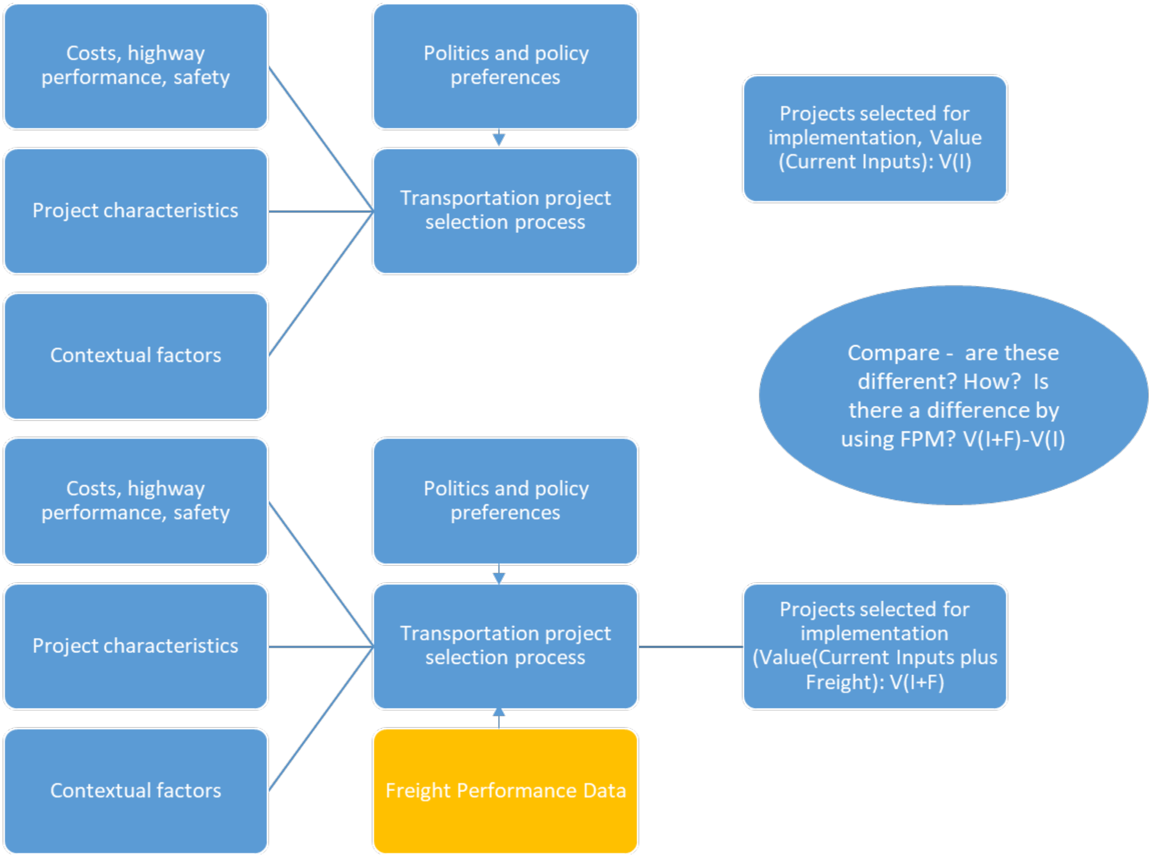

Figure 19: Concept of Decision Making and Value of Information

The left column depicts current transportation decision-making and the information inputs that go into the policy and investment decisions. This model assumes a value or benefit of the chosen policies and investments. The right column is similar except the inputs include the added information that FPM provides.

I hypothesized that by adding FPM to the mix for decision-making, there would be a net positive value that is greater than the original value.

Methodology Approach

The approach I used for this question is a focus group based on the approach for the Freight Research Roadmap feedback loop in NCHRP 20-114. I searched for other similar studies that used a feedback loop, and I learned that in qualitative research, this format is a new concept termed back-talk.

The use of focus groups in social research over the past few decades supports three basic types of research: self-contained, supplementary and multimethod research (Morgan, 1997). First, focus groups are used as a *self-contained* method where they serve as the principle source of data. When this is the case, it requires researchers to carefully match research goals with the data they want to get from focus groups. Research design is particularly important for this type. Second, focus groups support research in a *supplementary* way where studies rely on some other source of data, but the focus group work helps to back up or provide insight into the information. Third, focus groups can be used in *multimethod* studies where two or more means of gathering data are used and there is *no primary method determining the use of others* (Morgan, 1997).

One of the advantages of using a focus group approach is that it "provides the opportunity to observe a large amount of interaction on a topic in a limited period of time based on the researcher's ability to assemble and direct the focus group sessions" (Morgan, 1997, p. 8). These group conversations can provide direct evidence from participants on opinions and ideas as opposed to reaching these conclusions through survey instruments or some other type of research. Additionally, focus groups bring a level of depth that researchers might not achieve in an individual interview or other means. The group discussion may help encourage ideas or thoughts and expanded conversation on a topic that an individual might not offer up in a one no-on-one conversation (Morgan, 1997).

There are disadvantages as well. A focus group is less natural than an individual observation. Issues of group composition such as the amount of participants and whether participants know each other or the subject matter may affect the results. There may be issues related to the researcher and researcher bias, as well as researcher abilities to conduct the group. Additionally, the data that is gathered is limited to self-report or verbal behaviors, thought and ideas germane to the participants. Again, group dynamics and subject matter can have an effect on the responses. They could be robust, eye opening and present new lenses of a topic or participants could temper their response given other participants (Morgan, 1997).

There is much research on focus groups in qualitative research, but the use of them specifically for feedback on the research findings and results is not prevalent. In a thorough search, I did not find studies that presented findings back to stakeholders for feedback, especially in an applied context that I could use in my work. I finally found a group of social science researchers who are employing this concept in work related to migrants and violence against women (Hall-Sanchez, 2016; Frisina, 2006). They call it back-talk qualitative methods. Frisina (2006, p.1) describe it as making stakeholders who participated in the research an "integral part of the knowledge-generation process." She further describes this approach as allowing subjects to participate in the researcher's interpretations of the findings, which can take place in the form of a follow up focus group or back-talk with participants.

Hall-Sanchez (2016, p. 278) notes that back-talk focus groups are emerging as a "promising technique" and tool in qualitative analysis to develop new data. She describes that back-talk discussions consists of the research reviewing findings with subjects or other stakeholders related to the subject, which develops even more data in the form of the additional feedback.

The back-talk concept in qualitative research appears so new that I only found research work from both Frisina and Hall-Sanchez available, and it is limited to studies of groups who have been marginalized or experienced violence, abuse and other hardships. These groups are quite a stretch from the public-sector policy actors I am interested in for my work. However, the concept of presenting findings and have them weigh in on my interpretations is similar to the back-talk approach. Additionally, Frisina (2006, p. 2) remarks that the back-talk approach helps to challenge "dominant interpretive frameworks." This means that by allowing the subjects to provide feedback to interpretation of research findings from initial questions, the subjects can help improve or adjust the researcher's point of view and reduce bias based on the lens through which the research interpreted the results. For my work, this is helpful because I do have experience in this subject area both as a researcher and practitioner, and it may shape the way I interpret results. A feedback loop in the form of a back-talk focus group may provide a way to help reduce bias that I present in my work.

Process

For this question, I interviewed a group of three transportation decision-makers and planners in the Baltimore urban area to discuss the preliminary results of the elite interviews and the analysis of funded freight projects. I initially planned to consult the Baltimore Regional Transportation Board (BRTB) Freight Movement Task Force, which is a group of public and private stakeholders including the MPO staff focused on freight in the Baltimore region. However, as of December 2018, I learned that this group is meeting less frequently and is not meeting in time for me to finish this research. Instead, I decided to assemble this smaller focus group of members of the BRTB Freight Movement Task Force and was able to three participants, two of whom participated in the elite interviews and an additional senior, urban planner who was actually influential in deciding state-level funding during the time ten-year time period of the freight projects in my analysis. These individuals are influential in funding priorities for the Baltimore Washington urban area in conjunction with Baltimore City and MDOT. These individuals had seniority in that they were around for the 2009 Freight Plan and are still present in the decision-making process almost a decade later. Though I received permission to report their names, I felt that I had a responsibility to use pseudonyms because of the nature of some participants' comments and my observations that I thought needed a level of anonymity. I use Participant I, Participant II, and Participant III as the pseudonyms.

There were several limitations to this approach important to mention. First, the sample size was small. A bigger group would improve on this research. For focus groups, a concern for bias is the insider nature of these individuals. However, I did use the backtalk focus group approach that relies on participants who were subjects in another phase of the research. In this case, these individuals could speak to the results, especially for the Baltimore projects in the regression with the type of insight that could provide explanations of the findings.

I demonstrated preliminary research findings for the elite interviews and characteristics of funded freight plan projects as demonstrated by the descriptive statistics and correlations in the regression analysis. For the elite interviews, I described how urban areas reported using measures for policy and information as reported by the interviewees. I did not report my critical analysis of this information to them. For the characteristics of funded projects, I showed them the preliminary findings or relationships from the correlations and regression. To keep the presentation simple, I did not get into the mathematics such as the levels of significance.

Prior to the focus group, I followed a similar planning process as I did for the elite interviews where I prepared the construct and the questions. For this question, the construct I explore is usefulness of freight performance measures in urban policy. The purpose of choosing this construct is to understand the applied relevance for the practitioner of freight measures and to obtain feedback on policy significance and ideas for future research.

Similar to the elite interviews, I designed an unstructured approach in order to allow for flexibility in my approach and for the stakeholders to make interpretations. I did set a list of questions in order to best guide the discussion (Patton & Sawicki, 1993; Beamer, 2002). I chose open-ended questions that I designed to flow from initial reactions to more specific ideas on the usefulness or not of FPM. I first started with their general thoughts and feedback to the preliminary findings I presented. Then, I asked about what they did or did not agree with and what they thought about the specific research questions and their results. Then I moved to their thoughts on the effort of FPM and its usefulness, what value they perceived.

My questions included:

- Given the findings of the interviews, what thoughts or feedback do you have?
- What do you agree with from the interviews? Any disagreements or different points of view? If so, please describe.
- What does the funding information mean to you? What do you think about the results?
- What thoughts do you have about the results related to the influence of performance measures on investment decisions in the urban area?
- From what you see, what are your thoughts on the effort of engaging in freight performance measurement or its usefulness? Is the value to you in this information?
- Would more specific information on freight performance and performance trends be useful? If so, what?
- Would it help to facilitate informed decisions? If yes, how?
- Could it help advance essential projects? If yes, how?
- What kinds of information would be most useful?
- What are the risks of <u>not</u> having good freight performance information?

I did record my interview and was able to review it to write up results. I also took detailed notes. In an attempt to validate my notes and observations, I would summarize their comments and ask them if I understood correctly. I found that though I had a guiding set of questions, the discussion went in the same direction as my questions without me having to prod too much. I did have to bring the discussion back to the topic of usefulness at one point during the interview as the focus group participants were interested in the data and started to explore that on their own.

I then wrote up the results of the focus group within several hours of the event. In order to improve validity of my work, I employed a non-freight expert colleague to review my notes and results section for anything that appeared missed or poorly interpreted. I chose a non-freight expert in order to reduce any bias that they may have in interpreting the notes and reviewing the results. Her review found no significant errors, omissions or misinterpretations.

Results

Participant I said that the findings from the elite interviews were valid. In particular, he said that the concepts related to champions to driver policy changes or programs was "spot on." The others appeared to agree.

Participant I said that the concept of a freight champion driving activity is true. He recalled Mr. Jamie Kendrick, who was Deputy Director of the Baltimore City Department of Transportation (BCDOT). Several years ago when Kendrick was in this position and part of the BRTB Board and BRTB Freight Movement Task Force, he was a driver of using freight information. Participant 1 said that Kendrick was frequently calling for more freight information. He was particularly interested to understand how trucks were moving in the city, the issues with the port and other aspect of goods movement in the city.

Participant I mentioned that at the time when Kendrick was a freight champion, MDOT had just completed the 2009 State Freight Plan and there were numerous activities underway for freight analysis. He said that during this time, BRTB had a number of freight studies and programs that stemmed from the 2009 Maryland Statewide Freight Plan (SFP). One such project was similar to the Freight Rail Inventory Opportunities Program mentioned by Participant I in the elite interviews where BRTB, with MDOT's assistance, catalogued rail-served properties in the Baltimore region and assessed condition in order to have an accurate inventory that could help in both project development and economic development efforts. In addition, Participant I described building a strong Freight Movement Task Force and engaged private sector leadership to participate and designate strategies for freight projects. Participant II mentioned that during this time, they used freight performance information to score projects, although they no longer do that. This seemed to go away when there was not a champion. Participant 1 described that as Kendrick left and policy actors at BRTB, Baltimore City and MDOT changed, the focus on freight started to change and it became more challenging to maintain the focus.

Resources and Analytics

Participants I and II further agreed with the time and effort that I report in the elite interviews and said that indeed it takes many resources and analytics to assess freight performance. Participant I reiterated that there is some freight data sharing between the urban area planners and the state, which is helpful for them. In general, however, accessing freight data and analyzing it is a challenge. He further mentioned that they really have only limited data and do not have the commodity or value data that helps to tell the story in detail or help local officials connect to freight movement. If they could have more of it easily and cheaply, they would like to use it.

Participant III weighed in that for urban areas, especially MPOs, local elected officials drive priorities based on what is important to them. He mentioned the struggles to inform them and to develop plans and programs that focus on need and not their interests if the two are not the same.

