# Development of a Predictive Coalition Building Analysis for Stakeholders of Sociotechnical Systems

## Case Studies of High-Speed Rail Development in the Northeast Corridor of the United States and the Tōhoku Shinkansen Extension from Hachinohe to Shin-Aomori, Japan

by

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B.S. Mathematics, Physics, and Japanese
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Submitted to the Department of Civil and Environmental Engineering
in partial fulfillment of the requirements for the degree of

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**Abstract:**

This thesis lays out the intellectual underpinnings and the motivation for a visual, transparent, and user-friendly predictive stakeholder analysis tool for planners and project managers to better understand future uncertainties in institutional structures and cooperative relationships surrounding large, complex, multi-stakeholder infrastructure and transportation projects. We present the development of Predictive Coalition Building Analysis (PCBA). The three-phase methodological framework assigns likelihoods to possible future coalitions of stakeholders by 1) identifying and discussing stakeholders and their interests in various objectives for system development, 2) clustering stakeholders based on their similar interests, and 3) attributing salience to each stakeholder and cluster to discuss incentives and barriers to collective action.

We apply PCBA to two case studies of complex, multi-stakeholder high-speed rail (HSR) systems: 1) the Northeast Corridor (NEC) in the United States, and 2) the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori, Japan. In the NEC case, we test PCBA for its sensitivity and robustness to perturbations, demonstrating that the tool responds to small changes in the institutional context in meaningful ways. This highlights the usefulness of PCBA as a tool for exploring different future scenarios and understanding the uncertainty of stakeholder relationships and coalitions surrounding the system or project of study. In the case of the Tōhoku Shinkansen extension, we are able to directly verify the predictive validity of the coalition likelihood results obtained from PCBA by comparing them with what *actually happened* through the planning, construction, and start of revenue service (1994-2012).

This thesis lays the foundation for future research and application into PCBA. As a tool developed for professional application, the strength of this tool lies in its usability, transparency, and communicability. We have demonstrated that PCBA can provide real, predictive insight at a macro-scale to help explore uncertainties in stakeholder relationships, making it valuable for policy-makers who want to easily understand and visualize the broad institutional context of the

system. While the case studies in this thesis explore high-speed rail development, the author asserts that this tool could be useful for exploring other sociotechnical systems within and beyond the transportation domain, even more so as the tool continues to develop.

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# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# CHAPTER 1.

# INTRODUCTION

It is well established that complex infrastructure and engineering systems evolve under the influence of the social, political, environmental, and economic context in which they develop. This may be particularly important for major transportation projects, which are technologically based but have wide-ranging social, political, economic, and environmental impacts. The broad and multi-sector impacts of these systems necessarily involve many agents, and these organizations and stakeholders can be crucial to the successful implementation of infrastructure projects. Because of their technical and institutional complexities, the behavior of sociotechnical systems is difficult to predict, often counterintuitive, and will likely change throughout the system lifecycle. Therefore, these *sociotechnical systems* require interdisciplinary approaches for their study and proposed interventions (Long, 2013; Salembier & Benchekroun, 2002; Mumford, 1985; Pasmore, 1988).

While many analytical methods exist for forecasting changes in the technical and engineering aspects of these systems – such as projections for revenue, benefits, and costs – forecasting how the stakeholders surrounding the project may evolve is an area less studied. To contribute to this area of study, this thesis develops and introduces Predictive Coalition Building Analysis (PCBA). This methodology is designed for transportation managers, planners, and possible investors to understand not just which individuals or groups may have a stake in the project, but also how these individuals or groups might work together, forming coalitions to strengthen their collective interests in the future. Our intent with PCBA is to provide a structure for undertaking systematic, rigorous, and valid analysis of existing and future stakeholder relationships, while maintaining transparency and communicability for stakeholders with different backgrounds.

## 1.1 PCBA FRAMEWORK

PCBA is a three-phase methodology that identifies the most likely and most salient coalitions of stakeholders surrounding sociotechnical systems. The three phases of PCBA bring together

insights from stakeholder analysis in the public policy and strategic management domains to present first a descriptive and then a predictive treatment of the institutional context of the sociotechnical system. Therefore we have developed a tool for stakeholder analysis of sociotechnical systems that not only accurately reflects the current state of inter-actor relationships, but also provides useful information about how and around which issues stakeholders may come together to form coalitions in the future.

Figure 1 provides a high-level depiction of the three phases of PCBA and the intellectual theories that support the analysis. The first phase of PCBA gathers the necessary data and understanding of the system to form the input for further analysis. In particular, this phase characterizes stakeholders and their interests in the objectives of the system development. The second phase draws upon conclusions and techniques from the Advocacy Coalition Framework (ACF) in public policy literature to understand how multiple actors relate to each other and many different policy or performance objectives. Using clustering, this second phase of PCBA groups stakeholders based on the theory of "belief homophily" – the idea that similarity of interests in the system development objectives is a necessary condition for stakeholders to work together. The third phase incorporates understanding of collective action from the Institutional Analysis and Development (IAD) Framework and theories of stakeholder typology and salience from strategic management literature to take conclusions from the descriptive analysis in the second phase and apply them dynamically to current and future situations. This final phase considers incentives and barriers that may exist among stakeholders and possible partnerships to determine the likelihood of coalition formation.

**Figure 1.** The three phases of PCBA and their academic motivations.
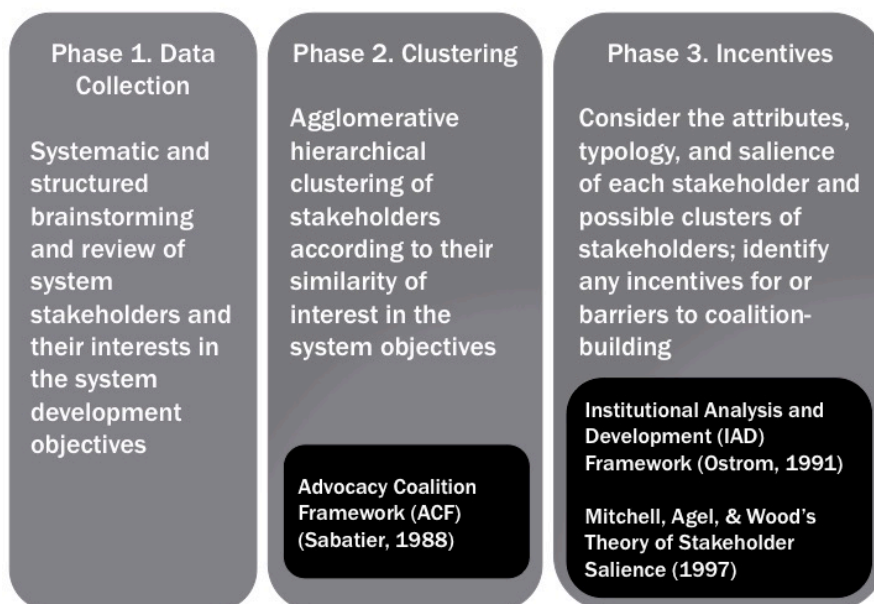
The above intellectual foundation and three-phase methodology of PCBA provides the structure for undertaking systematic, rigorous, and valid analysis of existing and future stakeholder relationships. In addition, PCBA is developed to be user-friendly for stakeholders with different backgrounds and to interface with existing stakeholder analysis and project planning and management practice. PCBA differs from other stakeholder analysis methods surrounding complex, large-scale, interconnected, and open sociotechnical systems because it is:

1. *Predictive* in the sense that it gives policy-makers and planners some knowledge about the likelihood that a coalition might develop among specific stakeholders in the future
2. *Macro-level* in that it considers the whole institutional context of the system rather than focusing on specific relationships
3. *Transparent and communicable* so that decision-makers and stakeholders with different backgrounds can each understand (and act upon) the information presented.

It is the intended audience and combination of these three features that differentiates PCBA from other methods for exploring how multiple stakeholders can affect the implementation of large infrastructure and engineering projects. PCBA allows policy-makers and other system stakeholders to easily understand how changes in the institutional context might affect system development. Project managers and planners can use PCBA to explore how the institutional structure and incentives for coalition building might change among the stakeholders under different scenarios (such as the entrance of a new stakeholder into the system, or a change in interests of an existing stakeholder). By identifying stakeholders who are likely to work together, analysts may be able to bring together supportive and like-minded stakeholders to build the political consensus necessary for implementation of the project or to identify stakeholders who might collectively present opposition.


## 1.2 CASE STUDIES IN HIGH-SPEED RAIL

While PCBA has a specific macro-structure, its inherent flexibility allows different analysts to tailor the process to the specific needs of their project and institutional context. The PCBA framework described above has been designed to be applicable to any sociotechnical system; however, in this thesis we explore its value for high-speed rail developments. Transportation systems, including high-speed rail, are prime examples of complex, large-scape, interconnected, and open infrastructure and physical systems that must be studied in the political, social, economic, and environmental context in which they develop (Sussman et. al., 2015). This is because transportation networks not only involve complex and interconnected infrastructure systems – such as roads, bridges, tunnels, rails, control systems, and communication links – but are also inextricably linked with the political, social, economic, and environmental framework of cities, regions, and nations.

We choose two case studies in high-speed rail development as our initial applications of PCBA. As a system still under development, we choose to explore the transportation network along the Northeast Corridor (NEC) of the United States (from Washington DC, through New York City, to Boston) as our first case study. This represents a rich pilot case because of the institutional complexities surrounding intercity travel along the corridor. The corridor passes from the seat of our nation's federal government through 8 states, each with their own state governments, and at least 4 major metropolitan areas. The NEC has been plagued for decades with congestion of all types on its roads, in the air, and on its rails, all of which have many different stakeholders. For instance, the rail system alone has four infrastructure owners and nine passenger rail operators.

As our second case study we apply PCBA to the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori in Japan. This case represents a system that has already been constructed and is in revenue service. While a case of a smaller scale than the NEC, the Tōhoku Shinkansen application allows us to test the performance of PCBA against the *actual* institutional relationships that manifested throughout the project lifecycle.

These two case studies serve as examples for how to apply the method developed in this thesis. Throughout the applications of PCBA to these two case studies, we synthesize and add to knowledge about the two systems and highlight the value and insights gained from using the structured PCBA methodology rather than ad-hoc professional judgment. While professional judgment has its uses, by providing a more comprehensive analytical framework PCBA can help to build better intuition about the stakeholder relationships surrounding these complex sociotechnical systems.

## 1.3 THESIS ORGANIZATION

Following the introduction above, this thesis consists of five additional chapters. Chapter 2 presents a review of relevant literature on stakeholder analysis from the public policy and strategic management literature. In particular, it presents ideas from the Advocacy Coalition Framework (ACF), Institutional Analysis and Development (IAD) Framework, and Mitchell, Agel, and Wood's theory of stakeholder salience that are integrated and operationalized in the framework of PCBA.

Chapter 3 describes the three-phase methodology for PCBA. This chapter is meant as a stand-alone "handbook" for how to apply the method to any sociotechnical system. It discusses key modeling decisions and highlights assumptions and tuning parameters that affect the results of the analysis.

Chapter 4 presents the first case study application of PCBA to high-speed rail development on the Northeast Corridor of the United States. This chapter illustrates each phase of PCBA,

18

highlighting the additional insight gained from structured exploration of stakeholder relationships. In the context of this case, we then explore the sensitivity and robustness of PCBA to small perturbations or changes in the institutional context surrounding the system. This chapter concludes with a comparison of results for the NEC obtained from PCBA with conclusions from the application of another method for exploring stakeholder cooperation surrounding large infrastructure projects – Multi-Stakeholder Trade Space Exploration (MSTSE). From this comparison we can examine key merits and limitations of PCBA and MSTSE.

Chapter 5 presents the second case study application of PCBA to the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori, Japan. This chapter serves as an additional example of how to perform PCBA and the additional insight gained through use of the tool. Furthermore, as a case study on a system that has already been constructed, we can compare the results from PCBA with *what actually happened* among stakeholders surrounding the Tōhoku Shinkansen extension project. In this way, we can test the predictive validity of the tool.

We then conclude this work in Chapter 6 by summarizing our findings and discussing the limitations and future directions of the methodology. We remark on possible application of the method in existing planning and project management practice and explore the value of PCBA results in identifying likely supportive (and oppositional) coalitions who might produce (or stand against) the political consensus necessary for successful project implementation.

With the motivation and structure of the thesis presented here, we now begin with a discussion of stakeholder analysis as an academic foundation for the methodological development and application of PCBA.

# CHAPTER 2.

# STAKEHOLDER ANALYSIS: A REVIEW

Stakeholder analysis is an approach, a tool or set of tools for generating knowledge about actors – individuals and organizations – so as to understand their behavior, intentions, interrelations and interests; and for assessing the influence and resources they bring to bear on decision-making or implementation processes (Varvasovszky & Brugha, 2000). Being clear about the aim of the stakeholder analysis helps to identify the scope and time dimensions (past, present, or future) of interest. In stakeholder analysis in the public policy domain, its scope can range from broad and retrospect - with the aim of understanding the roles of stakeholders in the evolution of the policy context and processes - to prospectively outlining more long-term and also broadly-focused policy directions. On the other hand, organizations and businesses use stakeholder analysis as a tool for achieving specific operational goals, or advantages in their dealings with other organizations, through identifying potential allies and building alliances or removing threats (Blair, Fottler, & Whitehead, 1996).

Stakeholders have a key role in determining policy, its implementation, and the efficacy of its outcomes. In project management, stakeholder analysis is used to increase the chances of project success through informing their design, preparation and implementation or as part of an evaluation, during or after project completion. For complex, large-scale, interconnected infrastructure projects with far-reaching and multi-dimensional impacts (like improvements to transportation systems), engaging stakeholders throughout the project life cycle is a key to (but not a guarantee of) project success.[1] In particular, involving the right stakeholders early on in the project process improves the chances that they will support the project throughout its lifecycle. This has made stakeholder analysis a vital tool for project managers who wish to design policies, plans and programs that will remain effective over the long-term (Bryson & Crosby, 1992; Baumgartner & Jones, 1993; Roberts & King, 1996). Managing stakeholders' expectations and ensuring their active involvement can be important to the successful completion of a project in the following ways:

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[1] While stakeholder analysis is frequently used during the planning phase of a project to assess the attitudes of the stakeholders regarding potential developments, stakeholder analysis can be done on a regular basis to track changes in stakeholder attitudes over time.