In relation to the other activities presented from other urban areas, they did respond that they have seen some of the concepts and materials that these places have generated. Later on after the focus group, Participant II sent me a copy of an e-mail he forwarded to MPO leadership about the Seattle delivery analyses and common carrier lockers. He had suggested that they consider this as an activity for the BRTB Freight Movement Task Force. I sensed that they felt that because freight interest was less than before, they may be lacking in comparison to others.

Participant III felt that the elite interview findings on needing to translate FPM into terms locals understand was most important. He said it seems "absolutely critical" to know the value of freight and to figure out how to tell the story and make it relevant for the local elected officials to understand freight and the impact of it to their local economy and to their voters. Further, he said that the locals do not have anything to help them know the value of freight information.

Participant III further noted that there seemed to be a gap of understanding what information is missed when using all traffic information versus freight specific information, noting that the all traffic and freight information was similar. He indicated that it is difficult to know what value the freight information brings if they are telling similar stories as all traffic data. If FPM can illustrate something different that they can use, and they can easily access and analyze FPM data to do that, it would be useful for them in decision-making.

The findings here, especially related to Participant III's ideas on local relation are consistent with views expressed by Schofer (2014) who lectured on the issues of relating freight project information value to decision-makers and stakeholders. Schofer said that there is a need for "a new value proposition to make the case for disruptive transportation investments"

(Schofer, 2014). No longer can transportation agencies describe transportation projects in terms of asset condition or general terms. It is important now to relate the benefits and the costs, as well as mitigation expectations to stakeholders. For example, he said that the "value proposition for freight projects should include information that helps communities understand the importance of the movement of freight to the nation, their own region, and perhaps to themselves. It is important to remember that communities and individuals want to know what is in the agreement for them. It will be easier to make the case if some aspect of freight performance improvement has been planned for return to the community – better service, job opportunities, or safer operations" (Schofer, 2014, p.9). In other words, the FPM information would help to make freight relatable directly to local leaders and their constituents instead of being abstract.

Statistical Analysis Feedback

Related to the freight plan funding analysis, Participant III remarked that he did not think that the Freight Plan was used in decision-making. He indicated a reliance on other information and priorities and that he was "really surprised" that the County Priority Letters had such relationship to funded projects. From his perspective, he said he did not realize that those letters would have a relationship. He remarked that the locals tended to ask for things like transit or non-highway projects that were less likely to be funded. He did not realize that they were including highway projects and the extent, especially for freight, that they were funded. It is possible that this result is because of interviewer bias where the participant did not want to disagree with the results.

All participants said that they were not surprised at the prominence of funded projects with high scores for safety and congestion. Safety and congestion rule the focus on projects and policies, but they felt that more freight data, especially telling the freight story for local governments, could help change perspectives and add something to their level of understanding when setting project priorities for the region.

Topology

Another observation is that there is no one size fits all way to accommodate freight in an urban region. All urban regions are different and have different needs. We discussed the freight centric areas like New York and New Jersey or Chicago and contrasted it with other places. Even though Baltimore has a significant freight presence, it just does not have what some of these regions have, so they could see how these other locations might have more success in pushing freight issues and policy change. In Baltimore, despite the presence of an international port and airport, their urban/local priorities were more like Washington, D.C. or Seattle where the focus is on freight problem mitigation and residential, or passenger freight balance.

Level of Effort and Availability

For data and level of effort, the participants described wanting freight data but challenges in getting it and analyzing it so that it could be used in analysis and project prioritization. Participants I and II described a good relationship among state and local planners in the region for data sharing on freight and vehicle probes generally used in freight congestion analysis, as well as the Strategic Highway Research Partnership 2 (SHRP2) C20 Freight Model developed by state and MPO planners. However, they said that they have competing priorities and need cheaper and easier access that they can understand well enough to use in analysis.

The participants remarked that the best way to help urban regions get more freight data is, again, not one size fits all and that there is value in having shared resources. Shared resources seemed to allow them access to more data and tools than if any one jurisdiction had to purchase access to resources alone. It would be helpful for them to have tools or resources similar to the RITIS tool I used in evaluating freight plan characteristics that they could tap into without a lot of effort in order to pull freight information. Additionally, it seemed best if the tool could not only provide data but put it into context that they could easily use when talking to the public or elected officials.

In wrapping up, Participant III mentioned, “local governments need more information on how freight relates to them. Developing data that ties freight to local impacts and spells out impact on jobs, businesses, and other elements is necessary to help them.”

Discussion

This focus group research revealed general support and agreement with findings from the elite interviews and funding analysis. This is important as the purpose of the focus group was to determine if the findings seemed valid and logical.

Participants validated elite interviewer comments agreeing that FPM are useful and wanting more data and ways to assess freight in the region. They reiterated ideas for developing

FPM in ways that showed a more complete picture of freight movement such as multi-modal or local level.

However, they also expressed difficulties in decision-making and competing priorities that influence investment decisions that matched with the strength of the regression model finding of safety, congestion, and local priorities a mostly influential. They described that safety and reducing congestion are primary motives in decisions they make.

Participants also noted that while the elite interviews described how FPM provided a new lens that decision-makers could not see before, in analysis like the regression, it is sometimes difficult to see that freight information is any different. They suggested that more research is needed to determine the difference between what all traffic and freight information shows in order to determine the value. Then, it needed to get into the hands of local leaders in ways they understand similar to the elite interview responses.

The concept of champions also resonated with them clearly. They spent significant time talking about the years when they had a freight champion and the success of freight activities during that time as compared to after this champion left the region.

In terms of if FPM is worthwhile, the participants indicated that it is but to a degree. They agreed it should be pursued and more information needs to get into the hands of urban area decision-makers. However, they did react to the costs and challenges they have seen in obtaining FPM. They agreed with elite interviews that it could give them information they otherwise would not have and that it may be valuable. As mentioned in the elite interview for Baltimore, urban decision-makers have invested in tools and resources to attempt to analyze and model freight, but their support for these activities was greatest when they had local elected official champions that cared. The concluding statement was that if the FPM data could be obtained cheaply and easily and if it could be visualized to tell a story that resonates with their leadership, then they would use it.

Chapter 8: Conclusion of Research

I found mixed results but general support for the alternative hypothesis that FPM is useful and worth the effort. For example, expert elites are using FPM but in limited ways due to the lack of multimodal data. They are affecting urban policy with FPM, and they overwhelmingly support development of FPM for multimodal, origin and destination, as well as local jurisdictional (county or municipality) data and measures so that they can do more.

The results were less straightforward and, perhaps, inconclusive, in the analysis of funding decisions. For example, I analyzed the relationship between funded projects and their scores for FPM as included in the 2009 Maryland Statewide Freight Plan (MSFP). I found a positive yet weak relationship for funding success based on the FPM mobility scores in the plan. However, when I used a proxy for mobility performance by analyzing newer probe data from actual vehicle movements for all traffic and freight[8], I found that projects in locations of the worst mobility (congestion) received funding. The relationship was stronger for the proxy measures that described all traffic congestion than freight, but both were statistically significant in relationship to project funding. Therefore, there appears support for the hypothesis at least for FPM mobility measures as useful; although, there appeared greater reliance or use of all traffic mobility measures or information.

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[8] Based on the National Performance Management Research Data Set (NPMRDS).

In this case, the proxy mobility measures of today, especially all traffic, were more related to funding decisions made over the past 10 years than the FPM mobility data used in the plan in 2009, which was based on a much less sophisticated awareness of mobility or possibly nothing but anecdotal understanding of congested areas. The findings for this analysis showed that decision-makers cared about safety, mobility and also the local government or county-level priorities. This analysis does not provide evidence of if the measures are worthwhile, but the importance of mobility information indicates that developing better freight mobility data and measures that align with the goals (safety and congestion reduction) of transportation agencies would be both useful and value added. For freight measures, perhaps continued use and robust availability would show a closer result to all traffic if this analysis occurred in future years after decision-makers had the opportunity to incorporate freight data into their plans and policies.

A challenge with the analysis of funding lies in the bias of the MSFP. The MSFP was developed by compiling projects to address known freight problems. A range of stakeholders contributed to the project list. Although FPM scores in the MSFP were used to provide an assessment of freight benefit, the projects included were not developed from a rigorous analysis of criteria including mobility or safety. The results show that it is highly possible that the Maryland Department of Transportation (MDOT) stacked the MSFP with highway projects that were known areas of congestion. If so, they would naturally correlate with mobility measure results for high areas of congestion for all traffic. What is unknown is whether these segments were truly the worst bottlenecks for freight movement or just all traffic, and for example, were the worst bottlenecks for freight included in the plan and funded?

While mobility in the form of the proxy appeared highly related to funding, it may have been because the projects were known problem areas. The results would be more meaningful if there could be some verification that the all traffic highway segments highest for congestion were also those that were highest for freight. Future research could explore the use of mobility data to determine the differences between all traffic and freight bottlenecks and then if the worst freight bottlenecks received funding.

The focus group of transportation decision-makers validated results and expressed support for FPM based on the preliminary results discussed with them and described FPM as worthwhile. However, they qualified that stance with the requirement that data must be inexpensive and easy to obtain and analyze.

They all agreed that more FPM measures would improve their policymaking activities. They described some of the challenges they have in balancing priorities and that the lack of FPM information impedes their ability to incorporate freight into their decisions. They echoed many of the comments provided by the elites especially about getting more data and granular, local level data. Further, they agreed with comments that FPM needed to be expressed in clearer ways and made relevant to issues like jobs and businesses that local leaders can digest and use with their constituency.

The focus group decision-makers also targeted differences they noticed between all traffic and freight mobility information similarly as I observed in the work on funding decisions. They were interested to explore that further and to get granular, origin and destination data as part of the discussion on funding decisions as well. For them, like the elites, they felt that better data access, ease of analysis through use of tools and resources that could digest and illustrate FPM data in simple ways and methods for communication would help them to incorporate freight more into urban policy, especially as it competes with all other priorities like safety, transit, bicycle and pedestrian issues.

These findings, as summarized above, contribute to the field of knowledge as they are an initial demonstration of how FPMs influence policy in the form of usefulness and whether they were perceived as worthwhile. This research provided a foray into capturing the direct policy outcomes from FPM, as well as the application of statistical tools to dissect funding decisions. This information, though incremental, helps to address the gap in research and advance understanding of the relationship of using performance measures, in this case for freight, and the direct policy impacts for urban areas.

The following specific findings provide more detail on usefulness and value, as well as ideas for future research.

Policy Influences

Expert elites discussed the use of FPMs for nine different types of activities ranging from federal compliance and awareness to safety analysis, but there were three key ways that use of measures directly affected policy.

1) To develop plans that identified specific policy actions and strategies that would then be implemented.
2) To develop funding prioritization and implement freight projects.

3) To solve urban problems with legislative changes or changes to regulations.

In urban areas such as the New York/Newark area, Texas, and Atlanta, FPM mobility measures helped define specific policy actions that were then implemented. These actions included the designation of funding or a new program and effort. The measures were used initially to determine the performance of freight and then to identify the types of strategies or policy actions that could benefit freight in the region.

FPM mobility measures helped to determine funding through their use for project prioritization in areas including Washington, D.C., Houston, New York/Newark, Chicago, and for urban regions in Kentucky. These regions used FPM to justify prioritization of spending and implement specific freight projects that FPM identified as beneficial.

For some areas, namely Seattle and Washington D.C., FPM analysis helped identify ways to solve specific problems that then led to policy changes through legislation or regulatory changes. In these urban areas, constituents and elected officials were solving for urban problems such as urban parking or land use conflicts. FPM measures for parking and specific urban issues use helped to illustrate the problem and identify solutions that were then codified.

Several FPM measurement activities led to indirect policy effects. I distinguished the use of measures from the three key policy areas in accordance with what elite interview experts specified as having a direct relationship on policy. Not all uses of measures were linked directly to urban policy when they were described. How it aided them or the specific policy influence was less clear in some cases. For example, Baltimore's use of FPM in analyzing economic development projects may have led to specific policy decisions to spend public funds on a particular project or design new transportation infrastructure. The relationship was not direct, but FPM appears to have influenced the outcome.

Freight Intensive Areas

There seemed to be a relationship between areas of major freight activity such as around New York, Chicago, and Atlanta with the influence on policy. This made sense since these areas have nationally and globally significant freight infrastructure and industries. In some cases, Atlanta for example, they were solving problems related to increased freight activity in addition to trying to improve economic development. In other cases like in Chicago and New York New Jersey, they had a history of using FPMs and urban freight policy development, and they considered themselves freight-centric.

Freight Champions

Self-promotion and champions also had a relationship with urban policy impacts. I found those who were strong self-promoters of their freight analyses seemed to have the most success in influencing policy. All of the experts I interviewed talked about champions in addition to what they did to promote their findings. Many spoke of people who got it or the raised eyebrows of politicians and constituents. Engaging these people seemed to help increase the focus of freight in funding or policy programs.

Mobility and Safety Measures

Mobility and safety measures appear in this research as the most used and important to public decision-makers. The elite interviewees all used mobility measures, in part because they have to for federal mandates but also because the measures told them how well freight moved and where bottlenecks occur. The funding decisions based on the MSFP showed that safety and mobility were important to funding decisions. This is not surprising since public agency goals tend to always include safety and mobility for transportation.

Public Sector Perception of FPM Value

The elite interviewees and the focus group decision-makers all commented on wanting more mobility measures and needing to know more about how well freight moves. This comes in conflict with the issues related to proprietary data and lack of multimodal data available for public decision-makers. Even with the challenges in measuring freight, I heard words such as invaluable or critical, much needed, and worth the effort when describing FPM, especially for mobility measures. Specifically, these specialists desired more information about the origins and destinations of freight, multi-modal data to show performance of freight trips across different modes such as a port to factory trip from ship to rail to truck, and the importance of local, last-mile links and transfers that are harder to measure.

FPM and Local Governments

Both the interviews and focus group feedback pointed to FPM as valuable for local governments at county and municipality levels. Experts reported benefits in using FPM to engage local governments, even to develop funding programs and priorities targeted at locals. In the feedback obtained during the focus group, I heard that freight information could help local elected officials and planners to support more freight projects if they understood the need. The result of funding being related to local jurisdictional priorities means that the jurisdictions had a high level of influence. It appears that if freight interests want to affect policy, engaging local governments (counties and cities) in ways local leaders can relate may best facilitate support for the desired freight policy.

FPM Communication

Though it appears that FPM is valuable and important to local government stakeholders in urban regions, most of the interview information or feedback I received was that FPM cannot just be measures and numbers. It must be turned into a story to explain why local elected officials should care. With so many competing priorities, the FPM information would be best translated to economic impacts and jobs or local dollars and what the jurisdiction should expect in terms of return on investment or revenues.

Future Research

Future research would help expand the discipline of transportation and urban policy. First, exploring a broader range of urban areas and experts might be eye opening to new and emerging ways in which they are using FPMs or even advancing new freight data and measurement to solve urban problems. Several of the interviewees mentioned the emergence of connected and automated vehicle data and the technological advancements occurring that might yield data in ways they have not had before. Future research could explore where FPM is in the midst of these developments and its usefulness in advanced, big data decision-making.

Second, future research might repeat this analysis or replicate it after several years have passed and the use of both all traffic and freight mobility measures based on vehicle probe data is ubiquitous. Currently, the use of freight mobility measures is newer than all traffic, and the results showed all traffic as more influential than freight mobility; although, both were statistically significant in the regression model. As decision-makers use freight mobility data and adhere to federal requirements to do so, future research should reassess the relationship and analyze usefulness.

Third, related to this is research that monetizes value and captures a benefit in the form of dollars or some economic output to describe the impact of FPM on policy. A research goal for this dissertation was initially to develop a model for capturing value, which proved too challenging due to data and methods. This research, especially the case studies, was needed first to understand and categorize how policy and FPM relate. The results helped identify the types of specific policy decisions that future research could target to assess fiscally. Future research would help advance some of the concepts and ideas in research on the value of information discussed in Chapter 7 with the focus group. It could examine ways to quantify value monetarily or in other economic terms such as jobs sustained or businesses supported, as well as reduced congestion costs, lives saved and even reduced greenhouse gases due to mobility efficiency. More development of value in quantitative ways might help improve advancement of this type of research as the dollar values are compelling for policy-makers and the private sector.

Fourth, another expansion would be to assess funding in relation to multi-modal data. For example with the MSFP, it would greatly improve the analysis to assess other modes such as marine, rail and air cargo. The multi-modal data do not exist, but if even a sample or some experiment with estimates were available, the funding analysis might open up so much more about the decision-making or the value of having multi-modal mobility data. Marine/ship movement data conveys that it is apparently growing in availability and could potentially be the next step in examining marine mobility and port project funding.

Fifth, an intriguing area is the behavioral/decision-making role in what drives policy (action or funding). This research used statistical analysis to dissect funding decisions based on examples from other researchers who have explored decision-making for other topics. This type of analysis could further explore relationships of data and performance information with behavioral (social and political) relationships of decision-makers. With a multi-faceted diverse group of stakeholders, like the freight community, this might help identify values and goals and how to target FPM information.

Sixth, future research resulting from the regression work would be to use FPM to differentiate all traffic and freight bottlenecks. Current research already shows that the freight experience is different than all traffic for roadway bottlenecks. The next logical step here might be to assess the difference in value or economic benefit that would be achieved if a transportation agency made decisions using the freight lens of bottlenecks. For example, a transportation agency may currently use all traffic mobility information to prioritize investments. If they used freight bottlenecks, would they achieve greater economic benefit for the region? Would they reduce delay and costs associated with delay and is that of more benefit to the economy and citizens than commuter delay? How can we optimize decisions for the transportation network?

Finally, the research findings point toward county level, multi-modal data that depicts origins and destinations and tells the public more about freight performance. This research continues to advance incrementally, but getting access to this data was a common refrain in my research. Future research should continue to advance this and aim toward a multi-modal, granular picture of freight performance that can be expressed meaningfully to decision-makers, especially at local levels. This is the information decision-makers wanted most and that might help inform local leaders who emerged as highly influential in this work.

Policy Significance

The impression I have from this research for policy significance is that while the transportation community has spent time trying to convince the private sector to give up multi-modal data, perhaps a better use of time and resources, for now, is to focus on local jurisdictions. Entities like FHWA and states have been spending resources to emulate Canada's approach. But, since multi-modal data and the ability to look at corridor, multi-modal performance does not exist here in the U.S. other than for highways, and perhaps limited marine information, it seems time to turn attention to urban areas and local governments.

Local government relationships and issues emerged as a key theme in all three of the analyses of this research. The elite interviews all described working with local elected officials of county and city decision-makers and how important it was to get information that described how freight impacted these smaller geographies. Additionally, the current highway information could do that, but more time and resources would need to be spent crafting the data for these smaller areas.

Local government leaders were also the ones who were the champions that the elites and focus group touted as the catalysts – the people who grasped on to something FPM revealed to them and then urban policy was influenced.

Local priority letters surprising emerged as important in funding decisions when other variables such as traffic volumes or the overall score in a freight plan were not as important. If local priorities are so strong in this example, it may be important to tailor information for locals to understand freight and its relevance to their region in order to improve on the information they have to make decisions.

Additionally, local leaders who champion freight may be better emissaries to industry through economic development relationships in order to encourage data-sharing for a multi-modal picture of freight flows. Freight discussions often revolve around the multi-state, cross-jurisdictional nature of freight flows. Perhaps it is time to look at the opposite level, the local, last-mile level for analytics and relationships with industry.

Another area of significance worth noting is in working to illustrate the ways freight relates or impacts key priorities of safety and congestion. The findings of this work showed a strong connection between decision-making and key transportation agency goals of safety and congestion management. This supports continued development of FPM for mobility because they are most relevant to the goals and values of decision-makers along with safety. The example of Baltimore funding decisions exhibited that funded projects were those with high safety and mobility benefits, as well as those that were local jurisdictional priorities. Though this is based on just one example of an urban area, the results are expected. Many DOTs and MPOs prioritize these things, especially as these are priorities of the constituents they serve.

A way to do this would be to improve analyses and visualization of how different the freight experience is versus all traffic. The regression work in this research indicated that the all traffic and freight information told similar stories, but other research claims the experience is different – that FPM shows that freight experience different bottlenecks than all traffic or in addition to all traffic that are important. This may be important in policy development since the two experiences may not be the same and may have different levels of impact such as cost of congestion or benefit in terms of sustained jobs or businesses if an investment is made.

Looking Forward at FPM

The challenging diagnostic is this, how can FPMs be more influential? What needs to happen to develop them further and improve on their usefulness?

First, this research points to a need to develop and deliver good, objective measures for transportation projects. This requires the development of data and analytical tools for FPM that help to demonstrate the potential benefit and current condition for freight. These should help contrast the freight experience with the all traffic experience and aim to be multi-modal and show freight from a system perspective.

At the same time, FPM measures need to be expressed so that local jurisdictions relate. Higher level, interstate highway measures are obtainable, but the needs observed as part of this research show that translating and relating information at the local, county or city level is important. Using FPM to translate freight impacts in economic terms like business impacts and jobs or even environmental terms and impacts on air quality can help improve local jurisdictional awareness of freight. This may help freight to be prioritized in plans and the development of policy based on transportation awareness of people and goods movement on equal footing.

Appendix A – Case Studies

Case Descriptions

The following section summarizes each interview. Unless otherwise noted by a citation, the quotes are direct from the participants interviewed.

New York/New Jersey Metropolitan Area

I interviewed two individuals representing this region. Participant I is an established freight expert having been a consultant for many years active in distribution and supply chain logistics and economic development. Participant II is newer to the MPO but came with experience in truck parking issues for New York City.

I learned from these participants that there are numerous ways in which the North Jersey Transportation Planning Authority (NJTPA), New Jersey Department of Transportation (NJDOT) and local governments use freight performance information. First, both states are active in required federal freight planning and performance measurement for MAP-21 and the FAST Act. The urban region participates in this as the states are required to coordinate with the MPO on both planning and freight performance measures. The state freight plans are multi-modal in nature and focus on a myriad of modal activities within the states including the ports and railroads. The New York metro area is not only huge in terms of population, but the level of infrastructure and freight activity is among the highest in the nation. Much of the area's infrastructure is nationally significant.

Participant I said that the state freight plans do not address urban issues, measures and policies in detail. Most of the measures are interstate-based or at the level where the state has most authority. The key measures in these plans include measures of highway reliability, mobility, and safety. The plans do include identification of urban corridors, which is a federal FAST Act requirement. Mobility and safety measures are key measures included in the plans. Of the safety measures, much of these include crash data for trucks, truck crashes with non-motorized and other vehicles.

In addition to coordination with state freight plans, they described that the MPO is working with stakeholders to establish "regional performance measures that will help planners and decision-makers in Northern New Jersey create more effective transportation plans and programs." The regional measures will include required MAP-21 performance measures and a collection of standardized performance measures, targets, and reporting for northern New Jersey's transportation system. The performance measure areas will include safety, asset condition, transit, freight, system performance, congestion, air pollutant emissions, and others. An important element of this work is not just to measure performance, but also to "tell the story." In other words, it is to express to the public and private sector how well the system is serving the region, which can help lead to "appropriate" choices for the system.

NJTPA is active in using performance information to educate a range of stakeholders. They are particularly active in pushing information about freight facilities to stakeholders. For example, they operate a Freight Activity Locator that "provides access to key freight data developed and gathered by the NJTPA" and presents maps of the region's freight network and major facilities (NJTPA, 2018b, para. 2). Organized by tabs, the locator provides not only maps and locations, but also demographic data and commodity data. The locator does not include performance metrics at this time, but it is a means of pushing information to a broad range of stakeholders whether to help businesses make site location decisions or public decision-makers have an awareness of freight facilities they otherwise would not have had.

NJTPA is particularly concerned with types of measures that resonate with the private sector. These include measures of travel time reliability. Participant I said that consistent travel time is a key consideration in selecting locations and the customer experience. It affects route planning, air quality, and really resonates with industry. She remarked that the National Cooperative Highway Research Program (NCHRP) research validates that predictable travel time is most important to the private sector. Travel time did not need to be the shortest but had to be the most predictable so that the private sector could ensure on-time delivery and a positive customer experience. Because the private sector cares about these measures, NJTPA uses these measures in its planning work and for studying freight issues throughout the region. Though Participant I and Participant II said they could not attribute a specific business decision to locate or invest in the area because of these measures or this information, they were aware that the private sector reported its importance in addition to having access or the accessibility of multi-modal facilities to move goods.

The MPO, particularly Participant I, is involved in the Council for Port Performance. According to her, the use of port performance measures has helped implement programs or policies at the Port Authority of New York New Jersey that improve reliability. She further remarked that big shippers bring goods through the Port to transport to Ohio because there is greater predictability for travel time and capacity than going through West Coast ports and being trucked or put on rail to reach middle-American markets.

The NJTPA Freight Initiatives Committee uses much of this information to recommend policies and project advancement for the region, as well as collaboration with state and local governments like New York City or the City of Newark. The Committee is comprised of executive leadership from the region such as Mayor Ras Baraka of Newark. Given the prominence of the region in worldwide goods movement, this committee's reach is influential and both Participant I and Participant II report that between influence, location and constant marketing and communication of the performance measures, they have been successful in influencing policy.

In the New York Newark metropolitan region, efforts to advance freight measurement and information have helped influence the development of new policies and programs, mostly through decisions to focus funding on freight and develop freight improvement programs for the region. For example, in August of 2018, NJDOT announced the first grants in a new Local Freight Impact Fund program. This program included $30.1 million for cities to improve truck traffic flow. Though the program is a state-driven program, it targets urban areas as a competitive program to help "enhance the safe movement of large truck traffic, renew aging structures that carry large truck traffic, promote economic development, and support new transportation opportunities." The program requires demonstration of need and benefit using performance measures such as traffic volumes, percentage of large truck traffic, crash frequency, connectivity to freight nodes and others (NJDOT, 2018, para. 3).

Additionally, Participant I described MPO efforts where measures helped influence the development of a Pilot Freight Concept Development Program (NJTPA, 2019). This program is ongoing to help establish a process to advance both metropolitan region and local freight initiatives identified by the MPO in studies using performance metrics. Currently, two freight projects are in a study phase under this program, and the hope is that this will help improve the rate of freight projects reaching completion.

Another policy initiative that freight measures helped to create is the NJTPA Freight Rail Industrial Opportunity (FRIO) Corridors Program. This program "establishes a framework for identifying and addressing locations in the NJTPA region that preclude access for national standard rail freight cars." It helped "foster the collaboration among public and private entities to address barriers to freight access to industrial properties" (NJTPA, 2018c, para. 1). Participant I said that measuring freight and asset condition revealed a need to create databases on freight rail infrastructure to track investment needs. In a similar effort, NJTPA created an Inventory and Assessment of Waterborne Transportation Resources that created an inventory of available sites for marine transportation with the goal of identifying opportunity locations for further investment by public and private sector developers. Participant I remarked that for the urban area, older infrastructure is an issue, but NJTPA's work to inventory physical impediments and measure asset condition, as well as marrying that up with economic issues associated with these impediments is important to making the infrastructure usable and marketable again or business.