- It is indispensable for continuation of the project and its successful completion by creating and sustaining necessary constituencies and promoting stakeholder 'buy-in' (Riker, 1962; Riker, 1986; Baumgartner & Jones, 1993).
- It ensure long-term viability of organizations (Eden & Ackermann, 1998; Abramson & Kamensky, 2001)
- It gives opportunity to individuals or groups to express their ideas, issues, or concerns over the project
- It gives a sense of accountability and enhances responsibility of project managers
- It enables effective risk identification and response planning to possible changes in stakeholder relationships and attitudes
- It opens up excellent learning opportunity for both the project team and stakeholders

The term stakeholder analysis encompasses a range of different methodologies for analyzing stakeholder interests and is not a single tool (Crosby, 1991). Broadly speaking, the purpose of stakeholder analysis is to indicate whose interests should be taken into account when making a decision. The aim of stakeholder analysis process is to develop a strategic view of the human and institutional landscape surrounding a project, and to better understand (and anticipate) the effect of relationships between the different stakeholders and the issues they care about. While stakeholder analysis can take many forms, most techniques help with the identification of stakeholders' interests, mechanisms to influence other stakeholders, potential institutional risks surrounding a project (including negative stakeholders as well as their adverse effects on the project), and key people to be informed about the project during its design, construction, and operation.

Stakeholder management processes for a project involves (but not limited to): identifying all stakeholders, documenting stakeholders' needs, assessing and analyzing stakeholders' interest and influence, and managing stakeholders' expectations. Generally, stakeholder analysis focuses on two key elements – groups or actors are analyzed in terms of 1) their interest in a particular issue and/or 2) the quantity and types of resources they can mobilize to affect outcomes regarding the policy issue or project (Crosby, 1991). The exact focus of the stakeholder analysis depends on the field of study and the intended audience. While no standard method exists for stakeholder analysis, qualitative techniques have been developed to help with each piece of the stakeholder management process.

This chapter does not represent an exhaustive literature review of all techniques and theories on stakeholder analysis and management. Instead, it presents the background necessary to motivation the development of Predictive Coalition Building Analysis (PCBA). First we briefly discuss techniques for identifying stakeholders and their objectives for transportation system or project development. Then we review stakeholder theory in public policy literature – particularly the Advocacy Coalition Framework (ACF) (Sabatier, 1988) and Institutional Analysis and

Development (IAD) Framework (Ostrom, 1991). Insights from ACF are operationalized in the clustering analysis in the second phase of PCBA, while the discussion of barriers and incentives to collective action discussed in the IAD Framework help motivate the third phase of PCBA. Finally we review Mitchell, Agel, and Wood's theory of stakeholder typology and salience from business and strategic management literature (1997), which we operationalize in applications to sociotechnical systems in the third phase of PCBA.

## 2.1 IDENTIFYING STAKEHOLDERS AND THEIR GOALS

While stakeholder analysis techniques vary in their scope and focus, the initial task for all theories and methods is to identify and categorize the 'stakeholders.' The potential list of stakeholders for any project will usually exceed both the time available for analysis and the capability of the technique to sensibly display and discuss the results. Therefore, the challenge is to focus on the 'right stakeholders' who are currently important to the project and to use stakeholder analysis to visualize and understand this critical subset of the many possible stakeholders within the institutional context of the sociotechnical system.

The task of stakeholder identification is nontrivial and the definition of who constitutes a 'stakeholder' can have significant impacts on the results of the stakeholder analysis. In other words, the decision about how to define stakeholders is consequential and it affects *who* and *what* counts (Mitchell, Agel, & Wood, 1997). Who constitutes a stakeholder depends on the scope and purpose of the analysis as well as the cultural and political context in which the project is being implemented.

In strategic management literature, stakeholders are often identified by considering who might have the strength to stand in the way of a project (opposition) or who might provide value to the project (support). Crosby suggests determining whether to give specific and serious consideration to an actor's interests by contemplating three questions (1991):

1. Is the actor or group in a position to damage or weaken the authority or political support of the decision maker or the organization?
2. Does the group's presence and support provide a net benefit, strengthen an organization, and/or enhance the decision-maker's authority (and capacity to secure compliance to decisions? For example, can the group bring new resources to the project or provide a link to other potential partners or markets?
3. Is the group capable of influencing the direction or mix of an organization's activities?

However, the definition of who constitutes a stakeholder has evolved over the years and does not have one specific definition. In other studies within the strategic management literature, stakeholders have been defined as:

> One who "can affect the achievement of an organization's objectives or who is affected by the achievement of an organization's objectives" (Freemand & Reed, 1983).
>
> Those who "benefit from or are harmed by, and whose rights are violated or respected by, corporate actions" (Evan & Freeman, 1988).
>
> Participants in "the human process of joint value creation" (Freeman, 1994).
>
> "Are or which could impact or be impacted by the firm/organization" (Brenner, 1995).

In the case of public policy and sociotechnical project management, it is wise to begin any stakeholder identification and analysis procedure with a more inclusive definition of stakeholders than what is often used in strategic management literature (Lewis, 1991; Bryson, 2004). One must consider not only those actors that have oppositional or supportive power, but also those who might be impacted by the project development but have no organized voice. Stakeholders can be defined as actors who have an interest in the system development under consideration, who are affected by the development, or who – because of their position – have or could have an active or passive influence on the decision-making and implementation processes surrounding the sociotechnical system (Varvasovszky & Brugha, 2000). Therefore, modifying the definition used by Freeman and much of the business management community (1984) to include a broader base, we define a stakeholder as *"any group or individual who can affect or is affected by the development path of the system."*

## 2.2 STAKEHOLDER ANALYSIS IN THE STUDY OF PUBLIC POLICY

Public policy analysis of coalitions and stakeholders tends to use surveys, practitioner interviews, and other data sources like the news and organizational websites to understand why certain groups work together or not on a given policy initiative (Brugha & Varvasovszky, 2000). Although this is often a descriptive and retrospective analysis, there are a few dominant theories and general conclusions that have been so often evidenced that we use them to motivate our new, prescriptive approach. In particular, we discuss some of the hypotheses on coalition building and collective action that make up the Advocacy Coalition Framework (ACF) and extensions of these hypotheses incorporating the Institutional Analysis and Development (IAD) Framework.

### 2.2.1 Advocacy Coalition Framework

The Advocacy Coalition Framework (ACF) is a policy-making framework developed to explore complex public policy problems. It provides a systematic way of understanding and explaining belief and policy change when there is disagreement about goals and technical disputes involving multiple stakeholders from several levels of government, interest groups, research institutions,

24

and the media (Hoppe & Peterse, 1993; Weible & Sabatier, 2006). Within the ACF, policy formation and change is a function of competing advocacy coalitions within a "policy subsystem." A policy subsystem consists of actors from "public and private organizations who are actively concerned with a policy problem" (Sabatier, 1988). The actors within a policy subsystem are grouped into a number of advocacy coalitions that consist of individuals "who share a particular belief system – i.e. a set of basic values, causal assumptions, and problem perceptions – and who show a non-trivial degree of coordinated activity over time" (Sabatier, 1988).

The ACF outlines causal logic and a set of hypothesis regarding the formation of coalitions around public policy issues. These hypotheses are based on five assumptions (Sabatier & Jenkins-Smith, 1999):

1. The central role of scientific and technical information in policy processes
2. A time perspective of 10 years or more to understand policy change
3. Policy subsystems (defined by policy topic, geographic scope, and influencing stakeholders) as the primary unit of analysis
4. A broad set of subsystem stakeholders that include officials from all levels of government, consultants, scientists, and members of the media
5. A perspective that policies and programs are best thought of as translations of beliefs.

Many of these assumptions also apply to complex sociotechnical systems and infrastructure projects, particularly in the public domain. For example, many of these systems require more than 10 years to complete planning, design, construction, and initial operation, in alignment with the second assumption. Furthermore, sociotechnical systems involve many distinct stakeholders in the public and private sectors, conforming to the fourth assumption. Among the assumptions of the ACF, the fifth assumption identifies beliefs as the causal driver for political behavior. ACF theorizes a three-tiered model of a stakeholder's "belief system" that ranks beliefs based on their scope and changeability as in Figure 2.

**Figure 2.** The Advocacy Coalition Framework's three-tiered model of a stakeholder's "belief system".
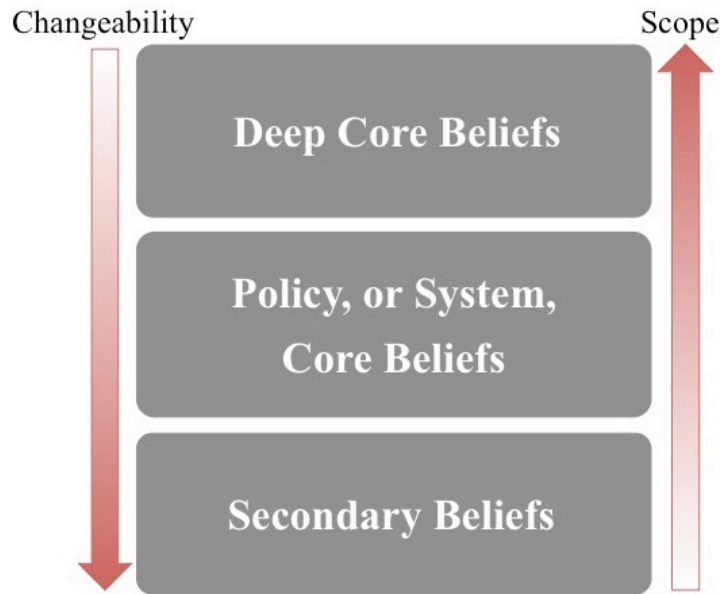


At the most fundamental level, stakeholders have deep core beliefs, which are the broadest (applicable across policy subsystems) and most stable among the beliefs (Weible & Sabatier, 2006). Deep core beliefs tend to consist of normative values about the role of government, beliefs about human nature, or priorities regarding who should participate in policy issues. Because these views are often the product of years of socialization, they are the most difficult to change.

In the middle of the belief system hierarchy are policy core beliefs, which are of moderate scope and span the substantive and geographic breadth of a policy subsystem, or in our case, sociotechnical system (Weible & Sabatier, 2006). Policy, or system, core beliefs are resistant to change, but are more likely to adjust in response to new experience and information or the influence of other stakeholders than deep core beliefs. Therefore it is these policy, or system, core beliefs around which coalitions are formed and activities among members are coordinated (Weible & Sabatier, 2006). As discussed in Section 3.2 in the following chapter, these system core beliefs are operationalized as the system development objectives in the application of PCBA.

At the bottom of the belief system are secondary beliefs. Compared to policy core beliefs, secondary beliefs are more substantively and geographically narrow in scope and often more empirically based (Weible & Sabatier, 2006). ACF explains that secondary beliefs, compared to deep core and policy core beliefs are the most likely to change over time. Because of their high degree of changeability and their narrow scope, secondary beliefs do not support the formation of long-term or comprehensive coalitions.

With the assumptions and "belief system" structure in hand, ACF sets out and tests a number of hypotheses regarding how stakeholders and their belief systems interact within coalitions (Weible, Sabatier, & McQueen, 2009; Schlager, 1995). Here we discuss only the subset of the 15 hypotheses of ACF that directly motivate PCBA, but have kept the numbering system used by Weible, Sabatier, and McQueen for ease of reference (2009). One of the most well evidenced hypotheses of the ACF discusses the longevity and stability of coalitions. It claims:

> **Hypothesis 2.** On major controversies within a policy subsystem when policy core beliefs are in dispute, the lineup of allies and opponents tend to be rather stable over periods of a decade or so.

Not only are coalitions stable over time, but also principal members or stakeholders within these coalitions (Jenkins-Smith & St. Clair, 1993; Jenkins-Smith, St. Clair, & Woods, 1991; Sabatier & Brasher, 1993; Zafonte & Sabatier, 2004). This equilibrium guarantees policy stability and is only interrupted when external perturbations ("pattern breaks") cause coalition members to refine their internal belief systems significantly (Leifeld, 2013; Elgin & Weible, 2013). Therefore, one can claim that understanding current coalitions of stakeholders is likely to give insight into opposition or support for the development of a sociotechnical system, even if the project is not implemented for a number of years. It is this hypothesis that lends credibility to the predictive nature of PCBA.

Two additional hypotheses discuss how coalitions form around policy core beliefs rather than deep core beliefs or secondary beliefs. Implicit in these hypotheses is the idea of "belief homophily" – the fact that people of similar beliefs interact more and are more likely to form coalitions together than people of dissimilar beliefs (Henry, Lubell, & McCoy, 2011; McPherson, Smith-Lovin & Cook, 2001). ACF qualifies the idea of belief homophily further by stating that coalitions are formed among stakeholder with similar policy, or system, core beliefs and that compromises are often made on secondary beliefs in order to work together.

> **Hypothesis 7.** Actors within an advocacy coalition will show substantial consensus on issues pertaining to the policy core, although less so on secondary aspects.
>
> **Hypothesis 8.** An actor (or coalition) will give up secondary aspects of his (its) belief system before acknowledging weaknesses in the policy core.

The coalition concept should not lead researchers to assume homogeneity among group members either in beliefs or in coordination patterns (Weible, Sabatier, & McQueen, 2009). Actors on the periphery of coalitions (often those who join a coalitions based on secondary beliefs) might very

well switch allegiances over relatively short periods of time to increase their political influence. Stability and defection of coalitions might also depend on the diversity of members.

ACF defines coalitions as consisting of members who share policy, or system, core beliefs and engage in a nontrivial level of coordination. However, while most applications discuss beliefs with some level of specificity, very few mention coordination (Weible, Sabatier, & McQueen, 2009). In other words, ACF provides relatively sophisticated explanations of the role that beliefs, information, and policy learning play in affecting policy choices, but it lacks an adequate explanation of collective action. While it claims that stakeholders with belief homophily are more likely to form coalitions, it does not explain why these actors might work together to collectively press their policy goals, how coalitions maintain themselves over time, or the strategies coalitions adopt to pursue policy goals (Schlager, 1995). The "coalitions" are coalitions because their members express similar policy beliefs, not because their members have engaged in collective action to realize policy goals.