Along with the inventories and measurement of assets, another initiative is to understand key commodities in the region and engage in business or economic development and sustainment. Participant I found it important to focus on business resilience and understand from an infrastructure perspective what "is secure, what needs to get back online."

Participant I and her partners at NJTPA have been successful in measuring freight and building several high profile freight programs such as those reported here. When asked about how she influenced NJDOT to develop a freight funding program for municipalities, what the catalyst was, she reported that it was about demonstrating strong analytics and educating stakeholders. She explained how the development of the State Freight Plan was important and helped drive a list of freight priorities. Performance measures helped identify the priorities. From there, the programs developed to address these needs like the Freight Fund.

In addition to the sound analytics and performance information to tell the story, it was an uphill battle with all types of stakeholders to advocate what the MPO was seeing for freight the economic connection and business development side, the port connection and much time spent with constituents, executives, leadership and many others. This included many stakeholder visits to freight facilities and "building an understanding" that she hoped would improve decision-making and policy.

Engaging the private sector was particularly important. Participant I noted that sometimes it was not specific mathematical performance measures but anecdotal information and private sector relationships propelling freight. After many years of effort, the MPO considers entities like railroads and the Port Authority partners. She reports that this relationship helped when the Port Authority needed help improving performance and capability. The partnerships helped to implement the activities needed to "turn the ship" for the Port Authority so that they could improve and accommodate larger, Post Panamax ships and be the first to sign a local labor agreement. Participant I said, "People are pretty happy. Rail percent is up due to all the work done on rail. Collaboration and understanding across the modes, recognition and public value, it starts coming together."

Despite the success Participant I reported, some challenges need focus. She described how data and analytics are expensive and there needs to be less expensive ways of talking about freight. In her opinion, there might be opportunity in crowdsourcing and the emergence of new, big data to understand the freight story. Some major issues to continue to address involve truck parking policies and solutions in the urban region. This includes understanding truck parking utilization data and hot spots for parking.

Her final thought when asked about the importance of all this: "Advocating and understanding freight and economic development is critical. Just try and make it happen."

Atlanta Regional Commission

Participant III is an expert active in Atlanta Metropolitan region freight activities. He has been involved in the Atlanta Regional Commission (ARC), which is the MPO for the Atlanta area.

At ARC, Participant III said that it was not so much performance information but the activity of planning and bringing stakeholders together that led to some of the policies and programs developed for transportation in the region. In 2008, ARC developed the first regional freight plan to consider goods movement challenges in the region. This was at a time when freight was starting to be included in federal policy such as in Surface Transportation Law and areas like Atlanta became the focus of federal efforts to measure freight on key corridors or freight routes (FHWA). The idea to do a freight plan was born from recommendations of a task force, the Atlanta Regional Freight Task Force, to develop a data-driven, policy-based Regional Freight Mobility Plan for the Atlanta Metropolitan area. The Georgia Department of Transportation (GDOT), ARC and identified stakeholders created a partnership. All felt that the plan was essential to improve freight in the region.

The plan did include measures of freight performance and quantified freight activity in the region. It also recommended numerous policies, investment priorities and needs in the region to make improvements (Atlanta Regional Commission, 2008). More than information, Participant III described the plan as being a collaborative, engaging process with stakeholders, which was the catalyst for the ARC to focus on freight.

Participant III explained that the ARC is responsible for development of county and regional plans for transportation investment. Due to the 2008 work, they decided to incorporate freight requirements and a set aside for freight project funding. The idea was that if they had a set aside funding for freight projects, they would get more projects in the plans and more applicable projects would be implemented.

However, when they made a call for projects from the local governments to incorporate in the plans, they did not get applications for freight projects. When they investigated, the takeaway was two-fold. First, they found that despite the plan, local governments did not know what qualified as a freight project. They mainly received roadway projects and commuter-based transit type projects. Second, local government elected officials responded that freight did not vote – only residents vote and they did not know what projects to put forth for freight. Elected officials wanted to keep voters happy who had other priorities that were not freight-based.

Since that occurred, the ARC continued promoting freight information and aspects of the freight plan by focusing on the county level plans, but in 2016, they decided they needed to update the 2008 Freight Plan. One of the findings from the new plan effort was that truck parking was a major problem for the Atlanta urban region. They decided to study it further.

A truck parking study then commenced that Participant III managed. Since it was ARC, the ARC Air Quality Committee and Policy Committee, made up of elected officials, was briefed routinely. Participant III said that at first, information on truck parking was poorly received, but then after hearing him speak about freight repeatedly, the elected officials started to make connections and ask questions. Participant III said, "The first time I got up and gave a presentation on truck parking, most of [the elected officials] were on their phones and not paying attention. But, midway through, they would give feedback and questions, so it caught their attention and began the conversation."

One of Participant III's findings from this experience is that "as we present this information, it may not be straight from a performance measure but the takeaways hit home."

After multiple presentations and relating the statistics or the measures to the elected officials' concerns, they were finally able to hone in the need for freight policy and funding as it relates to them.

Participant III said that they made connections about what they were hearing at a state-level about economic development, the Port of Savannah and major industries in the Atlanta region. Additionally, there is major economic growth occurring in Atlanta and throughout the state. So, for these elected officials, they were hearing about what is happening in their jurisdictions. They were hearing the benefit of the tax revenue, but they were also hearing from voters about the land use conflicts and too many trucks. Part of the MPO Freight Plan update in 2016 had to do with truck parking and illegally parked trucks, so as this information was presented, it caught the attention of decision-makers. Leadership started hearing about freight from multiple venues and it helped drive interest in freight.

Participant III said that an effective way to get this information through to decision-makers was that performance information needed to be presented in terms of "takeaways" or in how it affects them. He said that "…sometimes [planners] get in the weeds of data, but when it comes to funding elected officials, they need to hear the 'so what' or the takeaways…The planners need details and data, but it must be translated into what it means."

As the interest grew and the information continued to be presented, the ideas started to emerge. They knew the big projects in the region, but a concern had been capturing what needs to happen for freight at the local government level and what types of projects were needed such as turning radii for trucks. ARC saw a need for improved dialogues with local planners and to do detailed traffic studies that linked freight projects to jobs, accessibility to jobs and businesses, as well as to address land use conflicts. This grew into a need for local freight plans.

From this, ARC then received permission to create a new program, the Freight Cluster Plans. In promoting the idea among their leadership/elected officials and local governments, they received full support to develop $1 million program. This program ended up sponsoring four local projects at $250,000 per project to focus on local freight issues related to industrial areas for the first time in 2018.

Participant III remarked that heavy industrial presence helps drive interest in freight, but there are also citizen issues and challenges with freight and residential land use conflicts. It may be through these conflicts where interest in understanding freight grows rather than being an advocate for freight and its benefit to the economy. Many local issues occur when industry is growing. An already congested region has to accommodate both residential and freight land uses along with related activity. From his perspective, elected officials were hearing from Participant III about the 2016 Freight Plan update and the truck parking challenges, connecting that to citizen complaints about trucks and freight movement, and it resonated.

One other point Participant III made was that champions help. Participant III described a well-known consultant, Mr. Joe Bryan, who works for WSP, Inc. Bryan is known for his freight expertise and is a consultant to many states and the FHWA on freight issues. Participant III described him as having "a lot of personality when he presents" meaning he was like an evangelist for freight with these elected officials. He knew what to say to them and how, which had a lot to do with them paying attention and taking an interest, which in turn, helped them make connects and get excited about freight issues.

Washington, D.C./Houston, Texas/Denver, Colorado Perspectives

Participant IV held leadership positions in several major U.S. cities and was able to discuss freight in Washington, D.C. District Department of Transportation (DDOT) and Houston's MPO. He provided perspective on all three places, but his focus was mainly on D.C. with some attention paid to Houston. He did not mention anything about Denver, which is likely because his position in Denver is too new and not exclusive to freight.

Participant IV described his first experience with DDOT, coming in and seeing that the City leadership was about to make major decisions that affected freight movement, but with no data to inform decisions. He described his background and perspective as being one who tries to operate from a stance of having information and data to lead to decision-making. When he first started at DDOT and realized that there was not an understanding of freight information but decisions were needed, he embarked on an effort to get DDOT to use data to help tell the story. He felt it was important for leadership to understand what was moving on the D.C. transportation network and the value of it.

Participant IV was behind the first District Freight Plan. With this plan, they measured things like tonnage moving in, out and through the District, the types of commodities and the value of goods. This helped set a baseline along with recommendations to move forward for policy action.

The plan first included micro-level policy recommendations for the D.C. urban area. Such recommendations included curbside management and delivery parking, as deliveries were cited as a major challenge within D.C. From there, they set up a curbside management program all based on freight delivery. This included analyzing deliveries of all types and vehicles, the time for occupying space and any other issues related to this need.

The curbside analysis ended up being the baseline for a D.C.-centric model for delivery and curbside management and helped to make recommendations on several loading and length zones. Using data and performance measures, this program identified criteria for how to assess data for curbside demand, which can help with land use, transportation and development planning. In addition to curbside management, Participant IV saw success in advancing truck route and signage programs, as well as changing dialogues on truck oversize and overweight fees.

Participant IV remarked that Houston was much different that D.C. In Houston, freight is much more instrumental to the economy. He said that approximately 16 percent of the Gross Domestic Product is associated with the port and all types of commodities move through the Houston region.

In Houston, they used freight information to prioritize projects. In other words, information was tied directly to the way the MPO and decision-makers identified projects and even changed the way they prioritized projects. The MPO added an additional freight category to specify freight projects, and specific sponsor information was required before investment decisions could be made.

Participant IV described the catalyst for how he worked to integrate freight both in D.C. and in Houston into the planning and project prioritization processes. He remarked that for D.C., internally, it was a change. He spent time communicating why there was a need for analyzing and collecting freight data. He saw that others were trying to make decisions and change policy. For example, any truck oversize and overweight issue, without using any freight information. He recalled asking if others looked at industry trends or impact and their answers were no. He said that it was not that they were resistant but that they thought differently. From his experience, this would be the thing to consider so you can understand what makes sense to not disrupt the industry but create enough revenue to support the infrastructure.

From there, he believes the use of data and performance analysis helped to change perceptions and to show that the freight information his office could provide could improve decisions. The D.C. Mayor’s office started to better understand the need to integrate freight into their discussion and to discuss the benefits of having a transportation system to accommodate freight. His experience is that freight performance information helps to articulate information into more palatable proposals and justify certain decisions. He also felt that the information helped take away some of the negative anecdotal aspects of the public and facilitate a more informed dialogue with citizens about the transportation system as a whole. Moreover, by doing this, it made for better citizen and government interaction and development of policies and investments.

Participant IV believes that there is a consistent need to understand freight, regardless of mode. He said (and my favorite quote of all), " [I] never understood why we can't get our act together and get more accurate information as it relates to freight trips." Analyzing freight performance takes a lot of burden and time, but "I think it is worth it. Our roadways and streets do three things (people, goods and elements)." He said freight is a critical element and the time and energy for analyzing freight is "invaluable."

Seattle Metro Area

Participant V is currently an academic consultant, a recent transition, but has held state-level executive positions in the State of Washington. She is currently representing the City of Seattle on freight issues.

When asked about the use of performance measures and effects on policy, Participant V described current work with Seattle Department of Transportation on two projects that influenced policy. Seattle DOT was interested in learning about deliveries and related issues. The first project was to map all of the locations of the private sector loading bays and docks in the center city area including all alleys and curbs. They wanted to measure whether or not urban towers, buildings, relied solely on public space to accommodate deliveries. They wanted to know if the buildings were self-sustaining or took up valuable curb space or street space to accommodate deliveries, which may be driving congestion and parking challenges in the urban area.

This first project found that 87 percent of urban buildings were not self-sustaining and relied 100 percent on the surrounding public curb space and alley. For Seattle, she described this as very eye opening and the measure of curb use was something the city could incorporate over time to see trends in public space usage. Another issue identified was the percentage of freight vehicles at the curb that were parked illegally. Participant V said that it indicated a system that was out of control. She said that while there are bad actors, half of all freight vehicles are not stopping in an authorized space, so you then know the system is not designed for their use. The system is overloaded and overwhelmed, and the situation is much worse in retail centers than adjacent office buildings, which makes sense because you have multiple deliveries going on at retail than office towers. Participant V noted, "This was an important fact to help the city understand that you can't enforce your way out of this problem. It is a design problem." This is an important realization for considering what policies to put in place.

The direct policy change from this analysis was that the city changed building code and now requires new development to be self-sufficient. This means that any new building requires that delivery bays or non-public space be made to accommodate deliveries. In light of this policy change, the city started sending developers to the Supply Chain and Transportation Logistics Program and the University of Washington to understand what this means and to learn ways to comply.

A second project was to analyze five types of buildings (retail, tower, office, etc.) and develop process flow maps that were timed for every delivery activity in the building. The purpose was to figure out the delivery time and where in the delivery process the most delay was occurring. The intent was to find ways to improve delivery times at buildings, which would reduce the time a delivery vehicle was blocking public curbside space or streets.

What they found was that from the time the truck stopped to the time left, they could use detailed process flow charts to identify area of delay. The biggest delay was in going floor to floor, finding tenants for signature, and finding the right address. This took up about 67 percent of the time. Twelve percent was spent passing through and then exiting through security. Participant V said that they believe eliminating the floor-to-floor deliveries would help. A promising solution is common carrier lockers located on one floor. This is an operational solution and not yet a policy change, but she described it as the type of way in which measuring freight could be used to change policies. Like the first example, new laws might require use of lockers or other methods or new policies could incentivize downtown businesses and residents or retail to use common carrier delivery nodes.