Coordination among stakeholders is often only discussed in applications of ACF with other theories in the public policy literature – particularly the Institutional Analysis and Development (IAD) framework – that accounts of how coalitions form and maintain themselves over time and the types of strategies coalitions are likely to adopt to pursue their policy goals (Leach & Sabatier, 2005; Lubell, 2003; Schlager, 1995). The following section discusses important extensions of the ACF contributed by the IAD framework, focusing on the incentives and barriers that face stakeholders when forming a coalition. Through this additional discussion, we can account for how actors with similar belief systems overcome collective action problems and cooperate to pursue common strategies and common goals.

## 2.2.2 Institutional Analysis and Development Framework

The Institutional Analysis and Development (IAD) framework explains the emergence, maintenance, and dissolution of voluntary coalitions of actors and applies the theory of structural choice to explain the strategies coalitions are likely to pursue in realizing their policy goals. Like ACF, the IAD framework concentrates on voluntarily created associations or coalitions, but pays particular attention to the emergence, maintenance, successes, and failures of local-level, self-governing organizations (Schlager, 1995). Under this framework, policy change results from the actions of rational individuals seeking to improve their circumstances by designing and adopting changes in institutional arrangements (Ostrom, Garner, & Walker, 1994).

Ostrom and colleagues recognize that the emergence of cooperation must be explained, not assumed, because collective action is problematic – self-interested individuals face few incentives to cooperate, sometimes even in cases whereby cooperating they would make themselves better off (1990). A fundamental initial condition for coalition formation is that

individuals believe that by acting collectively to change policy, or the development of the sociotechnical system, they have something to gain (Schlager, 1995). Therefore, according to the IAD framework, coalitions are more than collections of individuals who share similar belief systems.

Even though members of a potential coalition may agree that each would be better off if they coordinated their actions, they face serious bargaining problems that, if not overcome, can prevent the formation of a coalition (Ostrom, 1991). For example, exhaustive empirical evidence shows that members of a potential coalition must share a common understanding of the problem that they face and must agree upon the content and structure of policies to be pursued. This may be extraordinarily difficult since alternative policy structures affect the distribution of benefits across members (Schlager, 1995). Thus depending upon the policies agreed upon, some members of a coalition will be made better off than others and this can breed ill will and become a barrier to collective action. Insights from the IAD framework led to the addition of three additional hypotheses within the ACF (Weibel, Sabatier, & McQueen, 2009):

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**Hypothesis 13.** Coalitions are more likely to persist if
  (i)     The major beneficiaries of the benefit that a coalition produces are clearly identified and are members of the coalition,
  (ii)    The benefits received by coalition members are related to the maintenance costs of each member, and
  (iii)   Coalition members monitor each others' actions to ensure compliance

**Hypothesis 14.** Actors who share policy core beliefs are more likely to engage in short-term coordination if they view their opponents as
  (i)     Very powerful, and
  (ii)    Very likely to impose substantial costs upon them if victorious

**Hypothesis 15.** Actors who share (policy core) beliefs are more likely to engage in short-term coordination if they
  (i)     Interact repeatedly,
  (ii)    Experience relatively low information costs, and
  (iii)   Believe that there are policies that, while not affecting each actor in similar ways, at least treats each fairly

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The conditions that the ACF and the IAD framework point to as promoting coalition formation and maintenance are mutually supportive. While shared belief systems alone fail to account for heterogeneous actors overcoming collective action problems and agreeing to coordinate their actions to achieve shared goals, it is a necessary condition for stakeholders to enter into collective bargaining.

By incorporating the IAD framework into ACF, the model of the instrumentally rational individual and the theory of structural choice is set aside in favor of a model of human behavior that is much more complex (Simon, 1985). In instrumental rationality and the IAD framework, individuals are assumed to act exclusively on the basis of their preferences and these preferences are assumed to be fixed and exogenously determined. However, in the ACF individuals act on the basis of their preferences and their beliefs, which include moral values, and these preferences can change and are endogenously determined (Schlager, 1995). Therefore, by incorporating the IAD Framework into ACF, we can better understand the incentives of stakeholders within coalitions based on "belief homophily" without jeopardizing the predictive nature of PCBA with the deterministic assumptions underlying IAD. This understanding of incentives is reinforced by stakeholder analysis in the strategic management and business literature, which also suggests a way to operationalize some of these findings for the third and final phase of PCBA.

## 2.3 STAKEHOLDER ANALYSIS IN STRATEGIC MANAGEMENT

The IAD Framework qualitatively discusses the necessity for incentives in coalition building and outlines certain conditions that foster the emergence and long-term maintenance of coalitions. This theory is based on empirical evidence from a substantial review of qualitative case studies. While the insights and general framework are useful, Ostrom was unable to come up with a cohesive model or operationalization of the theory (1991). Stakeholder analysis in the strategic management and business literature, particularly the theory of stakeholder salience introduced by Mitchell, Agel, and Wood, can help to add structure for considering and predicting incentives for coalition building and collective action.

Mitchell, Agel, and Wood provide a dynamic framework by which stakeholders are classified according to their possession of certain attributes over time. The combination of these attributes determines a stakeholder's "salience" – or "the degree to which managers give priority to competing stakeholder claims" (1997). The idea of stakeholder salience goes beyond the question of stakeholder identification, because it helps to capture the dynamics inherent in the relationship between a stakeholder and a manager. Developed in the business management context, Mitchell, Agel, and Wood's framework characterize stakeholder attributes and salience according to the relationship of a stakeholder to a corporate entity (the "manager"). However, in our application we must consider stakeholder attributes and salience according to the relationship between the stakeholder and the development of the sociotechnical system.

To apply the stakeholder typology, each stakeholder is first assigned zero, one, two, or three of the following independent characteristics – power, legitimacy, and urgency. Each of these attributes contributes to a stakeholder's salience in different ways and reinforce each other such that the more attributes a stakeholder has, the more salient its claim on the development of the

system. We adapt the definitions for power, legitimacy, and urgency from the strategic management to the sociotechnical system context.

Power is the ability of a stakeholder to bring about the outcomes it desires (Salancik & Pfeffer, 1974). In other words, it is the ability of a stakeholder to get another stakeholder in the system to do something that it would not otherwise have done (Pfeffer, 1981) or to get the system to adopt an alternative or develop in a direction it otherwise would not have. Power has different types that manifest in different ways. For example, coercive power can be exercised through threat, restraint or actual use of force and utilitarian power can be exercised through material or financial resources (Etzioni, 1964).

For a stakeholder in a sociotechnical system, having power alone is often not enough to command priority in the development of the system. If the stakeholder's claim is not legitimate, it may not have access to proper channels through which to exercise its coercive or utilitarian resources. Therefore, stakeholders with power gain authority by also having legitimacy. Similarly, a stakeholder can have power, but may not have the motivation to exercise it without also having the attribute of urgency.

Legitimacy is defined as the "generalized perception or assumption that the actions [or claims] of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman, 1995). This definition is imprecise and difficult to operationalize because there are multiple bases of legitimacy: the individual, the organization, or society (Wood, 1991). In practice, the source of legitimacy can range from contractual or legal rights (such as land ownership) to at-risk status or moral interests (such as environmental justice communities) (Mitchell, Agel, & Wood, 1997).

Legitimacy and power are distinct attributes that can combine to create authority but that can also exist independently. An entity may have legitimate standing in society, or it may have a legitimate claim on the development of the sociotechnical system, but unless it has either power to enforce its will in the relationship or a perception that its claim is urgent, it will not achieve salience. According to Mitchell, Agel, & Wood, *"legitimacy gains rights through power and voice through urgency"* (1997).

The third and final stakeholder attribute is urgency. Urgency helps capture the dynamics of stakeholder interactions and thus helps move the model from static to dynamic (Mitchell, Agel, & Wood, 1997). Urgency is a function of two conditions: the time-sensitivity and criticality of the issue at hand (Mitchell, Agel, & Wood, 1997). Therefore, a stakeholder is attributed urgency if its claim calls for immediate action *and* when its claim is considered to be of vital importance.

In combination with legitimacy, urgency promotes access to decision-making channels, and in combination with power, it encourages one-sided stakeholder action. In combination with both

power and legitimacy, urgency brings the stakeholder complete salience and triggers reciprocal acknowledgment and action between the stakeholders and system development (Mitchell, Agel, & Wood, 1997).

Despite the fact that each attribute operates on a continuum, in the most basic application of the framework each attribute is treated as "present or absent" (Mitchell, Agel, & Wood, 1997). While perhaps failing to capture particular nuances, this binary assignment of attributes helps to build a typology system that is manageable in its complexity but still rich enough to distinguish key differences in salience among stakeholders. After assigning each stakeholder its appropriate attributes, the stakeholders can be arranged into one of eight stakeholder types (as in Figure 3).

**Figure 3.** Stakeholder typology based on presence of power, legitimacy, and/or urgency (Mitchell, Agel, & Wood, 1997)
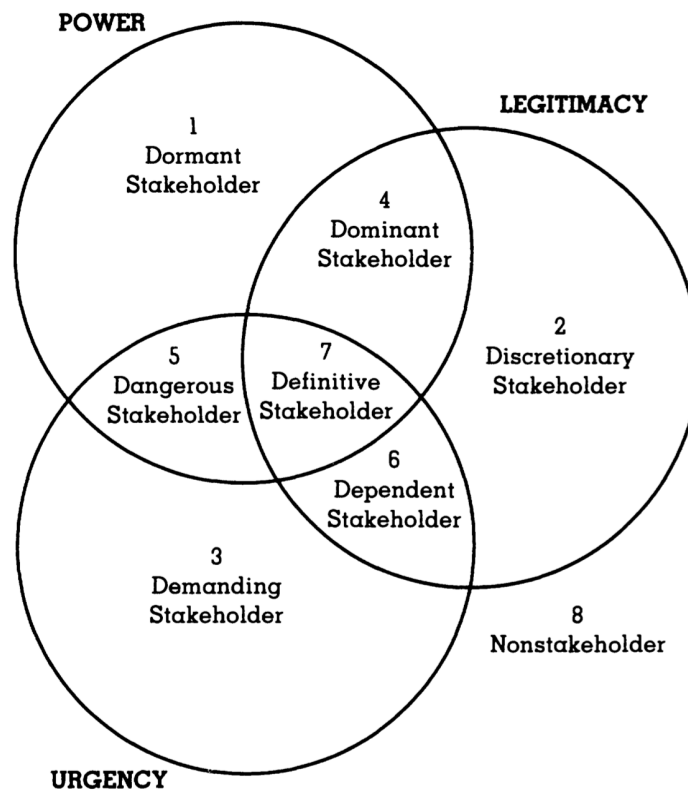


From these classes, we can determine stakeholder salience, or the degree to which system development should give priority to competing stakeholder claims. According to the framework, stakeholder salience is positively related to the cumulative number of stakeholder attributes – power, legitimacy, and urgency – perceived to be present (Mitchell, Agel, & Wood, 1997). In other words, the more attributes a stakeholder has, the more salient it is in determining the outcome of system development. Conversely, stakeholders with no power, legitimacy, or

urgency in relation to development of the system will have no salience and would be classified as a nonstakeholder.

One of the strengths of this framework is that the assignment of stakeholder attributes, typology, and hence salience is not a steady state. Mitchell, Agel, & Wood discuss how stakeholders can change in salience, requiring different degrees and types of attention depending on their attributed possession of power, legitimacy, and/or urgency that can vary from issue to issue and from time to time (1997). Any stakeholder can gain saliency by acquiring a missing attribute individually or through partnership (Mitchell, Agel, & Wood 1997). In this way, the typology allows prediction about the circumstances under which a stakeholder of one type might attempt to acquire a missing attribute – often through cooperation with other stakeholders – and thus enhance its salience and ability to influence system development. We operationalize this incentive for coalition building in the third phase of the PCBA as discussed in Chapter 3.


## 2.4 IMPLICATIONS FOR PREDICTIVE COALITION BUILDING ANALYSIS

Predictive Coalition Building Analysis takes its motivation from general conclusions of stakeholder analysis in the public policy and strategic management literature to provide a predictive methodology that describes *who among the system stakeholders might work with whom and why*. The Advocacy Coalition Framework (ACF) suggests that a necessary, but not sufficient condition for coalition building is a similarity of interests or "policy beliefs." In the next chapter, we discuss how we operationalize the idea of "belief homophily" by performing clustering analysis on the interests of the stakeholders in the many system development objectives in the second phase of PCBA. Using insights from the Institutional Analysis and Development (IAD) Framework and incorporating the Mitchell, Agel, and Wood theory of stakeholder typology and salience, we can discuss which stakeholders with common interests might have an incentive to work together in the third phase of PCBA. This can help explain why some pairs or groups of stakeholders may or may not work together despite having very similar interests in the development of the system.

While the theory of stakeholder analysis and collective action from public policy literature and strategic management literature help give qualitative insight on how and why stakeholders might work together, they do not produce actionable tools for planners and project managers to predict possible institutional context surrounding complex sociotechnical development. In the next chapter, we present a new methodology – PCBA – that operationalizes important insights from these theories in a way that provides transparent and visual feedback for project decision-makers.

# CHAPTER 3.

# METHODOLOGY

This chapter is meant to be a stand-alone process "handbook" for conducting Predictive Coalition Building Analysis (or PCBA). This methodology operationalizes theory from stakeholder analysis in public policy literature, such as Advocacy Coalition Framework (ACF) and Institutional Analysis and Development (IAD) Framework, and in strategic management literature to identify likely coalitions based on similarities in objectives and then discuss how likely these coalitions might form based on incentives for partnership and the existence of possible barriers to coalition building.

Tying back to the review of stakeholder analysis theory and techniques in Chapter 2, this chapter will describe each stage of PCBA in detail, paying particular attention to the choice of tuning parameters where applicable. Each phase will be further broken down into steps as in Table 1.

**Table 1.** Phases and steps of Predictive Coalition Building Analysis.

| Phase | Step |
|---|---|
| Phase 1 | Data Collection<br>    1. Defining the system and project<br>    2. Identifying stakeholders and the system objectives<br>    3. Developing a stakeholder-objective matrix |
| Phase 2 | Clustering analysis<br>    1. Choosing the clustering variables<br>    2. Deciding on the clustering procedure or type<br>    3. Selecting a measure of (dis)similarity<br>    4. Selecting a linkage algorithm |
| Phase 3 | Discuss incentives and barriers of coalition building for each stakeholder cluster using Mitchell, Agel, & Wood's theory of stakeholder salience and typology |

## 3.1 PHASE 1: DATA COLLECTION

The application of PCBA requires a comprehensive understanding of the sociotechnical system in question. Therefore, significant effort is required to gather data and consolidate the analyst's domain knowledge into the input for PCBA – a matrix that maps the level of each stakeholder's interests to the system development objectives. In each step towards development of the stakeholder-objective matrix, the decision of how to characterize the system, the stakeholders, the objectives, and the stakeholders' interests in these objectives can all influence the outcome of the stakeholder analysis. Therefore, this section discusses the tradeoffs that must be considered when putting together the inputs for any PCBA application.

### 3.1.1 Defining the System and Project Boundary

When performing stakeholder analysis for a sociotechnical system, one of the challenges is determining the boundary of the analysis. Since many of these sociotechnical systems are large, interconnected, open, and complex, there may be many groups or individuals who are indirectly or tangentially affected by the development of the system and the impacts of the system development are often far-reaching and multidimensional. For example, high-speed rail and transportation systems might involve stakeholder groups in government, the private sector, as well as individual users and the impacts of system development can have economic, environmental, and social implications. Therefore, the scope and definition of the project directly affects the identification of stakeholders and their interests in the system goals and objectives.

The definition of the system or project boundary is dependent on the culture and context of the particular case study. Managerial, administrative and political cultures are influenced by history and cultural traditions and therefore so too is the stakeholder analysis influenced by these contextual factors (Varvasovszky & Brugha, 2000). For example, in the United States, independence and individual initiative are valued within management practice; whereas in Japan, organizational allegiance and specialization are highly valued (Economist, 1999).

The analysis can take place at one or more levels – local, regional, national and international – which influences how one collects data and who to consider a stakeholder (Varvasovszky & Brugha, 2000). A local level analysis often means that all stakeholders can be reached and interviewed individually. A national-level analysis or one involving international actors is likely to rely more on a review of policy documents, reports and existing data. Defining the boundary of analysis comes with particular tradeoffs, since a narrow scope often allows the analyst to go into more detail while a larger scope tends to support general conclusions.

### 3.1.2 Identifying Stakeholders and the System Objectives

As a first step in the process, the system or project for which the stakeholder analysis is being conducted is clearly defined before identifying the stakeholders. Identifying the stakeholders to include in the model is the next important step in the process. Failure to include any key stakeholders could create unexpected difficulties should that stakeholder begin exerting influence later during the life cycle of the project that was not anticipated or considered (Sutherland, 2009). Differing definitions of stakeholders and methods for identifying them are discussed in more detail in Section 2.1, but for the case of PCBA we define a stakeholder as "*any group or individual who can affect or is affected by the development path of the system.*"

There are four well-established techniques for identifying stakeholder and their objectives (or needs): basic stakeholder analysis technique, power versus interest grids, stakeholder influence diagrams, and participation planning matrix (Bryson, 2004). All of these techniques are fairly simple in concept and rely on first-hand interviews with relevant individuals and organizations as well as structured, iterative brainstorming and review of secondary sources such as published and unpublished documents, reports, policy statements, organizational mission statements, internal regulations of organizations, news articles, and other sources in the public domain (Varvasovszky & Brugha, 2000).

Often the preliminary list of stakeholders is too long to include in full detail throughout the entire stakeholder analysis. Therefore, once the initial stakeholders have been identified, the list can be refined into a smaller, more manageable number of stakeholders. The challenge in this part of the process is to define the stakeholder groups so that the representation of the institutional context of the system is as simple as possible, yet captures enough complexity to produce insightful results. Two classification schemes can be used to simplify the model: hierarchy and aggregation (Sutherland, 2009). Hierarchy involves combining stakeholder such that each level within the hierarchy has jurisdiction or control over lower levels. Hierarchy is often useful for government stakeholders, which might combine numerous branches of government or individual offices within each branch. For example, it may be the case that local or municipal governments are made to conform to the interests of their host state government and therefore do not really represent a distinct stake in the system development. Aggregation involves combining multiple stakeholders with similar roles or functions into a single stakeholder. For example, one might combine different news outlets into a single stakeholder: the Media.

Once the stakeholders for the system are identified and reviewed, one must identify the goals and objectives for the system development. A similar process of structured and iterative brainstorming, interviews, and review of documents in the public domain is used to identify the goals and objectives for system development, which can be further refined using classification schemes as discussed above. When analyzing complex systems, especially those in the public

domain with wide-ranging and disperse impacts, beginning with qualitative approaches is essential so as to preclude premature focusing on a limited number of alternatives for development to the neglect of others which may emerge during the process of data collection and analysis (Varvasovszky & Brugha, 2000). Therefore, the principal objective in the first phase of PCBA is to identify the issues, actors, and system objectives, generating rather than testing a range of hypotheses. In this, careful judgment is needed to avoid premature assumptions on subsequent directions for the analysis.

The identification of stakeholders and objectives is an iterative process that is refined as the analyst improves their knowledge and understanding of the system. And often deciding when to stop this phase and to prepare for the rest of the analysis is difficult because there is no standard test for "completeness." One can never definitively say whether all of the stakeholders and all of the objectives necessary for the analysis have been included. However, there are a number of logic checks that can help to maintain due diligence in identifying the system stakeholders and objectives. For example, if there is a stakeholder interest that does not seem to be reflected in the objectives, then perhaps it should be included. Conversely, if there is an objective in which no stakeholders are interested, it should either be removed or the analyst should think of other stakeholders who might be involved in the system around this objective. Once the stakeholders are identified and the system development objectives are determined, the stakeholders' interests are mapped to the objectives to form a stakeholder-objective matrix.

### 3.1.3 Developing a Stakeholder-Objective Matrix

The approach used to generate the stakeholder-objective matrix for PCBA is similar to that proposed by Honadle & Cooper (1989). Honadle and Cooper's matrix arrays the primary actors or stakeholders across the horizontal axis, and on the vertical lists a series of problems upon which those stakeholders might have some impact or capacity to help resolve the issue. Their matrix, however, is not clear about how stakeholders can actually help in resolving the problem indicated, merely that they might be able to, and does not indicate the level of interest of the stakeholder in the problem nor the direction of that interest (Bryson, 2004). As a "first cut" mechanism for illustrating the array and range of problems and stakeholders, Honadle and Cooper's approach is quite useful and we can form a similar matrix of stakeholders and their interest in the system development objectives.

The process of mapping stakeholders to objectives also has similarities to the mapping of customer attributes with engineering characteristics in the relationship matrix within quality function deployment (QFD) applications (Akao, 1998; Kim, Moskowitz, & Shin, 2012). In our case, objectives describe desired future outcomes, so that relating stakeholders to objectives provides insight into how each stakeholder hopes to improve the system.

By indicating the stakeholder's interest not as a binary variable but as a categorical variable, which differentiates whether a stakeholder has 'no interest,' 'weak interest,' 'medium interest,' or 'strong interest' in each objective, we can mitigate some of the drawbacks of Honadle and Cooper's approach and capitalize on work in QFD applications. If a stakeholder is concerned about improving a given objective, a ○, ◑, or ● is entered into the corresponding cell indicating whether the stakeholder has a weak (○), medium (◑), or strong (●) interest as in Table 2. If an actor has no interest in the objective, the corresponding cell is left blank.

**Table 2.** Key for symbolic stakeholder-objective matrix.

| Interest Level | Symbol |
|---|---|
| No interest |  |
| Weak stakeholder interest | ○ |
| Medium stakeholder interest | ◑ |
| Strong stakeholder interest | ● |

This complete and symbolic stakeholder-objective matrix will be converted into a set of numeric vectors, reduced in dimension, and then input into the second and third phases of PCBA to identify possible collaborative partnerships that have the similarity of beliefs necessary for coalition building and the incentive to work together.

## 3.2 PHASE 2: CLUSTERING

In Section 2.3, we assert that stakeholders of a sociotechnical system will consider forming coalitions only with those other stakeholders who share interest in a similar set of objectives for the development of the system. This was based on well-tested hypotheses of the Advocacy Coalition Framework and the idea of belief homophily. To identify sets of stakeholders who have belief homophily, we perform clustering analysis on stakeholder-objective matrix to place actors into groups such that there is high within-group similarity of interests and low inter-group similarity. This 'operationalization' of the theory of belief homophily via clustering is reported in the literature (Zafonte & Sabatier, 1998; Elgin & Weible, 2013; Duggan, Farnsworth, & Kraak, 2013).

Clustering analysis is the task of grouping a set of objects (in our case, stakeholders) in such a way that objects in the same cluster are more similar to each other than to those in other clusters. Although most commonly applied within the fields of machine learning, pattern and image analysis, and bioinformatics, clustering analysis has also been applied extensively in market research, particularly for segmentation of customers (Mooi & Sarstedt, 2011). More recently, researchers have extended the market research application and explored the use of clustering

analysis to identify functional stakeholder clusters for management and decision-makers. Initial findings of these clustered stakeholder analyses have found that, compared with an intuitive or survey-based stakeholder categorization that often include unhelpful stereotyping, clustering of stakeholders based on literature-evidence shows "a high degree of common interests among clusters and is encouraging for those seeking to maximize dialogue and consensus forming" (Duggan, Farnsworth, & Kraak, 2013). This demonstrates that clustering analysis as an unsupervised learning technique can identify stakeholder structures that are not captured by simple professional judgment. This may be particularly true if the number of objects (stakeholders) is large and the underlying pattern among the many similarity measures is not evident from inspection alone (Johnson, 1967).

Zafonte and Sabatier identified coalitions using a method of k-means clustering analysis and silhouette means (1998). Modifying this approach Elgin and Weible use a series of questions on policy core beliefs relating to the particular problem of climate change and proposed policy solutions (2013). They then partition the actors into clusters based on the similarity of their policy beliefs (as captured by their answers to the survey questions). They perform the clustering for two, three, or four advocacy coalitions and then evaluate the "goodness of fit" of the various coalitions by assessing the average silhouette values of the clustered coalitions (Elgin & Weible, 2013).

PCBA chooses to employ a different clustering approach similar to that employed by Duggan, Farnsworth, and Kraak (2013). Performing clustering analysis involves four main decisions, which we will discuss in detail in the context of PCBA:

1. Choosing the clustering variables,
2. Deciding on the clustering procedure or type,
3. Selecting a measure of (dis)similarity, and
4. Selecting a clustering algorithm

For the first three decisions, all applications of PCBA will follow the same choice of clustering variable, clustering procedure, and measure of (dis)similarity. For each we will discuss the tradeoffs involved and the reason for making the particular choice. For the fourth and final decision we will discuss the options and why one might want to choose different algorithms based on the case study.

### 3.2.1 Choosing the Clustering Variables

The first step in a clustering analysis is deciding on the characteristics or variables that will be used to group the objects (stakeholders). In our case, since we are interested in which stakeholders have similar levels of interest in the system development objectives (and therefore greater belief homophily), the logical choice of clustering variables are the system objectives. This follows a recent trend in clustering analysis performed for market research, where the use of

40

general, directly measurable or observable variables is being replaced by analyses performed with product-specific unobservable variables. It has been found that the use of more specific, unobservable variables (like an stakeholder's categorical level interest in an objective) generally provides better guidance for decisions on market instruments' effective specification (Mooi & Sarstedt, 2011). In other words, the clusters found using specific unobservable variables are usually more homogenous and the actors within the groups respond more consistently to actions taken on the system (Wedel & Kamakura, 2000).

Generally it is best to avoid using an abundance of clustering variables, as they increase the chances that the variables are no longer dissimilar or "independent" (Mooi & Sarstedt, 2011). If there is a high degree of correlation between the clustering variables (in this case the objectives), then specific aspects covered by these variables will be overrepresented in the clustering solution. Therefore, we suggest reducing the number of objectives included in the stakeholder-objective matrix by combining objectives that have a high degree of correlation to avoid overrepresentation in the clustering. By combining similar objectives, we can reduce the number of clustering variables without losing important differentiating information among the actors and their interests.

## 3.2.2 Deciding on the Clustering Procedure or Type

Now that we have chosen to cluster the stakeholders based on their level of interest in the system development objectives, we must choose the type of clustering procedure. Different types of clustering methods produce different results, and therefore one must consider the application before choosing a method. In general there are two broad types of clustering procedures: flat or partition clustering and hierarchical clustering. We discuss the main advantages and disadvantages of each type of clustering and explain why we choose to employ hierarchical clustering in the application of PCBA.

The most common methods of flat or partition clustering are k-means clustering (which reduces the within-group sum of squares) and Gaussian mixture algorithms (Fraley & Raftery, 1998). K-means clustering is simple and easy to implement efficiently and is therefore often used to reduce massive data sets to centroids, where the meaning and quality of the resulting clusters is of less importance. However, the simplicity of the procedure comes with two main drawbacks: 1) the results of k-means clustering depend on the random initialization of the algorithm and are sensitive to outliers and noise, and 2) the analyst must specify the number of partitions or groups at the onset of the analysis.

The first drawback is easily mitigated by averaging the analysis over a number of runs, each with a random initialization; however, the results will still not be completely reproducible. The second drawback could be a particularly serious limitation for our *predictive* application since there is no

way of knowing a priori how many distinctive groups or clusters of stakeholders would best represent the current and future states of a system's development. Optimizing a k-means clustering analysis for a range of partition numbers can mitigate this limitation to some extent. Combined these two limitations make flat or partition clustering a less suitable methodology for our prospective application.