This type of analysis has not only led to code changes but also the city's creation of a new budget item for a goods trip reduction program. I could not find this program spelled out in the Seattle budget, but it is referenced in their new mobility plan (City of Seattle, 2018). This program includes a suite of for developers to use or for building managers such as creating incentives for tenant businesses or residents to use lockers or alternative delivery options that help reduce delivery problems.

When asked about the catalyst as well as how she, and others, have been successful in getting the City of Seattle to enact policy change from the research and performance information, she provided an interesting perspective as a former DOT employee. When she was Director of Freight for WSDOT, she had several bureaucratic layers to go through if she wanted to talk to elected officials. Messages about freight or urban needs could not always be expressed to decision-makers (although she has had quite a lot of success in her past role). However, in her current position at the University, she has much more freedom to interact with elected officials and feels she can call them up and ask to brief them on "cool projects." It seems she has been successful with this approach. Participant V remarked that she has been briefing council members on the University's work and they are catching on. A particular council member "got it." She has latched on to the information and became a champion for enacting policy change.

One reason for this is that constituents are "having a fit" due to the developer of a "very large retail group that is furious that they have to share an alley with another giant development." They call this council member on a regular basis, so this official is quite motivated by constituent complaints over tapped out curb space in the downtown area.

In addition, the Mayor's office is very interested in innovation and environmentally friendly aspects of the city. So freight is getting attention at the highest levels through work with UPS and their E-bike delivery vehicle pilot. This aligns very well with constituent and policy goals.

Participant V said that if she could measure or understand more about freight, it would be about loading and unloading for deliveries and not as much about through lane traffic or mobility. The focus in Seattle is more on the lack of capacity for deliveries and parking to accommodate urban buildings and less so about mobility. In addition, she would like to track parking seeking behavior and understand a way to know how long drivers search for spaces to park before they find one. She commented that the urban landscape had the biggest lack of data. Analysts use a lot of factoring or data synthesis and she finds that if she wants data, she or students are often out there creating it themselves.

Chicago Metropolitan Region

Participant VI represented the Chicago Metropolitan region. Participant VI is responsible for freight analysis and has previously served in positions as an economic development planner for the North Central Wisconsin Regional Planning Commission and as a Parking Analyst with the City of Madison.

Participant VI described two ways that performance measures are used from his perspective. He said that first, they provide an understanding of the importance of an issue. Therefore, for example, delay at highway grade crossings can be expressed through use of performance measures, which has shown that in Chicago, this amounts to a very concentrated issue at a small number of crossings, but it affects the region. The measures help to understand the issue, what and where it is, and how it affects people's lives in the region relative to all the other issues that affect traffic.

Participant VI said that the other way is to actually rank projects. He said that this can be done using a variety of measures with different weights to determine individual investment priorities. For Chicago, this has been a broadly applied method for many years in the transportation program. What is new for freight is that for the first time, they have data for freight that is now comparable to the type of data they had for passenger vehicles for a long time. Participant VI described the ways that they are able to use the new truck freight data to measure performance like mobility and congestion instead of just using truck volumes to rank projects.

Participant VI described that the freight performance measures can be used to call attention to a problem and draw investment that way. For example, the American Transportation Research Institute's bottleneck analysis identified the nation's number one bottleneck as being in Chicago. The Governor was unhappy with this result, and the "calling out" of the bottleneck helped to get it funded. It also helped to improve the type of treatment that was selected. Initially and on its own, the location was ripe for investment because it had a deficient bridge in poor condition, but understanding the bottleneck through the freight performance information changed the type of investment. Ultimately, they made a $500 million investment that they believe will improve congestion significantly when it is completed.

Another way in which performance information has helped spur investment is that because MPO planners had performance information, they were able to identify a location that had been missed in an engineering study of the system. Engineering work was being completed for a particular section of roadway, but because the engineering study did not analyze it for freight bottlenecks, this type of treatment would not have resolved the issue. Planners had performance information and could identify the bottleneck, so they were able to recommend treatment that would improve the problems appropriately. “Showing them actual data from ATRI truck probes helped show how things got bottled up in the location.”

Asked about the level of effort or value in getting data and doing performance analysis, Participant VI said that data helps put projects on equal footing. This is important for the Chicago area to help prioritize projects. Participant VI reacted positively to the value for data saying that there was an initial level of effort and expenditure to get truck probe data. However, once the data started coming online and it was analyzed and made relatable to constituents, “they lapped it up.” However, the effort to get a point of having data, analyzing it and putting it in terms people could understand (telling the story) was tremendous.

Participant VI said that people in Chicago grew up thinking of Chicago as the freight handler to the nation, so people understood that freight is important in Chicago. Getting data was assumed to be a worthwhile and beneficial activity even though it required a high level of effort. Participant VI also remarked that stakeholders reacted to congestion data and bottleneck data more favorably. He said that the level of effort to work with the data is often weeks or months. Then, you “find out things that are just impossible to know.” Given the level of effort, “It has made a big splash. We used it to solve problems that would otherwise be left addressed.”

<u>Baltimore Washington Metropolitan Region</u>

For this interview, I spoke representatives of the Baltimore metropolitan region. Participant VII opened by saying that it has been helpful that more people are thinking about performance measures to inform policy and investment. He said that state-level performance analysis and perspectives drove much of what he saw, even concerning the urban region. He is hoping that there may be a point when we get comfortable with freight performance measures so that it trickles into the MPO planning process. Participant VIII further stated that he felt like there needs to be a better information flow between states and MPO regions on performance data and performance analysis. He implied that it would be beneficial for the state to work with MPOs and locals to collect, analyze, and share data/information to help planning have more synergy.

Participant VIII remarked that there is real opportunity in data sharing and performance analysis because they are a part of federal MAP-21 and FAST Act requirements. He said that together, the MPOs and the state could "look at if there are freight projects that really make a difference" from a regional perspective, and "we can start to develop plans and programs that start to develop some projects that make a difference." He said that joint efforts could identify the best projects from the analysis for these urban corridors and then put them into the Transportation Improvement Plan that MPOs develop and submit to states, jointly work together to find funding and then implement. He referenced Chicago as a model where one of their internal performance measures is the actual implementation of projects .

Participant VIII described how they use data and performance analysis to do analyses that are typical of an MPO, such as traffic impact analyses or modeling. In one instance they were asked to do modeling and analysis in support of a major redevelopment for the former Bethlehem Steel property in Baltimore, Maryland into a mixed-use industrial property to breathe new industrial life into the urban area. The MPO uses data to develop a level of service analysis as a performance measure. For the Tradepoint project, they were able to analyze the impact and conclude that there was adequate capacity. This helped determine for both the public and private sector stakeholders that this was a viable project and the Port of Baltimore area could support it.

In addition to traffic analysis, the MPO also uses data and performance measures for workforce and economic development analysis. Recently, Harford County, Maryland requested the MPO analyze accessibility to transit for workers at major freight facilities/distribution centers in the region. Though the angle of this was more about transit options, the concept is whether a workforce exists and the commuting means exist to support such major freight industry development.

In light of a lack of data and tools, Participant VIII mentioned that they continue to base much of the decision-making on volume of trucks in relation to activity centers. They have not been able to capture commodity flows or other freight movement, freight fluidity information to then prioritize routes for freight flows in the TIP.

Participant VIII described the BRTB's recent partnership with Maryland Department of Transportation (MDOT) and the FHWA on the Strategic Highway Research Program 2 (SHRP2) Freight Demand Modeling and Data Improvement Challenge (FHWA, 2018c). BRTB and MDOT were awarded funds to develop a truck model (FHWA, 2018d). This model has been in development for a number of years and both BRTB and MDOT have been hoping that it would help with project selection. Participant VIII said that they have made strides, but even so, the model is not accurate. He explained that with traditional transportation modeling, the emphasis has typically been on mobility and minimizing congestion, but he believes it is important to get more sophisticated with freight and look at issues such as mobility, accessibility, and last mile issues.

Participant VII saw the need for freight performance measurement as being more for the state with a mega-regional freight movement perspective and then more last mile, traffic impacts and connections or accessibility needed by MPOs and locals. Where others I interviewed took a more “I’ll take it all” approach, Participant VII presented an argument for the roles of the state versus the roles of the urban area and which entity needs which data and how the two work together.

Participant VIII mentioned that the MPO has struggled to engage the economic developers in the local area. Indeed, as I analyze this, I have learned that the MPOs efforts to have a Freight Task Force of public and private sector economic and freight interest has slowed down. Participant VIII mentioned that they look at measures in a different light. Participant VII followed that some MPOs go beyond what the federal requirements for MPOs are and do more for freight analysis, but BRTB is much more aligned with what is federally required.

Louisville, Kentucky/Texas MPOs

I interviewed a freight expert representing Kentucky and Texas. Participant IX serves as a freight and MPO coordinator for TxDOT. He was a Senior Planner for Freight in the Kentucky Transportation Cabinet (KYTC), working with major freight projects in smaller yet significant urban places like Louisville.

Immediately upon asking about how measures influence policy, Participant IX recalled the KYTC program that he helped implement for the scoring of transportation projects using performance measures to specify investments and policy. Even though the process is at the state level, it deeply affected investments for freight and in urban areas.

Participant IX said that this program, the Strategic Highway Investment Formula for Tomorrow (SHIFT), had an interesting origin as a program implemented to control the Kentucky legislature. The Kentucky legislature approves what roadway projects are funded each year. KYTC submits the list of proposed projects and legislators choose which projects to fund. This process was perceived by many of the state employees at KYTC as bogging down the process with political investments.

Participant IX said that there came a champion, John Moore, Director of Planning at the State Highway Engineering (SHE) office. When he became Director of Planning, he developed a project scoring system based on performance named SHIFT. It is a robust scoring system with data, mobility information, performance measures for all vehicle and freight, criteria, and a scoring system. The Governor supported this scoring system, as he also shared concerns on project priorities and funding.

On the KYTC website, the SHIFT Program description cites Governor Matt Bevin as the catalyst who directed the Kentucky Transportation Cabinet (KYTC) to create a better process for funding transportation projects (KYTC, 2018). SHIFT works by starting with a list of projects developed by state and local transportation leaders such as MPOs and KYTC district offices. To move forward, local transportation leaders must sponsor a project or the project must currently be funded. Each Area Development District (ADD), MPO and KTYC District has a number of sponsorships based on population, lane miles and number of counties served. Then, leaders make decisions as to which projects to advance.

A project that advances through the initial stage is reviewed and scored. Each project is scored on a scale of 0 to 100 with a formula that uses objective performance measures for five key attributes: safety, congestion, asset management, economic growth and benefit/cost. Freight is part of the scoring and is accounted for in the categories (KYTC, 2018). High scoring projects advance to a list that is further refined by regional priorities by the ADDs, MPOs and KYTC. These projects are then captured in the recommended State Highway Plan. The legislators of Kentucky refine the plan based on additional information and funding availability. The product is the Enacted State Highway Plan including two years of funded projects and spending priorities for the next four years (KYTC, 2018).

Not only did they want better investments, they also wanted a policy change – an increase in the gas tax. SHIFT was used as political leverage to change policies related to the gas tax. For years, Participant IX said, the gas tax had not been touched, and the state needed funding to improve infrastructure. Participant IX noted that it became a situation where the transportation cabinet pushed the legislators into a position where based on the data provided by the KYTC, their decisions not to raise the gas tax would be so negative and potentially affect jobs, as exposed by the scoring system of the projects. It helped to expose legislators on the gas tax issue.

Though a gas tax has not been passed, the following is a recent news article from last year's legislative session as published in the local news site, WRDR.com (WDRB.com, 2018). It effectively illustrates the dialogue among policymakers:

> Representative John Sims said that "the idea came from a transportation work group appointed last year by former House Speaker Jeff Hoover. Sims said a gas tax increase is overdue to address the $1 billion backlog in unfunded resurfacing needs and more than1,000 bridges in need of repair. "The legislature, in the past, hasn't acted as far as taking that hard vote to make things right for the state," Sims said. Kentucky's gas tax is tied to the price at the pump. As it goes down, so does the tax. Right now, by law, the tax cannot go below 26 cents a gallon. Some supporters of HB 609 said that is not enough to fuel Kentucky's future infrastructure needs. "We have a perfect storm coming in about two years, said Sen. Ernie Harris (R-Prospect), who chairs the Senate Transportation Committee. Harris said expenses, such as pension costs, are rising. Also, the federal toll credit the state has enjoyed is about to expire. That means Kentucky's contribution to federal road projects will increase. According to Harris, it will all add up to a very bumpy ride. "There will be no money for state road projects to speak of."

When asked about how the legislator received the scoring system, Participant IX remarked that there was a squeeze. The KYTC was pressing up and the Governor pressing down to make legislators follow suit.

Though this is an example of using performance information to influence policy, and it includes heavy influence from urban areas in Kentucky through the MPO and district influence built into the process, the scoring system is limited in its treatment of freight. Participant IX said that the only freight component in the scoring was whether it was on the freight network that was identified and what the truck volumes were. Participant IX said that it was truly a small portion of the score. This is likely due to limited measures and data for freight.

Participant IX said that KYTC did purchase freight data, but it was expensive for them. He compared it to Texas where there is more funding available to the DOT and significant funding for freight data and analytics. KYTC had a basic level of data but did not pay for extra freight data. They mainly relied on free data such as the Freight Analysis Framework.