The second type of clustering analysis is hierarchical clustering. With this type of clustering, the number of clusters or partitions does not need to be given as an input and there is no need to specify an initialization condition. This addresses the first and second drawbacks listed above for k-means clustering. Another strength of hierarchical clustering is that partitions can be visualized using a tree structure (or dendrogram), which allows an analyst to view clusters at different levels of granularity (Rai, 2011). Therefore, hierarchical clustering is more transparent and allows the analyst and other users of the analytic results to trace back through each step of the clustering algorithm to see not just which actors are clustered together, but also how dissimilar they are to other clusters (based on how close to the trunk of the tree the two clusters branch from one another). This flexibility and transparency in visualizing how the actors can be clustered is appropriate for the intended audience and application of PCBA, which seeks to provide a common framework of discussion for project planners and system stakeholders with differing backgrounds. Therefore we choose to use a hierarchical clustering approach for PCBA.

Within hierarchical clustering approaches, there are two main approaches: divisive (top-down) or agglomerative (bottom-up) hierarchical clustering. For our analysis we use the more common agglomerative (bottom-up) hierarchical clustering approach. An agglomerative hierarchical clustering procedure starts will all actors in their own singleton cluster. These clusters are then sequentially merged according to their similarity. First, the two most similar actors (i.e. those with the smallest distance between them) are merged to form a new cluster at the bottom of the hierarchy. In the next step, another pair of actors or clusters is merged and linked to a higher level of the hierarchy, and so on. The algorithm runs until all stakeholders are merged into a single cluster.

One drawback of hierarchical clustering analysis that we can see from the agglomerative algorithm is the fact that a cluster on a higher level of the hierarchy always encompasses all clusters from a lower level. This means that if an actor is assigned to a certain cluster, there is no possibility of reassigning this object to another cluster (an important distinction between hierarchical and partition methods like k-means). The implications of this on the PCBA results are an important area of further exploration. Another potential disadvantage of hierarchical clustering is that it can be computationally slow compared to flat clustering since it has to make several merge or split decisions for each iteration (Rai, 2011). However, in our case study the size of the stakeholder-objective matrix is small and hence this is not a significant limitation. Therefore, based on the above discussion we conclude that hierarchical clustering is more

appropriate for our application because it does not require prior specification of the number of partitions, it does not depend on initialization conditions, and because it provides a visual, traceable, view of partitions at different levels of granularity (similarity of interests).

### 3.2.3 Selecting a Measure of (Dis)Similarity

In any clustering analysis, the choice of the similarity measure and the scale of the numeric vector entries are very important. Similarity or dissimilarity among actors is measured either by correlation or distance depending on the application and the class of data being compared. In general, correlation is used when the focus of the clustering is on the relative magnitude of a clustering variable. In our case study, we would use correlation if we wanted to emphasize the difference in interest level ('none,' 'weak,' 'medium,' or 'strong') among objectives for the same actor. Conversely, distance measures are used to give more weight to the relative magnitude of each variable across objects (or stakeholders) (Mooi & Sarstedt, 2011). Since we are trying to cluster the actors based on their belief-relations to one another, this would suggest the use of a distance measures.

The distance measure used depends on the type of data captured by the clustering variables. Most distance measures can be applied to metric (ratio or interval) or ordinal data; however applying them to nominal or binary data is meaningless. Euclidean distance (or straight-line distance) is the most commonly used type when it comes to analyzing ordinal, ratio or interval-scaled data. In applications of PCBA, we have three levels or values of interest ('none,' 'weak,' 'medium,' or 'strong') that can be ranked. These data could be seen as ordinal, since the quantities have a natural ordering. Therefore we use Euclidean distance, defined as the square root of the sum of the square differences in the interest levels in the objectives, to calculate the distance between any two stakeholder's interest vectors. The distance equation is given below, where X and Y are any two stakeholders, $i_x$ is the interest-level of stakeholder X in system objective $i$, and $n$ is the total number of system objectives in the matrix:

$$d_{Euclidean}(X, Y) = \sqrt{\sum_{i=1}^{n} \left(i_x - i_y\right)^2}$$

### 3.2.4 Selecting a Linkage Algorithm

Although the choice of the (dis)similarity measure is important, perhaps more critical to discovering the underlying cluster structure is the choice of the linkage algorithm. There are several agglomerative hierarchical clustering procedures and they can be distinguished by the way they define the distance from a cluster to a certain object (stakeholder) or to other clusters in

the solution. The most popular agglomerative clustering algorithms define the distance between two clusters as the following:

- Single linkage (nearest neighbor) – the shortest distance between any two members in the two clusters
- Complete linkage (furthest neighbor) – the longest distance between any two members in the two clusters
- Average linkage – the average distance between pairs of the two clusters' members
- Centroid – the distance between the two centroids, geometric center of mass, or arithmetic mean position of all the points in the cluster

These algorithms and how they define the distance between two clusters are depicted in Figure 4, with the points representing the full n-dimensional interest vector of the stakeholders (with n being the number of system objectives used in the clustering analysis) (Mooi & Sarstedt, 2011).

**Figure 4.** Common algorithms for determining the distance between clusters

**Single linkage (nearest neighbor)**
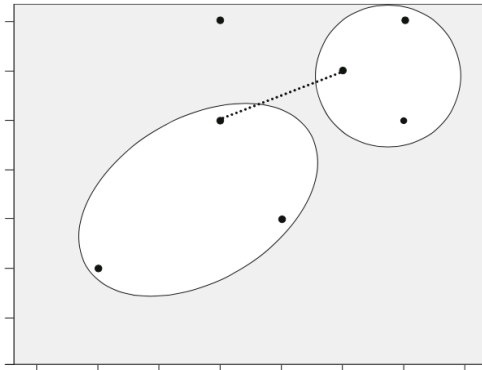
**Complete linkage (furthest neighbor)**
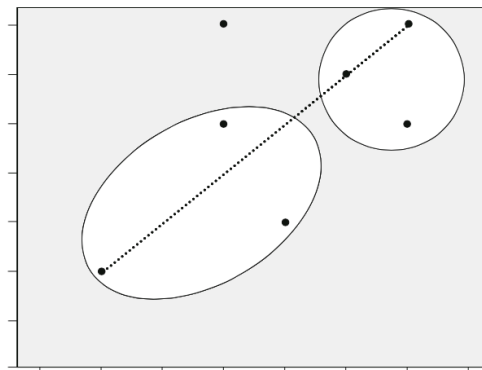
**Average linkage**
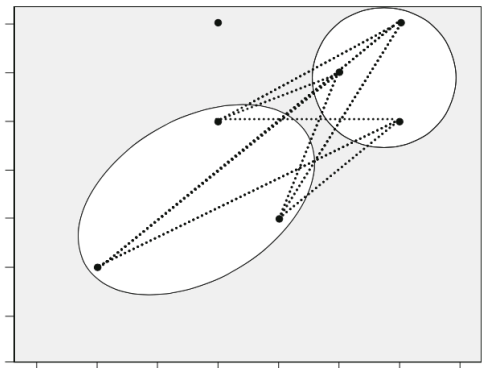
**Centroid**
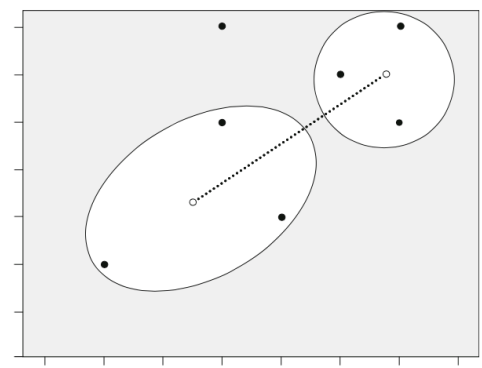
These linkage algorithms often yield different results when used on the same dataset. As the single linkage algorithm is based on minimum distances, it tends to form one large cluster with the other clusters containing only one or few objects each. Generally, single linkage is considered the most versatile algorithm and it is often best at detecting outliers. The opposite of single linkage, the complete linkage method, is strongly affected by outliers and often produces many compact and tight clusters. The average linkage and centroid algorithms tend to produce clusters with rather low within-cluster variance and similar sizes (Mooi & Sarstedt, 2011). Another commonly used approach in hierarchical clustering is *Ward's method*, which combines objects whose merger causes the smallest increases in the overall within-cluster variance rather than combining the two most similar objects. Ward's method is best used when the analyst expects somewhat equally sized clusters and the dataset does not include outliers (Mooi & Sarstedt, 2011).

Given this discussion, there is no one clustering algorithm that is best for all applications of PCBA. Instead, the choice will depend on the historical and cultural context surrounding the project and its stakeholders. For example, for the first case study on the NEC presented in Chapter 4 we have decided that, despite its sensitivity to outliers, we will employ the complete linkage method. We choose this linkage algorithm because, given the history of fragmentation among stakeholders of the NEC transportation system, we do not expect stakeholders to form equally sized clusters nor do we expect one large cluster of NEC stakeholders. Instead, we would expect many compact clusters (some being single stakeholders) around particular interests.

For the second case study on the Tōhoku Shinkansen extension in Chapter 5 we have decided to use the versatile single linkage method. Unlike the stakeholders on the NEC of the United States that have a history of fractious interests, the stakeholders surrounding Japanese high-speed rail development have a long history of collaboration with well-defined and complementary roles. Therefore, we might expect the stakeholders of the Tōhoku Shinkansen system to form one large cluster, with the possibility of a few outliers. This suggests the use of a nearest neighbor algorithm such as single linkage.

### 3.2.5 Interpreting the Clustering Output

Given the above discussion, any application of PCBA takes as its input the stakeholder-objective matrix with interest levels of 'no interest,' 'weak interest,' medium interest,' or 'strong interest.' After coding these categorical interests into a numeric scheme and eliminating correlation among the objectives, we run an agglomerative hierarchical clustering analysis to group stakeholders based on their interests in the system objectives using Euclidean distance as our dissimilarity measure. This analysis produces a dendrogram that can help us visualize which actors are most similar in their interest for the HSR system development.

Figure 5 shows the dendrogram produced by the hierarchical clustering analysis for the stakeholders of the Tōhoku Shinkansen system described in Chapter 5. At the right of the diagram at position zero we have the finest level of detail, where the actors are each placed into their own singleton cluster based on their unique interests in the system development objectives. When two branches come together at a node, this indicates that the two stakeholders have been clustered together based on their interests in the system objectives. The further to the left this node is located on the diagram, the less-similar the interests of the stakeholders in the cluster are and therefore the less likely the cluster will form according to belief homophily. For our analysis, we interpret less similarity among actors as indicative of the need for more compromise on interest or more effort expended in order to work together and form a coalition. Indeed, while similarity of interest is a necessary condition for coalition building, it is not sufficient and therefore this coalition may never form. Certain incentives must be in place for the actors in the cluster to work together. Therefore, in the dendrogram the further left the node where two actors come together, the less likely they are to form a coalition based on their interests based on the second phase of PCBA, and the more incentive there will need to be in the third phase of PCBA.

**Figure 5.** Example of a dendrogram clustering stakeholders by their interests in the system objectives.
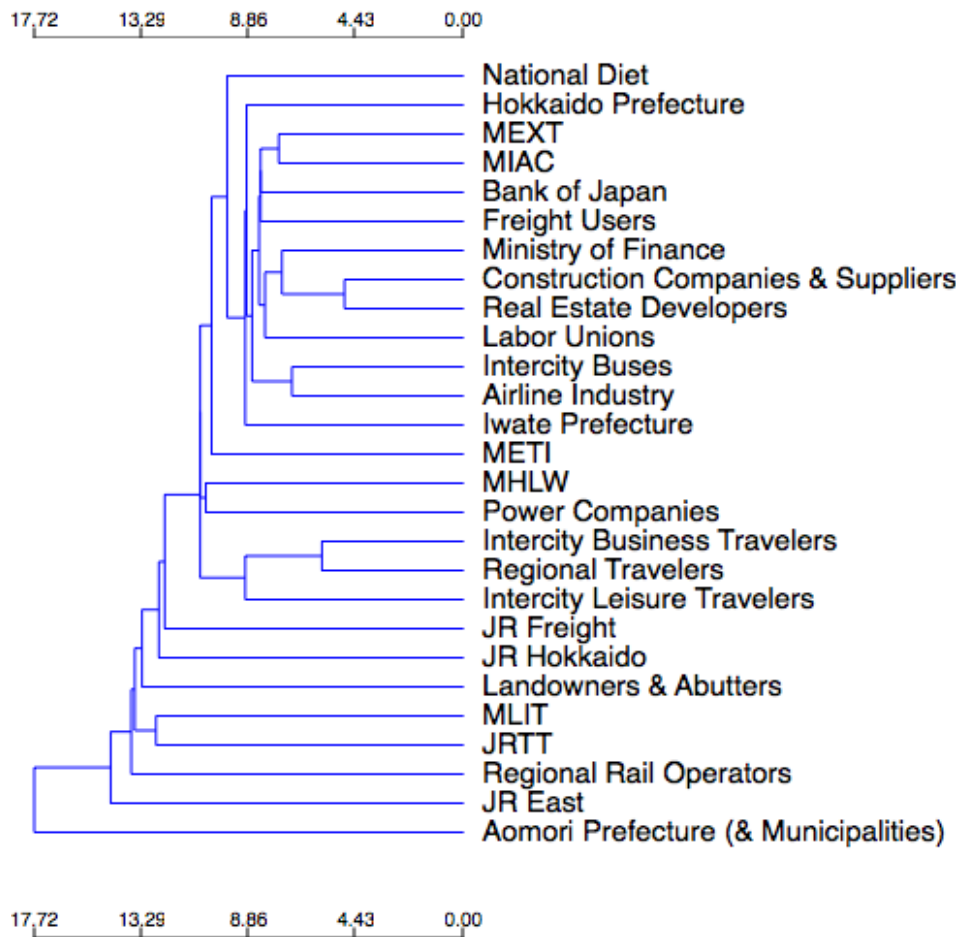
When interpreting a cluster analysis it is important to realize that this method is mostly an exploratory technique whose results provide only rough guidance for managerial decisions (Mooi & Sarstedt, 2011). Further explanation on the application of PCBA, how to interpret the results, and the added value of the technique are found throughout the case studies of high-speed rail development in Chapters 4 and 5.