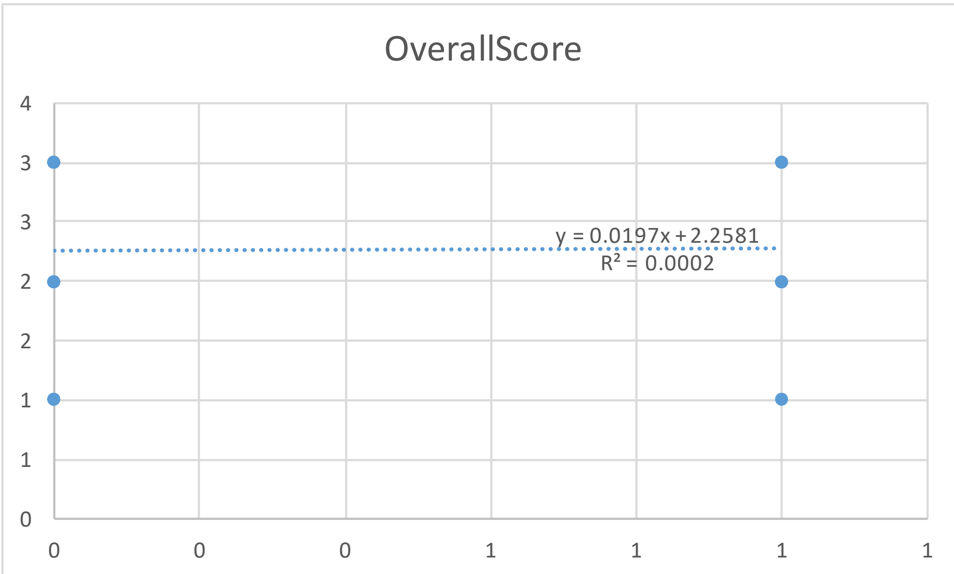
Participant IX said that from his Texas experience and even the KYTC use of measures and scoring, the effort to measure freight is worth it. Participant IX spoke mostly about the robust KYTC scoring system and mentioned that Texas prioritizes freight projects and use measures for freight and other aspects of the transportation system in its policy development and project identification. Participant IX remarked that because of the focus on freight in Texas, even CAV type projects that get a lot of attention these days are a step behind freight projects, which, because of the focus on freight analytics, helps projects succeed.

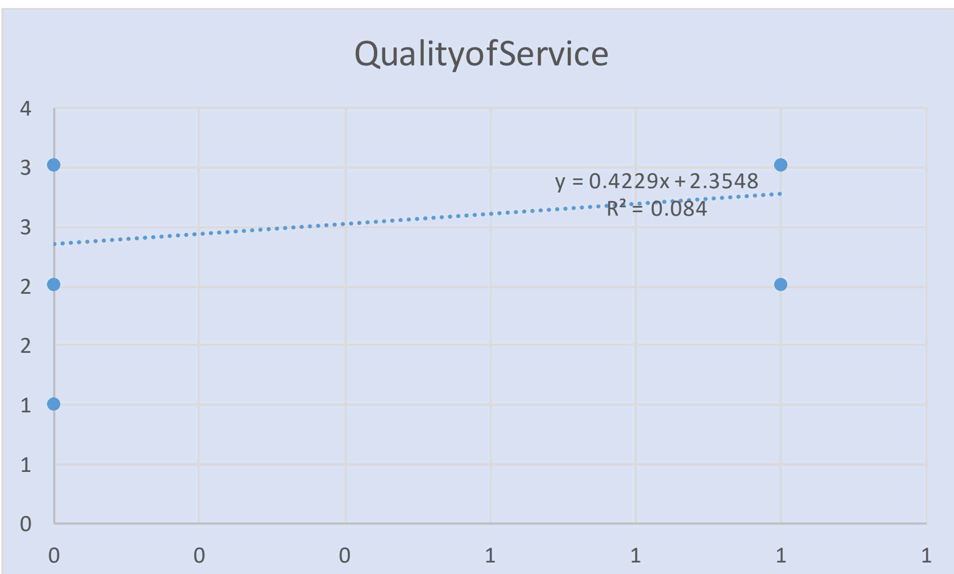
Though Participant IX spent most of the interview discussing KYTC, he did describe his work with metropolitan areas in Texas and the Texas Freight Fluidity program to advance multimodal measurement of freight (Katsikides, et al., 2018). The program will help to improve data and analytics for freight project selection and policy or strategy development. In Texas, they have a robust, yearly program to identify highway bottlenecks for all traffic (Texas 100) and freight (Texas 50). They have also completed numerous freight fluidity analyses to understand the best ways to use multimodal performance data married with supply chain and market analyses to identify bottlenecks and how those bottlenecks impact supply chains and broader economy (Katsikides, et al., 2018) (TTI, 2017) (TXDOT, 2017).

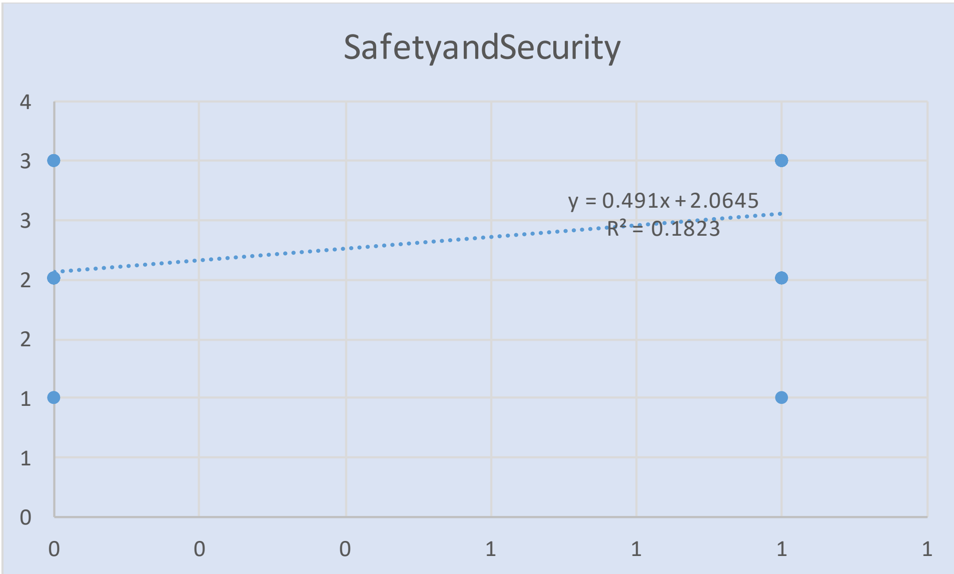
The focus of fluidity analysis is to first develop a concept or framework of what to measure and what is important (Katsikides, et al., 2018). In Texas, they used stakeholder discussions to understand what was important to know such as tonnage and value in an urban area, port-related performance, commodities in the region and more. Then, they conducted a market analysis. The aim of this analysis was to get a baseline sense of the economy, jobs, and economic opportunities in the region. They then ran performance measures and assessed the urban area for where it fell on the Texas 100 all traffic bottlenecks list and Texas 50, which is the freight only list of bottlenecks. Finally, they ran performance measures for the highways in the region and assessed them in relation to known bottlenecks and economic information. Assessing this information with economic information helped them identify investment opportunities and use that information to help prioritize funding (Katsikides, et al., 2018).

Appendix B – Scatterplots

The following are select scatterplots for this research.



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0
1
1
1
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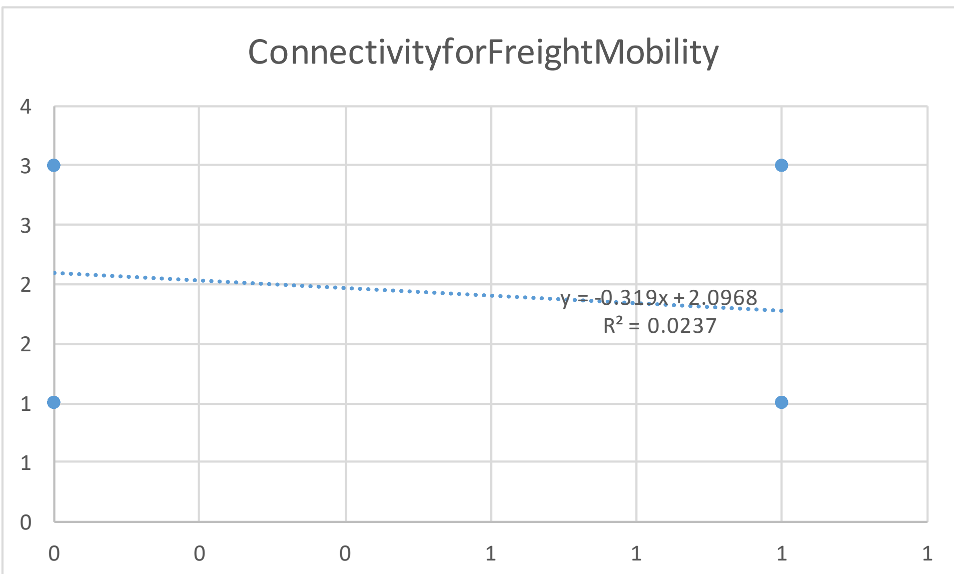
R² = 0.1823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1
1
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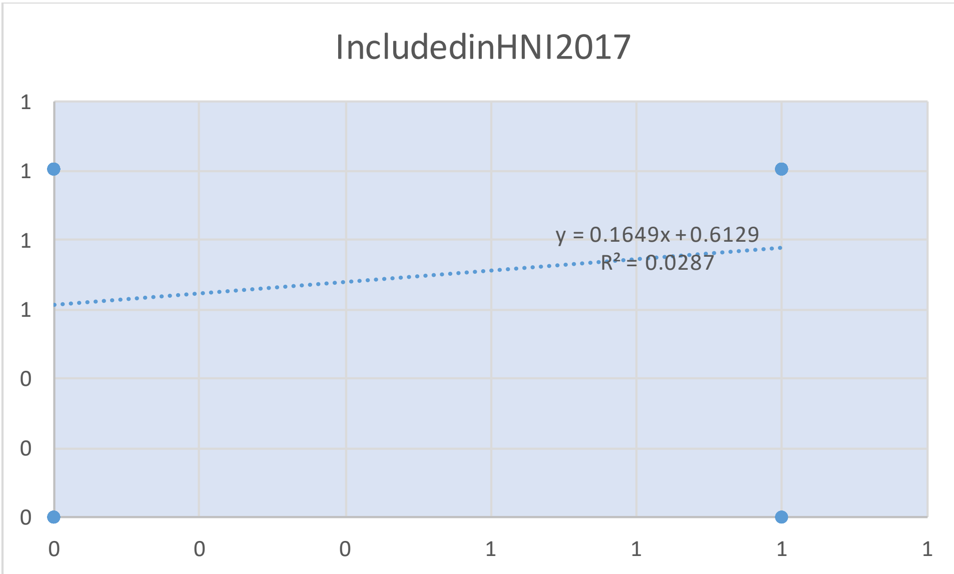
R² = 0.0237


IncludedinHNI2017
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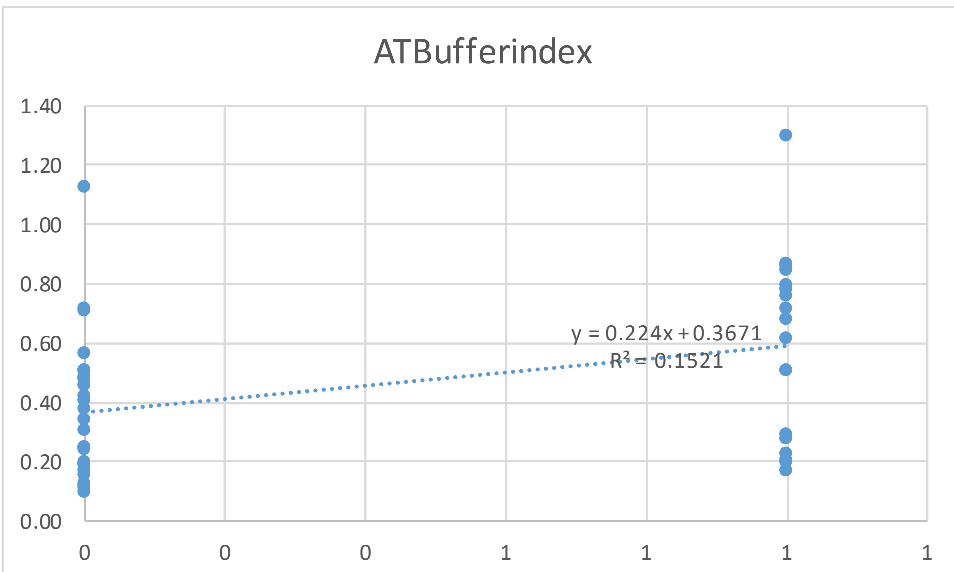
1
1
1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0
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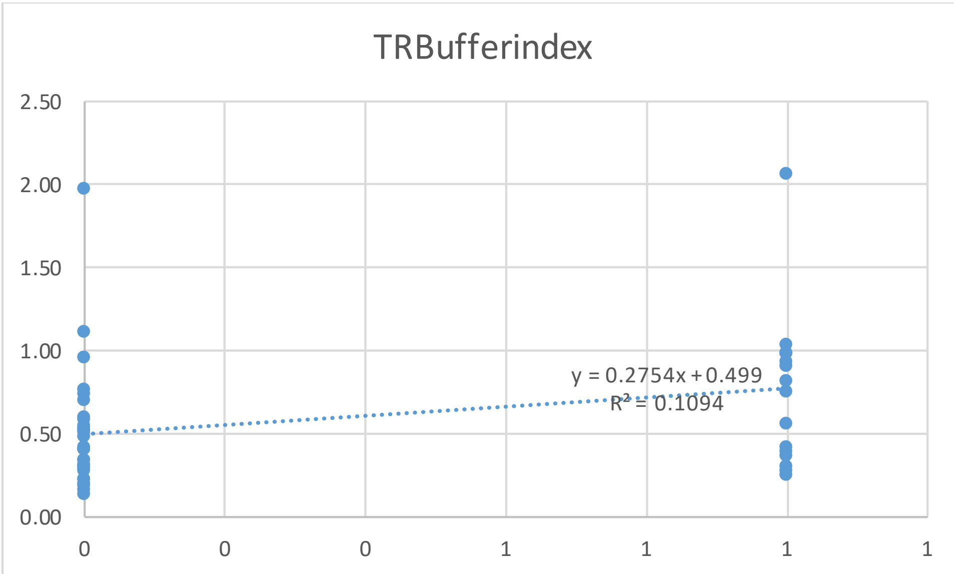
1
1
1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1
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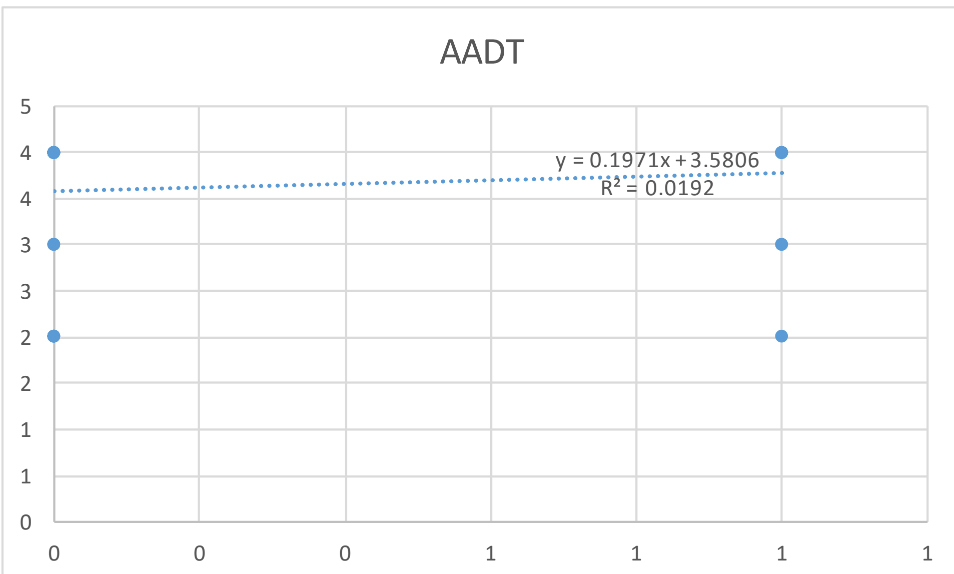
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4
3
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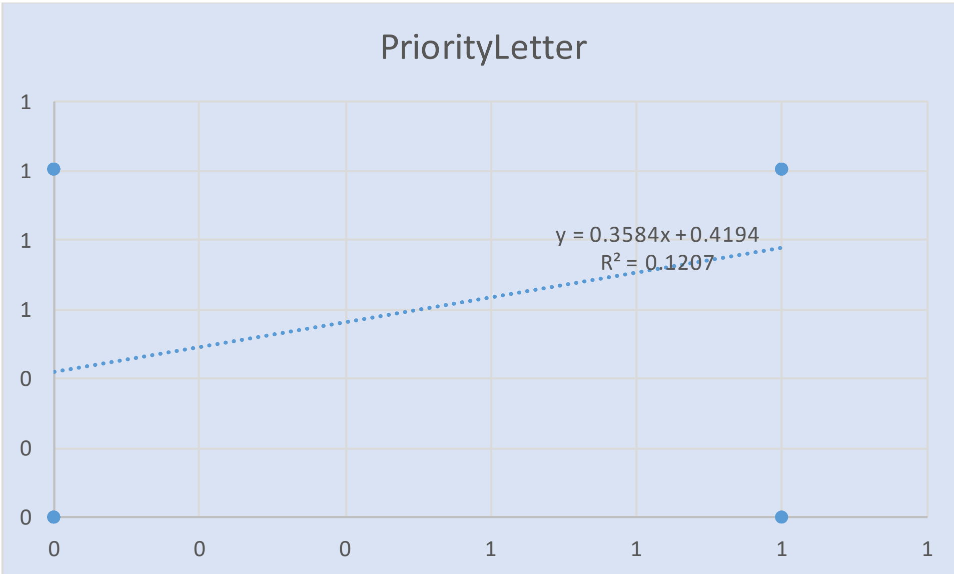
R² = 0.0192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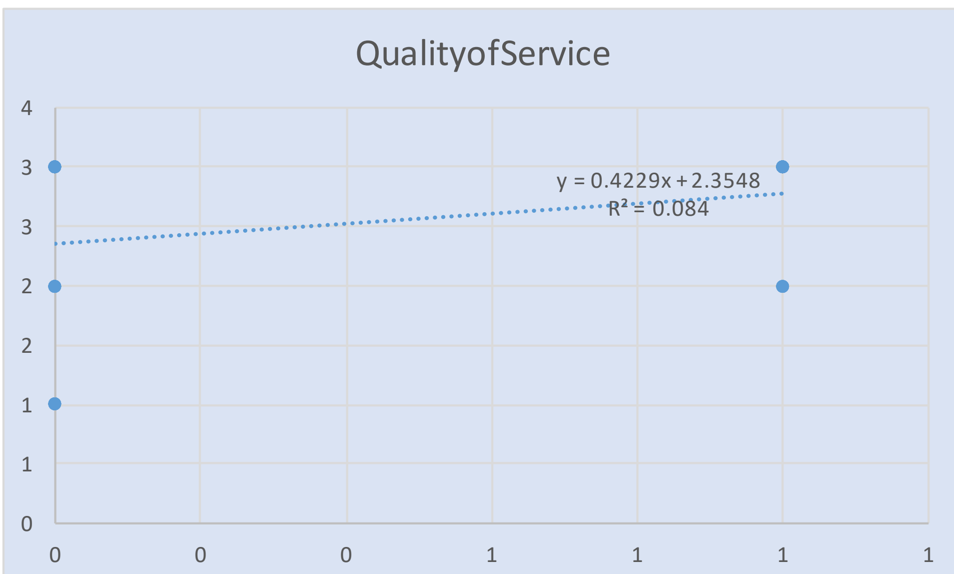
1
1
1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2
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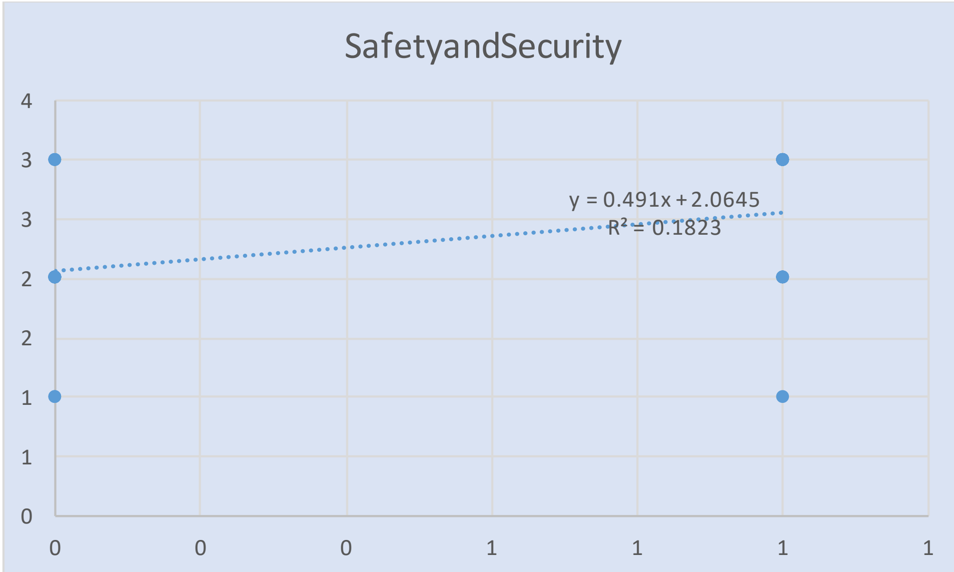
1
1
1


SafetyandSecurity
y = 0.491x + 2.0645
R² = 0.1823
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3
2
2
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0
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0
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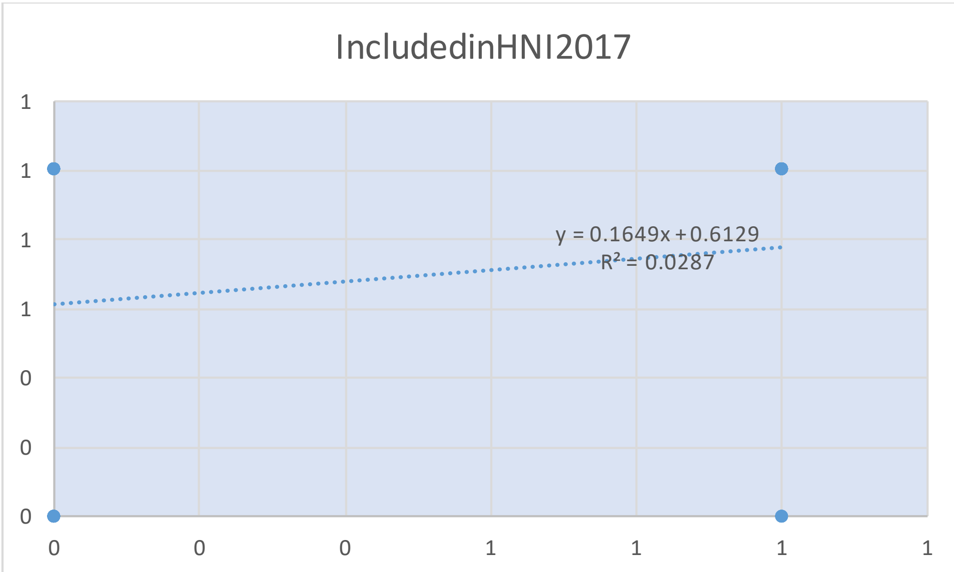
1
1
1


IncludedinHNI2017
y = 0.1649x + 0.6129
R² = 0.0287
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1
1
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0
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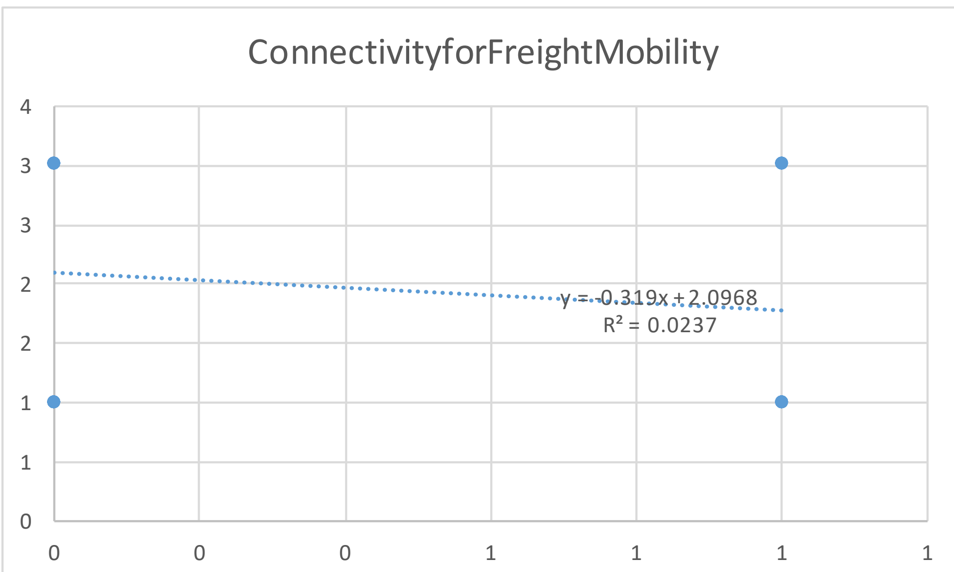
0
1
1
1
1