One might wonder how performing a clustering analysis on the current state of the institutional sphere can provide insight for a predictive analysis. To support this, we can draw on general conclusions of public policy research into stakeholder behavior. Applications of the Advocacy Coalition Framework (ACF) suggests that policy subsystems are structured around competing advocacy coalitions that are stable for long periods of time, often much more than a decade (Leifeld, 2013; Elgin & Weibel, 2013). This equilibrium guarantees policy stability and is only interrupted when external perturbations cause coalition members to refine their internal belief systems significantly. In other words, the interests of stakeholders do not change readily. Therefore, we claim that clustering based on an understanding of the institutional context of the system at present is extensible; coalitions are most likely and easily built along current channels and understanding the similarity of interests among actors at the present time will give insight into support for system development for a number of years. If there were to be such a major policy shift, the identification of stakeholders, system objectives, and their mapping could each change. In this case, any stakeholder analysis methodology, including PCBA, would need to be reapplied to the new situation.

Although the second phase of PCBA describes the channels along which coalitions might form surrounding sociotechnical system development, it has not yet discussed the likelihood of the stakeholders forming these relationships. In other words, we have identified stakeholder pairs or groups that have enough "belief homophily" to work together and who they would most likely reach out to were they to strengthen their stake in system development. But we have not yet identified what incentive they have for working together rather than alone or what barriers might prevent the formation of the coalition. This is the contribution of the third phase of PCBA.

## 3.3 PHASE 3: INCENTIVES

The third phase of PCBA considers the output from the hierarchical clustering in the second phase and uses ideas from the Institutional Analysis and Development (IAD) Framework and Mitchell, Agel, & Wood's theories in business and management literature to discuss incentives and barriers to coalition building among the clusters of stakeholders. This combination of the Mitchell, Agel, & Wood typology with public policy analysis of multiple stakeholders and their interests is similar to Yu, Chen, Chen, and Chang's modified QFD application to public policy (2012).

Drawing on the theory of stakeholder typology and salience (Mitchell, Agel, & Wood, 1997), we assign each stakeholder any of three characteristics – *power, legitimacy, and urgency*. The assignment of stakeholder attributes is binary. In the traditional strategic management framework, all of these attributes apply to the relationship of a stakeholder to the corporate entity. However, in our application we consider these attributes according to the relationship between the stakeholder and the development of sociotechnical system:

- Power is the ability of a stakeholder to impose its will on the development of the project; it is the ability of a stakeholder to get another stakeholder in the system to do something that it would not otherwise have done.
- Legitimacy is a socially constructive, normative concept – it is the generally perceived assumption that a stakeholder has a proper claim to influence system development.
- Urgency is a function both of the time-sensitivity of the issue *and* of whether the stakeholder considers the issue to be of vital importance.

It is important to note that the initial determination of stakeholder attributes is a matter of multiple perceptions and as such is an inherently subjective process. Since stakeholder analysis relies, in some part, on the professional judgment of the analyst, it is important to have attribute assignments peer reviewed and to provide a transparent discussion of why each attribute determination was made (Varvasovszky & Brugha, 2000). Following this best practice, all stakeholder attribute assignments are accompanied by a brief explanation of our reasoning in the application of PCBA to the case studies in Chapters 4 and 5.

After assigning each stakeholder its appropriate attributes, the actors can be arranged into one of eight stakeholder classes or types based on the combination of stakeholder attributes the stakeholder possesses. From these classes, we can determine stakeholder salience, or the degree to which the development plan for the sociotechnical system will give priority to competing stakeholder claims. According to the framework, stakeholder salience is positively related to the cumulative number of stakeholder attributes – power, legitimacy, and urgency – perceived to be present (Mitchell, Agel, & Wood, 1997).

This assignment of attributes and typology is not static. Any stakeholder can gain saliency by acquiring a missing attribute individually or through partnership (Mitchell, Agel, & Wood, 1997). In this way, the typology allows prediction about the circumstances under which a stakeholder of one type might attempt to acquire a missing attribute, often through cooperation with other stakeholders, and thus enhance its salience and ability to influence the development of the sociotechnical system. Therefore, acquiring a missing stakeholder attribute and gaining influence on the development of the system provides a powerful incentive for partnership. In the case of a partnership, it is assumed that any attribute possessed by either of the two stakeholders will be possessed by the coalition. Therefore, the set of attributes of the coalition is the union,

rather than intersection, of the sets of attributes of the individual stakeholders making up that coalition.

Depending on the stakeholder typology of the stakeholders within the cluster, the incentive for partnership can be nonexistent, one-sided, or two-sided. If the two stakeholders have the same typology and neither can gain an attribute from partnership, it is unlikely that they would put in the effort to work together. This is a case of nonexistent incentive. If one stakeholder in the cluster could gain an attribute through partnership, but the possible partner already has any attribute this stakeholder could lend, the incentive would be one-sided. Therefore, we note that even if a stakeholder or cluster has gained all three attributes and status as a definitive stakeholder, it does not necessarily preclude another actor joining. Instead, it implies that when working with a definitive stakeholder or joining a fully salient cluster, the onus is on the less salient actor to be the one to make compromises in its interests in order to achieve a relationship with only one-sided incentives. Finally, if both parties can lend different, missing attributes to each other, the incentive for cooperation is highest and the coalition is likely. After considering the incentive structure implied by the stakeholder typologies within the cluster, we discuss historical or existing relationships between the stakeholders and any possible legal or political barriers to coalition building identified in the IAD Framework (see Section 2.3.2).

The three-phase PCBA presented here blends together techniques and conclusions from stakeholder analysis in both public policy and strategic management literature. By doing so, we have developed a predictive tool for stakeholder analysis for complex sociotechnical systems that not only accurately reflects the current state of inter-stakeholder relationships surrounding a sociotechnical system and its development, but also provides useful information about how stakeholders may come together to form coalitions. The visual and predictive nature of PCBA distinguishes it from other methods for exploring how multiple stakeholders can affect the implementation of large infrastructure and engineering projects that have many disparate objectives. We claim that PCBA can provide real, transparent insight at a macro scale – all features that are useful for policy-makers who want to easily understand and visualize the broad institutional context of the system.

This chapter provided the methodological foundation for the development and application of PCBA. The following chapters apply this methodology to two case studies of high-speed rail development: the Northeast Corridor of the United States and the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori, Japan. Through these case studies we show the insight that can be gained from application of PCBA, perform sensitivity testing on certain assumptions and tuning parameters in the clustering procedure, and compare results to those of other methods, existing domain knowledge, and historical trends.

# CHAPTER 4.

# CASE STUDY I: THE NORTHEAST CORRIDOR OF THE UNITED STATES

In this chapter we present the application of Predictive Coalition Building Analysis (PCBA) to the case study of the transportation system and high-speed rail development along the Northeast Corridor (NEC) of the United States. First we introduce and motivate the specific case of the NEC in Section 4.1. Then, in Section 4.2, we present the results of the data collection phase of the analysis. We identify the stakeholders of the system, including government departments and agencies from the national to the local level, private sector interests, and key user groups. Then goals for the development of the transportation system are identified and further broken down into objectives for high-speed rail development along the NEC. These objectives are not simply related to improving transportation system performance, but also consider external impacts of the transportation system, the financial viability and profitability of the project, and the robustness of the resulting transportation system and its management. Then we can create a matrix that maps each stakeholder's interests to the objectives for future system development. This matrix is the input for the second phase of PCBA: clustering.

We perform hierarchical clustering analysis and discuss general implications of the resulting grouping of stakeholders from the second phase of PCBA in Section 4.3. In Section 4.4, stakeholder attributes and typologies are assigned to each of the stakeholders identified for the NEC and the implications of the third phase of PCBA are discussed. With this discussion, we present general conclusions about the future of transportation development along the Northeast Corridor.

In the final sections of the chapter, we address the validity and robustness of the results of PCBA as it applies to the case study of the Northeast Corridor. In Section 4.5, we compare the results obtained from Predictive Coalition Building Analysis with those from application of Multi-Stakeholder Trade Space Exploration (MSTSE). By comparing to the results of other existing techniques, we can discuss the validity and added value of PCBA in understanding the uncertainties and possible futures of stakeholder relations surrounding HSR development along the NEC. In Section 4.6, we explore the robustness of the PCBA methodology by imposing perturbations on the stakeholders and their interests in the system objectives. We conclude by discussing how PCBA captures changes such as the emergence of a new stakeholder or changes in a stakeholder's interests or typology and the implications of these changes for the transportation system of the NEC.

## 4.1 INTRODUCTION TO THE NORTHEAST CORRIDOR OF THE UNITED STATES

The Northeast Corridor of the United States stretches 457 miles from Washington, DC, through Philadelphia, PA and New York City, NY to Boston, MA. In addition to connecting four of the ten largest metropolitan areas in the United States, the Northeast Corridor is the most densely settled region in the United States. The NEC contributes 30 percent of all jobs in the United States and accounts for 20 percent of the nation's GDP (NEC Future, 2016).

The economic activity and population density of the NEC is supported by a complex transportation system. However, much of the infrastructure along the corridor was built around the turn of the 20th century and is in need of repair and rehabilitation. As a result, the corridor has been plagued for decades with growing congestion on its roads, in the air, and on its rails, which have not been able to keep up with and support regional growth.

The NEC is one of the most complex and congested railroad territories in the world. Close to 2,200 passenger trains use the NEC with a total of 750,000 people riding along some part of the corridor each day (NEC Future, 2016). In fact, nearly half of all commuter trips and a third of all intercity passenger rail trips nationwide rely on some portion of the NEC network of tracks, stations and facilities (Amtrak, 2014b). In addition to the passenger traffic, 70 freight trains use the NEC daily, amounting to over 350,000 carloads per year.

Future population, employment, freight, and economic growth is projected in the Northeast region that will further strain the transportation infrastructure unless there is significant investment to accommodate future capacity, frequency, reliability, and travel time needs of NEC travelers, particularly with market-competitive passenger rail service (NEC Future, 2015). While the technological feasibility and criticality of high-speed rail development has been well studied along the corridor, significant institutional barriers make planning and implementation of alternatives difficult. Therefore, one might assert that the social and political complexity is one of the most significant barriers to high-speed rail development and transportation improvement along the corridor.

There are many institutional complexities surrounding HSR investment on the NEC corridor, such as federal and multi-state politics, complicated funding structure, many travel modes, and multiple rail owners and operators. For example, the rail infrastructure spans from Washington, D.C. through nine states, each with their own funding, laws, and regulations for transportation on the road, in the air, and on the rails. Within many of those states, strong municipal governments further complicate the political situation. Furthermore, the rail system alone has four infrastructure owners and nine passenger rail operators that compete for limited capacity (see Figure 6).

**Figure 6.** Map of Northeast Corridor rail infrastructure owners and passenger rail operators (NEC Infrastructure Master Plan Working Group, 2010)
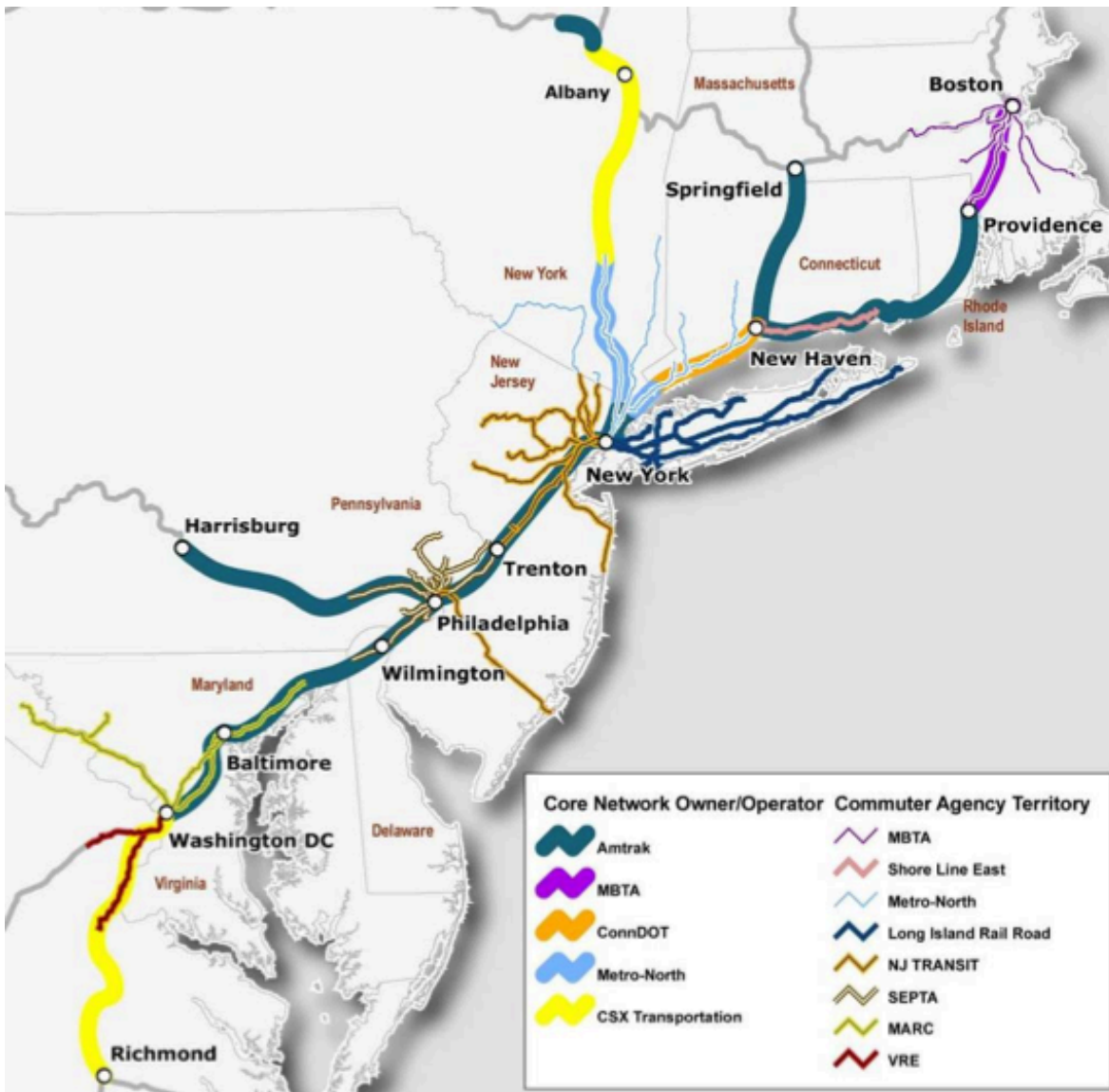


It is this institutional complexity and its importance in the development of HSR (as a sociotechnical system) and the many uncertainties in how the stakeholders of the system might work together towards HSR implementation that make the NEC a particularly interesting case study for PCBA. With this case study, we evaluate PCBA's ability to deliver useful insights to a relevant and realistic problem of large scale and complexity.

## 4.2 PCBA PHASE 1: DATA COLLECTION

The application of PCBA requires a comprehensive understanding of the sociotechnical system in question. Ultimately, the first phase of PCBA gathers data and consolidates the analyst's domain knowledge into a matrix that maps the level of each stakeholder's interests to the system development objectives. In each step towards development of the stakeholder-objective matrix, the decision of how to characterize the stakeholders, the objectives, and the stakeholders' interests in these objectives can all influence the outcome of the stakeholder analysis (see Chapter 3). Therefore, transparency of the input and its development are crucial for stakeholder buy-in and understanding. In this spirit of transparency, this section presents each step in the development of the PCBA input for the case of high-speed rail on the NEC and serves as an example of the level of detail and effort required for other similar applications of the method.

### 4.2.1 Identifying and Describing Stakeholders of the NEC HSR System

The first step in any stakeholder analysis should be the definition and identification of who is and is not a stakeholder in the system. Through structured and iterative brainstorming and review of relevant documents, we identified 30 stakeholders for the NEC HSR system. These stakeholders included (1) government agencies at the federal, state, and local level, (2) private sector actors such as transportation operators, financial sector stakeholders, and those involved in or affected by construction of new infrastructure, and (3) transportation users. The final category of stakeholders for HSR system development along the NEC is transportation users. Transportation users are a diverse group of single individuals or small groups whose views are likely to vary based on their sociodemographic characteristics and travel patterns. For the purposes of this study, we choose to divide users first based on their type of transport activity – namely, the use of passenger vs. freight service – and on their demand for certain trip lengths – intercity vs. urban. Therefore, we discuss the collective stake of intercity passengers, commuters, and freight users. Figure 7 lists the stakeholders identified in this case study, which are each described in more detail in the following text.

**Figure 7.** Stakeholders identified for the NEC.



**Government**

Federal Level
- Congress
- USEPA
- Dept. of Commerce
- Dept. of Energy
- USDOT
  - FRA
  - FTA
  - FAA
  - FHWA

State and Local Level
- State Governments
- Local & Municipal Governments
- Commuter Rail Agencies
- Urban Public Transit Organizations
- Terminals
- NEC Commission
- I-95 Coalition
- Port Authorities

Amtrak

**Private Sector**

Operators
- Airline Industry
- Freight Railroads
- Trucking Industry
- Intercity Bus Operators

Construction & Real Estate
- Private Consortiums
- Suppliers
- Labor Unions
- Private Landowners
- Abutters

Financial Sector
- Banking Industry
- Insurance Industry

Political Activists/Lobbyists

Media

**Users**

Intercity Travelers

Commuters

Freight Customers

## Congress

Congress is the bicameral legislative branch of the United States federal government based in Washington, D.C. The House of Representatives has 435 seats apportioned by population to state districts across the U.S. and filled by directly elected members serving two-year terms. The Senate is comprised of two directly elected senators from each of the 50 states, filling a total of 100 seats. Senators serve six-year terms on a rotating election system (so that approximately one-third of seats are up for election every two years). Although each of the chambers of Congress has unique powers, in general both must be in agreement for laws to pass.

Any federal funding for high-speed rail (or any other transportation initiatives) has to pass through both houses of Congress. In recent history Congress has considered the transportation budget on a year-by-year basis without guaranteeing a certain level of funding for future investment. This uncertainty in funding levels makes it especially difficult to plan multi-year infrastructure investment projects. Although leadership from the executive branch of government (the President and his cabinet) can influence the chances of a funding bill being approved by Congress, the distribution of political affiliation in both chambers can also have a strong impact on its chances.

It is important to note that within each house of Congress, representatives and senators sit on different committees that review bills. For a bill to make it to the floor of Congress for a vote, all committees with jurisdiction over any part of the bill must approve it. Given the interconnected nature of high-speed rail systems and impact of transportation initiatives on the environment, the economy, and communities, any federal HSR initiative in the U.S. would need to be reviewed by many of these committees. For example, an HSR bill in the House of Representatives could see review by any or all of the following committees: Appropriations, Budget, Energy, Financial Services which oversees urban development, Natural Resources, Science, Space and Technology, Transport and Infrastructure, and Ways and Means. A similar range of committees also exists in the Senate.

**United States Environmental Protection Agency (USEPA)**

The USEPA is an executive agency of the U.S. federal government given authority to develop and enforce environmental and safety regulations based on laws passed by Congress. One of the missions of the USEPA is to ensure "all Americans are protected from significant risks to human health and the environment where they live, learn, and work" (USEPA, 2015). Although the USEPA does not deal with transportation issues directly, it would be concerned with the impacts associated with NEC investment from the perspective of increases or decreases to air pollutant emissions, use of land, and impacts to water quality.

The National Environmental Policy Act (NEPA), which is administered by the EPA, requires federal agencies to integrate evaluation of possible environmental impacts of their actions and reasonable alternatives into their decision-making process. Any transportation infrastructure project that is partially funded through a grant from the USDOT or other government agency is subject to compliance with NEPA regulations. Thus each project must develop an Environmental Impact Statement (EIS). The EIS will provide a comprehensive, interdisciplinary evaluation of the best engineering solution in consideration of potential impacts on the adjacent community and environment. The EIS must consider reasonable alternatives, including the "No Action" alternative, and discuss mitigation initiatives if environmental impacts must be incurred. Coordination with the public and federal, state, and local agencies will be an integral part of the study and provide valuable input for project decision-making.

**United States Department of Commerce**

The U.S. Department of Commerce is a Cabinet-level department of the executive branch of the U.S. federal government. According to its mission statement, "the U.S. Department of Commerce promotes job creation, economic growth, sustainable development and improved standards of living for all Americans by working in partnership with businesses, universities, communities and our nation's workers. The department touches the daily lives of the American

people in many ways, with a wide range of responsibilities in the areas of trade, economic development, technology, entrepreneurship and business development, environmental stewardship, and statistical research and analysis" (U.S. Department of Commerce, 2016). The Department of Commerce gathers economic and demographic data to measure the health and vitality of the economy, promotes U.S. exports, enforces international trade agreements, and regulates the export of sensitive goods and technologies. The Department of Commerce also issues patents and trademarks, protects intellectual property, forecasts the weather, conducts oceanic and atmospheric research, provides stewardship over living marine resources, develops and applies technology, measurements and standards, formulates telecommunications and technology policy, fosters minority business development, and promotes economic growth in distressed communities.

The Department of Commerce would be interested in transportation development along the NEC that would continue to promote economic growth in the region. If a decision were made to develop high-speed rail in the U.S., the Department of Commerce would also likely be involved in promoting and protecting the development and export of U.S. high-speed rail technology, as well as securing access to high-speed rail technology from abroad.

**United States Department of Energy**

The U.S. Department of Energy (DOE) is a Cabinet-level department of the executive branch of the U.S. federal government that works to "ensure America's security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions" (U.S. DOE, 2016). The Department of Energy's policies could influence NEC investment decisions by impacting the relative costs of different sources of energy (such as electricity generated using different raw materials, gasoline, or diesel). As a result, not only would it be important to evaluate the source and amount of energy required for high-speed rail in the NEC, it would also be important to evaluate the sustainability tradeoffs from an energy consumption perspective of increasing rail ridership at the expense of auto, bus, or airline travel, as these modes use different sources and volumes of energy.

**United States Department of Transportation (USDOT)**

The U.S. Department of Transportation is a Cabinet-level department of the executive branch of the U.S. federal government that serves the United States by "ensuring a fast, safe, efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future" (USDOT, 2015). The USDOT includes a number of operating organizations that regulate specific transportation modes. These operating organizations include the Federal Railroad Administration (FRA), the Federal Transit Administration (FTA), the Federal Aviation Administration (FAA), the Federal

Highway Administration (FHWA), the Maritime Administration, the National Highway and Traffic Safety Administration, the Pipelines and Hazardous Materials Safety Administration, and the Federal Motor Carrier Safety Administration. The USDOT in general (and the FRA in particular) is the federal department most directly concerned with the development of HSR on the Northeast Corridor. Besides direct operation allocations from Congress to Amtrak and from state governments to commuter rail agencies, USDOT and the FRA serve as important sources of transportation funding, providing grants for specific infrastructure investment projects and deciding regulations for safety and federal-state partnerships.

**Federal Railroad Administration (FRA):** Of any federal agency, the FRA has the most direct control over the NEC. Although in 1985 it transferred management control of all NEC infrastructure upgrades to Amtrak (as a result of provisions in the Passenger Railroad Rebuilding Act of 1980), it is still responsible for distributing funds for NEC upgrades and overseeing its management. The FRA is also responsible for developing and enforcing regulations that pertain to freight and passenger rail transport, such as regulations on track, signaling, and railcar standards, which would impact the cost of any high-speed rail project.

**Federal Transit Administration (FTA):** The FTA provides funding and oversight for mass-transit programs, including commuter rail. Although the FTA cannot provide funding or regulation for intercity rail transportation, a major component of high-speed rail projects is ensuring transit connectivity and easy access and egress at urban terminals.

**Federal Aviation Administration (FAA):** The FAA is responsible for overseeing the airline industry in the U.S., including commercial airlines, private plane operators, air traffic control, and airports. Although the FAA does not directly impact the NEC rail infrastructure, a decision to invest in high-speed rail in the NEC would likely impact air traffic volumes at northeast airports. Therefore, any rail policy and investment decisions should consider potential impacts to air travel demand and aviation policy.

**Federal Highway Administration (FHWA):** The FHWA is responsible for developing and overseeing the federal interstate highway network. Although its policies do not directly impact the NEC rail infrastructure, a decision to invest in high-speed rail would likely impact highway traffic along the Northeast. As a result, any rail policy and investment decisions should include the interests of FHWA and consider potential impacts of HSR development on travel demand, highway policy, and congestion faced by intercity buses and cars, trucks, and commuters on the roads.

**State Governments**

The Northeast Corridor passes through the District of Columbia and nine states: Massachusetts (MA), Rhode Island (RI), Connecticut (CT), New York (NY), New Jersey (NJ), Pennsylvania (PA), Delaware (DE), Maryland (MD) and Virginia (VA). Each state has its own goals for the NEC and will be impacted differently by any improvements. In general, states will often vie to receive the most benefit from investment while trying to reduce the costs that they must cover.

Differing goals and political views among state governments with different political affiliations and the conflict between state- and federal-level governance is likely to result in complex relationships among these stakeholders. Although there is still support for high-speed rail in the northeast, the polarized view of high-speed rail between states will make it difficult for the federal government to create a nationwide high-speed rail program. Currently, there are no formal organizations or institutionalized processes that allow states to make collective decisions regarding the NEC, but representatives from each state's Department of Transportation are part of the Northeast Corridor Infrastructure and Operations Advisory Committee, which provides a forum for discussion and possible collective action (see below).

**The NEC Infrastructure and Operations Advisory Commission**

"Congress created the NEC Commission in recognition of the inherent challenges of coordinating, financing, and implementing major system improvements that cross multiple jurisdictions. The Commission is comprised of members from each of the Northeast Corridor states, Amtrak, and the U.S. Department of Transportation and includes non-voting representatives from freight railroads and states with connecting corridors" (NECC, 2016). Mandated by Congress, a major responsibility of the Northeast Corridor Commission is the development of a standardized formula and methodology to determine and allocate costs, revenues, and compensation among Northeast Corridor (NEC) owners and operators that ensures each service takes proportional financial responsibility for its use of shared NEC infrastructure and related facilities. Although the NEC Commission is focused on improving traffic flow on the existing NEC rail infrastructure (and therefore does not have immediate jurisdiction over new HSR investment projects), it may be an important forum for negotiation among key private sector and government stakeholders.

**Local and Municipal Governments**

Given the scope of the NEC, the decision to implement high-speed rail in the NEC will be driven from federal and state levels of government. However, local governments may still play a significant role in ensuring the political viability of the system. Local governments might include county governments, metropolitan planning organizations and regional councils. Although the power of each of these levels of government varies from state to state, in general they serve

important transportation planning and land-use governance roles. As a result, engaging these levels of government in the planning process for HSR may be critical for ensuring successful implementation of the system.

Municipalities are incorporated cities, towns, or villages within or independent of a county having their own governing and taxing authority. Responsibilities of municipal governments include public safety, maintenance of city streets, parks and recreation, waste-water treatment, trash removal, zoning and building code enforcement, fire and rescue services, animal control, public transportation regulation, and other essential services. Larger cities may also provide assisted housing, operate public hospitals, and administer social welfare programs funded by the city, the state, or the federal government. Many cities also own or regulate public utilities such as water, electric power, natural gas, and telecommunications.

Of particular importance in the development of HSR along the NEC will be the city governments and mayors of the four main metropolitan areas along the corridor: Washington DC, Philadelphia, New York City, and Boston. These cities will have particular interest in the planning and funding of station development that connects smoothly with local transit and commuter modes. In addition, the governing bodies of other urban areas directly served by the corridor, such as Baltimore, Wilmington, Trenton, Newark, New Haven, and Providence, could be vocal stakeholders.