ConnectivityforFreightMobility
y = -0.319x + 2.0968
R² = 0.0237
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3
3
2
2
1
1
0
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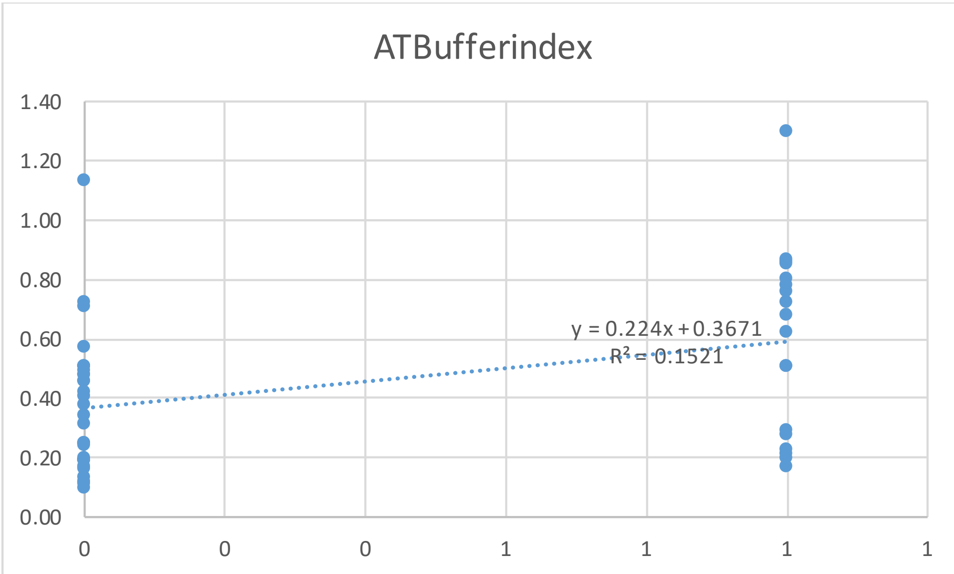
0
1
1
1
1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1.20
1.00
0.80
0.60
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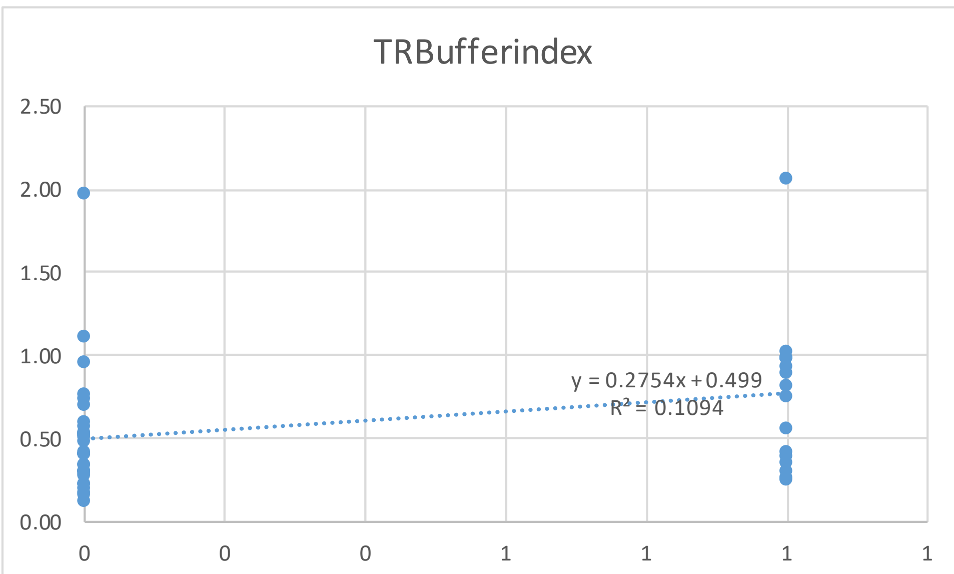
1
y = 0.224x + 0.3671
R^2 = 0.1521


TRBufferindex
2.50
2.00
1.50
1.00
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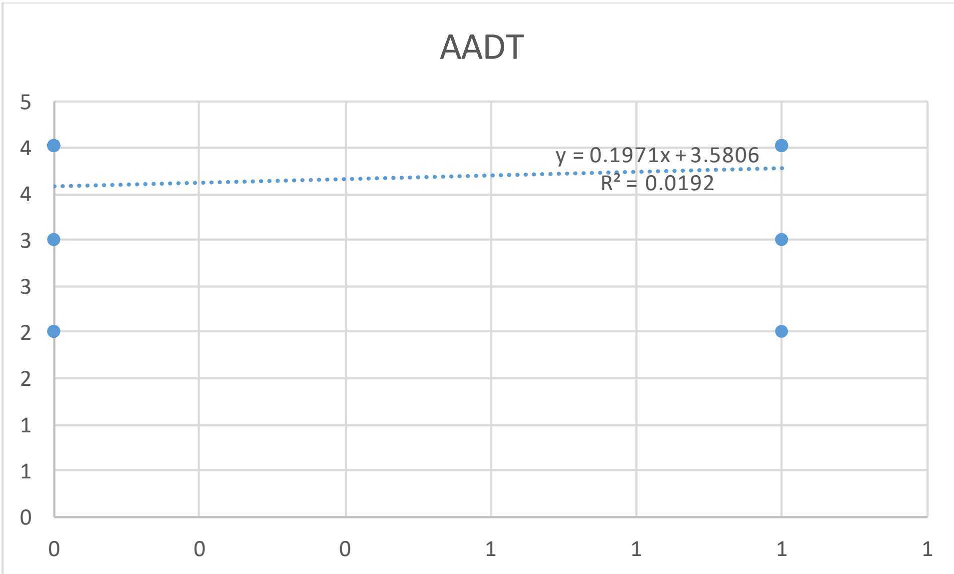
1
y = 0.2754x + 0.499
R^2 = 0.1094


AADT
y = 0.1971x + 3.5806
R² = 0.0192
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4
4
3
3
2
2
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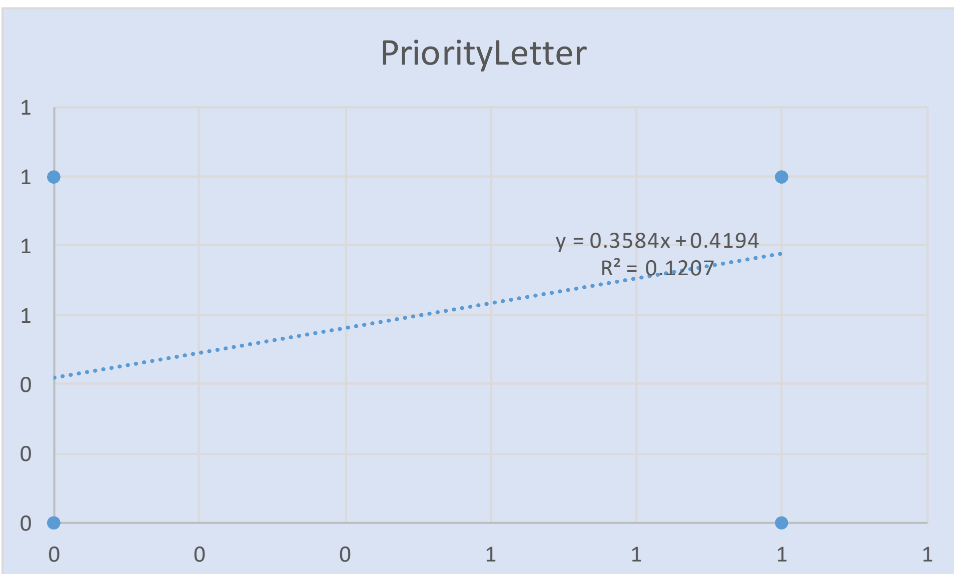
1
1
1
1


PriorityLetter
y = 0.3584x + 0.4194
R² = 0.1207
1
1
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1
0
0
0
0
0
0
1
1
1
1

Appendix C - FPM Correlations

	Funded	OvSc1	OvSc2	OvSc3	QS1	QS2	QS3	Safety andSecurity1	Safety andSecurity2	Safety andSecurity3	ES1	ES2	ES3	CFM_Low	CFM_Mod2	CFM_High3	Coord1	Coord2	Coord3
Funded	1	-0.069	0.078	-0.030	-.285*	-0.040	0.229	-0.018	-.473**	.504**	0.122	0.023	-0.117	0.154	.c	-0.154	-0.026	-0.117	-0.213
OvSc1	-0.069	1	-.369**	-.339*	0.203	.310*	-.415**	-0.104	0.190	-0.145	.766**	-0.138	-.547**	.400**	.c	-.400**	.381**	-0.151	0.113
OvSc2	0.078	-.369**	1	-.750**	0.038	0.154	-0.163	.283*	-0.163	0.024	-0.177	0.102	0.078	.474**	.c	-.474**	0.038	0.078	0.078
OvSc3	-0.030	-.339*	-.750**	1	-0.184	-.376**	.461**	-0.212	0.030	0.079	-.367**	-0.006	.311*	-.765**	.c	.765**	-.310*	0.029	-0.159
QS1	-.285*	0.203	0.038	-0.184	1	-0.213	-.490**	-0.095	0.155	-0.113	0.003	0.080	-0.058	-0.008	.c	0.008	0.050	-0.058	0.083
QS2	-0.040	.310*	0.154	-.376**	-0.213	1	-.747**	.448**	-0.157	-0.069	0.262	-0.192	-0.088	0.178	.c	-0.178	0.222	0.020	-0.088
QS3	0.229	-.415**	-0.163	.461**	-.490**	-.747**	1	-.335*	0.034	0.139	-0.236	0.117	0.117	-0.154	.c	0.154	-0.232	0.022	0.022
SafetyandSecurity1	-0.018	-0.104	.283*	-0.212	-0.095	.448**	-.335*	1	-.335*	-0.170	-0.113	-0.086	0.153	-0.261	.c	0.261	0.164	-0.039	-0.232
SafetyandSecurity2	-.473**	0.190	-0.163	0.030	0.155	-0.157	0.034	-.335*	1	-.872**	-0.007	0.117	-0.074	0.016	.c	-0.016	-0.103	0.213	0.213
SafetyandSecurity3	.504**	-0.145	0.024	0.079	-0.113	-0.069	0.139	-0.170	-.872**	1	0.066	-0.078	-0.002	0.119	.c	-0.119	0.022	-0.203	-0.102
ES1	0.122	.766**	-0.177	-.367**	0.003	0.262	-0.236	-0.113	-0.007	0.066	1	-0.149	-.735**	.433**	.c	-.433**	.509**	-0.235	0.140
ES2	0.023	-0.138	0.102	-0.006	0.080	-0.192	0.117	-0.086	0.117	-0.078	-0.149	1	-.561**	0.061	.c	-0.061	0.080	-0.256	-0.103
ES3	-0.117	-.547**	0.078	.311*	-0.058	-0.088	0.117	0.153	-0.074	-0.002	-.735**	-.561**	1	-.404**	.c	.404**	-.481**	.372**	-0.047
CFM_Low	0.154	.400**	.474**	-.765**	-0.008	0.178	-0.154	-0.261	0.016	0.119	.433**	0.061	-.404**	1	.c	-1.000**	0.241	-0.126	0.243
CFM_Mod2	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c	.c
CFM_High3	-0.154	-.400**	-.474**	.765**	0.008	-0.178	0.154	0.261	-0.016	-0.119	-.433**	-0.061	.404**	-1.000**	.c	1	-0.241	0.126	-0.243
Coord1	-0.026	.381**	0.038	-.310*	0.050	0.222	-0.232	0.164	-0.103	0.022	.509**	0.080	-.481**	0.241	.c	-0.241	1	-.622**	0.083
Coord2	-0.117	-0.151	0.078	0.029	-0.058	0.020	0.022	-0.039	0.213	-0.203	-0.235	-0.256	.372**	-0.126	.c	0.126	-.622**	1	0.162
Coord3	-0.213	0.113	0.078	-0.159	0.083	-0.088	0.022	-0.232	0.213	-0.102	0.140	-0.103	-0.047	0.243	.c	-0.243	0.083	0.162	1

Appendix D – Classification Tables Showing Predictions for Model 3

Casewise List

Case	Selected Status[a]	Observed Funded	Predicted	Predicted Group	Temporary Variable Resid	ZResid	SResid
1	S	1**	.415	0	.585	1.187	1.682
2	S	1	.889	1	.111	.353	.501
3	S	1**	.239	0	.761	1.786	1.759
4	S	0	.068	0	-.068	-.270	-.382
5	S	0	.063	0	-.063	-.260	-.368
6	S	0	.070	0	-.070	-.275	-.388
7	S	0	.266	0	-.266	-.601	-.817
8	S	0	.097	0	-.097	-.327	-.461
9	S	0	.306	0	-.306	-.663	-1.039
10	S	0	.059	0	-.059	-.249	-.354
11	S	0	.285	0	-.285	-.631	-.851
12	S	0	.224	0	-.224	-.538	-.741
13	S	1	.818	1	.182	.472	.752
14	S	1**	.182	0	.818	2.119	1.923
15	S	0	.215	0	-.215	-.524	-.735
16	S	0	.132	0	-.132	-.390	-.546
17	S	0	.082	0	-.082	-.300	-.423
18	S	0	.082	0	-.082	-.300	-.423
19	S	0	.082	0	-.082	-.300	-.423
20	S	0	.060	0	-.060	-.254	-.359
21	S	0**	.519	1	-.519	-1.039	-1.618
22	S	1	.873	1	.127	.382	.540
23	S	1	.881	1	.119	.367	.520
24	S	1	.881	1	.119	.367	.520
25	S	1	.881	1	.119	.367	.520
26	S	1**	.214	0	.786	1.919	1.827
27	S	1	.852	1	.148	.417	.587
28	S	1	.837	1	.163	.441	.619

29	S	1**	.392	0	.608	1.246	1.508
30	S	0	.138	0	-.138	-.399	-.559
31	S	0	.084	0	-.084	-.302	-.426
32	S	0	.494	0	-.494	-.987	-1.274
33	S	0	.074	0	-.074	-.283	-.401
34	S	0	.216	0	-.216	-.525	-.726
35	S	0	.172	0	-.172	-.455	-.639
36	S	0	.214	0	-.214	-.521	-.721
37	S	0	.125	0	-.125	-.378	-.530
38	S	0	.069	0	-.069	-.272	-.385
39	S	0**	.692	1	-.692	-1.499	-1.644
40	S	1**	.399	0	.601	1.226	1.491
41	S	1	.513	1	.487	.973	1.259
42	S	1**	.445	0	.555	1.116	1.350
43	S	1**	.230	0	.770	1.829	1.781
44	S	0**	.878	1	-.878	-2.682	-2.124
45	S	0	.279	0	-.279	-.622	-.975
46	S	0	.178	0	-.178	-.466	-.653
47	S	0**	.784	1	-.784	-1.904	-1.832
48	S	0	.298	0	-.298	-.651	-.875
49	S	1	.753	1	.247	.573	.794

a. S = Selected, U = Unselected cases, and ** = Misclassified cases.

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