**Amtrak**

The *Rail Passenger Service Act* of 1970 created the National Railroad Passenger Corporation (Amtrak) to take over deficit-ridden intercity passenger rail services from freight railroad companies. Amtrak is the sole intercity passenger rail provider in the U.S. (Amtrak, 2014). The company is operated and managed as a for-profit corporation, incorporated under the District of Columbia Business Corporation Act (D.C. Code section 29-301). Across the nationwide network, Amtrak operates as many as 307 daily intercity trains over approximately 21,300 route miles (70% of which is not owned by Amtrak) and serves 513 communities in 46 states, DC, and three Canadian provinces. According to FY2013 data, approximately 810,000 people commute every weekday on Amtrak infrastructure or on Amtrak operated commuter trains around the country under contracts with 19 state partnerships and 5 regional commuter authorities. In 2013, it had $2.1 billion in ticket revenue, but had substantially more in expenses. Amtrak operates with a fare box recovery ratio of about 67%, with the federal government subsidizing the remainder (Amtrak, 2014a).

After recent management restructuring within the company, Amtrak's General Manager for the Northeast Corridor (NEC) Operations business line is accountable for the financial and operating performance of services that connect Boston, New York, and Washington (with a mainline route

of 457 miles). The NEC is the busiest passenger rail line in the United States and the only one currently capable of services up to 150mph (Amtrak, 2014b). Amtrak's NEC passenger rail services operate roughly 150 Amtrak trains daily serving the NEC mainline and connecting corridors, carrying 11.4 million passengers annually and delivering over $1.1 billion of passenger revenue. Amtrak's core NEC routes include the *Northeast Regional* and high-speed *Acela Express* services, which transport 76% of all passengers using rail or air between Washington, D.C. and New York City (with smaller market share for the leg between NYC and Boston) (Amtrak, 2014b). Of the 2,200 daily trains that use some portion of the Northeast Corridor, over 90% are non-Amtrak services - commuter trains operated by or for the various public authorities of the region as well as some 60 daily freight trains operated by CSX, Norfolk Southern, Providence & Worcester and Conrail. (Amtrak, 2014b)

In addition to operating the Acela and Northeast Regional train services, Amtrak serves as the infrastructure manager for the majority of the NEC. Amtrak acquired the entire segment of the NEC from Washington, D.C. to New York City and the segment from New Haven, CT to the Massachusetts-Rhode Island border in 1976 as a result of the *Railroad Revitalization and Regulatory Reform* (4R) Act. In addition to Amtrak, the State of Connecticut owns 56 miles and the Commonwealth of Massachusetts owns 38 miles of the NEC mainline. As infrastructure manager, Amtrak provides dispatching services and electric propulsion power, and coordinates maintenance and improvement of the infrastructure and facilities that are used by the commuter and freight rail services. In addition to the main line, three connecting corridors – the Springfield Line in Massachusetts and Connecticut, the Hudson Line in New York and the Harrisburg Line in Pennsylvania – have all or portions of their route under Amtrak NEC ownership and operations. Operating and capital costs of these corridors are apportioned under the terms of the Passenger Rail Investment and Improvement Act of 2008, Sections 209 and 212 (Amtrak, 2014b).

Since 1985, Amtrak has been responsible for managing infrastructure upgrades over its portion of the NEC. However, over the past decades the United States General Accountability Office has raised concerns over Amtrak's ability to adequately manage significant infrastructure projects given that its management structure and business are focused on operations. As a result, better understanding the past and future role of Amtrak will be critical for addressing the institutional uncertainties and to developing potential alternatives for HSR development on the NEC.

**Commuter Rail Agencies**

There are currently eight commuter rail agencies operating over some portion of the NEC. Although Amtrak intercity trains represent the majority of train miles traveled because of the longer distances they cover, commuter trains represent over 90% of all train trips on the NEC. The eight commuter agencies on the NEC are:

- The Massachusetts Bay Transportation Authority (MBTA)
- The Connecticut Department of Transportation Shore Line East (SLE)
- The Metropolitan Transportation Authority Metro-North Railroad (MNR)
- The Metropolitan Transportation Authority Long Island Rail Road (LIRR)
- New Jersey Transit (NJT)
- The Southeastern Pennsylvania Transportation Authority (SEPTA)
- The Maryland Transit Administration MARC (MARC)
- Virginia Railway Express (VRE)

Of these eight agencies, only the MBTA and MNR own the track over which they operate. The MBTA owns the NEC segment from Boston South Station to the Massachusetts-Rhode Island border, but has contracted with Amtrak for much of the segment's operation and maintenance. The MNR owns and operates the NEC segment from New York City to the New York-Connecticut border and also operates the NEC segment from the New York-Connecticut border to New Haven, CT, which is owned by the Connecticut DOT.

In the past, concerns have been raised that the needs of commuter rail agencies (and freight rail companies) have often not been addressed when considering increases to intercity passenger service. Even as far back as the 1970s, the "Northeast Corridor Improvement Project Redirection Study" was written in response to shortcomings of the Northeast Corridor draft Programmatic Environmental Impact Statement in addressing the concerns of commuter rail agencies and freight railroad companies (FRA, 1979). The influence of and impact on commuter rail agencies must be considered when discussing the institutional context of HSR development along the corridor. Since representatives from the commuter rail agencies are also included in the NEC Commission, the Commission may be a useful forum for negotiating these many operator interests.

**Urban Public Transportation Organizations**

Transportation to and from high-speed rail stations is an important component of the door-to-door travel time experienced by users of the system. As a result, providing high-quality transit access to high-speed rail stations will be an important component of the overall system design. While there is often significant overlap between urban public transportation organizations and commuter rail operators, large metropolitan cities often have multimodal services that include bus transit. Ensuring that commuter rail service and other forms of urban transit can continue to provide quality service while sharing track and terminals is an important consideration when planning HSR development.

In Boston, MA and surrounding areas, the Massachusetts Bay Transportation Authority (MBTA) operates transit services, including subway, bus, commuter rail and ferry. In New York City, the

Metropolitan Transportation Authority (MTA) provides most bus, subway and commuter rail services. The MTA Long Island Rail Road and Metro-North Railroad collectively own the largest commuter rail network in the U.S. with over 250 stations and 20 lines. Additionally, after Boston, the MTA has the oldest subway system in the U.S. New Jersey Transit also provides commuter rail services into New York City, but primarily serves the state of New Jersey as opposed to New York. New Jersey Transit also provides some service from Atlantic City, NJ to Philadelphia.

In the Philadelphia area, the Southeastern Pennsylvania Transportation Authority (SEPTA) operates buses, trains, rapid transit, and trolleys. Additionally, it has the third-oldest subway system in the U.S. In Baltimore, the Maryland Transit Administration provides public transit services. Baltimore also has a publicly-funded, privately-operated shuttle bus service called the Charm City Circulator, which offers free rides on three routes. In Washington, D.C., the Washington Metropolitan Area Transit Authority (WMATA) provides urban transportation services (including subway and bus service). Additionally, several commuter rail services converge in Washington, D.C., including the Maryland Transit Administration MARC trains and the Virginia Railway Express.

**I-95 Corridor Coalition**

Interstate 95 (I-95) encompasses 1,917 miles along the eastern seaboard of the United States from Maine to Florida. While the interstate extends beyond the NEC spine to the north and south, it is one of the major highways that parallel any high-speed rail development on the corridor. The I-95 Corridor Coalition region of the United States hosts many of the nation's vital governmental, business, industrial, agricultural, entertainment, and recreational activities. In order for the nation to thrive, the transportation facilities that serve these activities must be managed and operated efficiently. Since many of the trips resulting from these activities, whether transporting freight or people, cross over multiple state and authority jurisdictional boundaries, no single operating entity is responsible for the overall efficiency, safety, comfort, or cost of travel, or its effects on the environment (I-95 Corridor Coalition, 2016).

The I-95 Corridor Coalition provides a forum where key decision makers such as federal, state, and local Departments of Transportation, transit and rail agencies, port authorities, motor vehicle agencies, state police and public safety officials, and transportation industry associations can discuss intermodal connectivity, traffic incident management, tolling, and upgrade initiatives on the Corridor. These programs are partially funded through membership fees paid by participating organizations. Like the NEC Commission, it may serve as a useful space for collective discussion and action.

**Port Authorities**

In the United States, port authorities are (quasi)-governmental public authorities for a special-purpose districts formed by a legislative body to operate air and water ports and other transportation infrastructure like bridges. Port authorities can also operate shipping terminals, airports, railroads, and irrigation facilities. Most port authorities are financially self-supporting, as they own land, set fees, and sometimes levy taxes. Port authorities are usually governed by boards or commissions, which are commonly appointed by governmental chief executives, often from different jurisdictions (AAPA, 2013). Along the NEC, the primary port authorities include:

- Massachusetts Port Authority
- Bridgeport Port Authorities, CT
- Port Authority of New York and New Jersey
- Delaware River Port Authority, NJ and PA
- Philadelphia Regional Port Authority, PA
- Chesapeake Port Authority, MD and VA

In general, port authorities are charged with expanding financing sources and revenues for seaport development, including for seaport security measures, creating sustainable seaports through a balance of environmental, economic and social responsibility initiatives, securing resources for intermodal landside access to seaports, enhancing free and fair trade, and using transportation trust funds for infrastructure development, not deficit reduction (AAPA, 2013). Many others, like the Massachusetts Port Authority and the Port Authority of New York and New Jersey, also oversee the functioning of airports.

**Airports:** There are 13 major airports that serve the NEC area, including:

- Manchester-Boston Regional Airport (MHT),
- Boston Logan International Airport (BOS),
- T.F. Green Airport (PVD),
- Bradley International Airport (BDL),
- John F. Kennedy International Airport (JFK),
- LaGuardia Airport (LGA),
- Newark Liberty International Airport (EWR),
- Long Island McArthur Airport (ISP),
- Westchester County Airport (HPN),
- Philadelphia International Airport (PHL),
- Baltimore/Washington International Thurgood Marshall Airport (BWI),
- Ronald Reagan Washington National Airport (DCA), and
- Washington Dulles International Airport (IAD).

Many of the nation's most congested airports are located in the Northeast Megaregion. Due to near- or at-capacity operation, the three major airports in the New York metropolitan area – John F. Kennedy International Airport (JFK), Newark Liberty International Airport (EWR) and La Guardia Airport (LGA) – have an average on time arrival performance of 68%, the worst of any major metropolitan area (America 2050, 2011). Other airports in the Northeast are also among the nation's worst performers, such as Philadelphia with 74% and Boston with 76% of air trips arriving on time.

According to the Federal Aviation Administration, John F. Kennedy International Airport (JFK), LaGuardia Airport (LGA), Newark Liberty International Airport (EWR) and Philadelphia International Airport (PHL) will not have sufficient airspace capacity by 2025 even if planned improvements (such as runway extensions, airspace reconfiguration, etc.)[2] are completed (FAA, 2007). The same report indicates that Boston Logan International Airport (BOS), T.F. Green Airport (PVD) and Washington Dulles International Airport (IAD) will have sufficient capacity, but only if improvements are completed. As a result, the impact of high-speed rail on airport usage will be of concern to port authorities. In particular, replacing some NEC airline shuttle services with HSR travel could free-up precious airport terminal and runway space for longer-distance domestic and international flights. On the other hand, reduced air market share might jeopardize airport revenue from landing fees.

**Terminals**

Since much of the competitive advantage and value of intercity HSR over other modes lies in its ability to connect city center to city center, HSR stations must connect to downtown terminals (and existing commuter rail and urban public transportation systems). Initial NEC HSR planning would call for significant expansion or new construction of the following terminals in the major hub cities:

- South Station in Boston
- Penn Station in New York City
- New Market Street station (not 30th Street Station) in Philadelphia
- New Charles Center station (not Penn Station) in Baltimore
- Union Station in Washington, D.C.

The governance and management of these terminals differ, but in all cases issues of intermodal connectivity will be of the highest importance. These stations may also present real estate design projects that could be sources for future profits along the corridor.

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[2] The Port Authority of NY and NJ is undergoing major expansion and modernization projects at Laguardia Airport (LGA) and Newark Liberty International Airport (EWR).

In addition to these major hubs, other HSR stations along the planned NEC could include:

- Rhode Island: Providence Station
- Connecticut: New London, Hartford Union Station, New Haven Union Station, Bridgeport Station, and Stamford Station
- New Jersey: Newark Penn Station, Newark Liberty International Airport, and Trenton Rail Station
- Delaware: Joseph R. Biden Jr. Railroad Station in Wilmington and Newark Rail Station
- Maryland: BWI Rail Station

Each of these smaller station represent important opportunities for intermodal connectivity and have implications for the ease of access/egress for HSR service. Any HSR development plan will have to consider how intercity travel will work with connecting commuter services given limited terminal capacity.

**Airline Industry**

The airline industry stakeholder includes both commercial and general aviation that operate flights in and out of the Northeast region. Improvements to NEC rail service will likely impact demand for shuttle flights among northeast airports. Improved rail service also has the potential to encourage coordination between air and high-speed rail modes, such as "codeshare" train trips. Evaluating these multimodal impacts and the potential for both competitive and cooperative relationships within the market is an important consideration in any stakeholder analysis of the system.

The 9 states and District of Columbia that make up the NEC accounted for about 19% of US enplanements in 2005. The same states account for about 22.5% of the US population. Thus, annual enplanements per capita are about 2.1 in the Corridor vs. 2.46 nationally (Anderson, 2007). By this measure, the Northeast Corridor is *less* air transport intensive than the US as a whole. This can be explained by two factors, 1) that the probability of flying as opposed to choosing another mode is generally increases with the length of trip, and 2) that the large number of urban areas in the Northeast Corridor gives rise to a large number of relatively short intercity trips that can be made by car or rail. NEC air travel shows greater than national enplanements in two subcategories: foreign carriers and small carriers. The large share of foreign carriers is clearly due to trans-Atlantic flights. The large share of small carriers probably reflects the high proportion of short-distance flights (Anderson, 2007).

On the densest section of the corridor, Amtrak captures nearly two-thirds of the rail/air market (not including highway) starting and ending in New York and Washington, DC. Still, airlines

carry more than 1 million annual passengers on this route, which include travelers connecting to their final destinations (see Figure 8).

**Figure 8.** Distribution of air traffic along the NEC (America 2050, 2011).
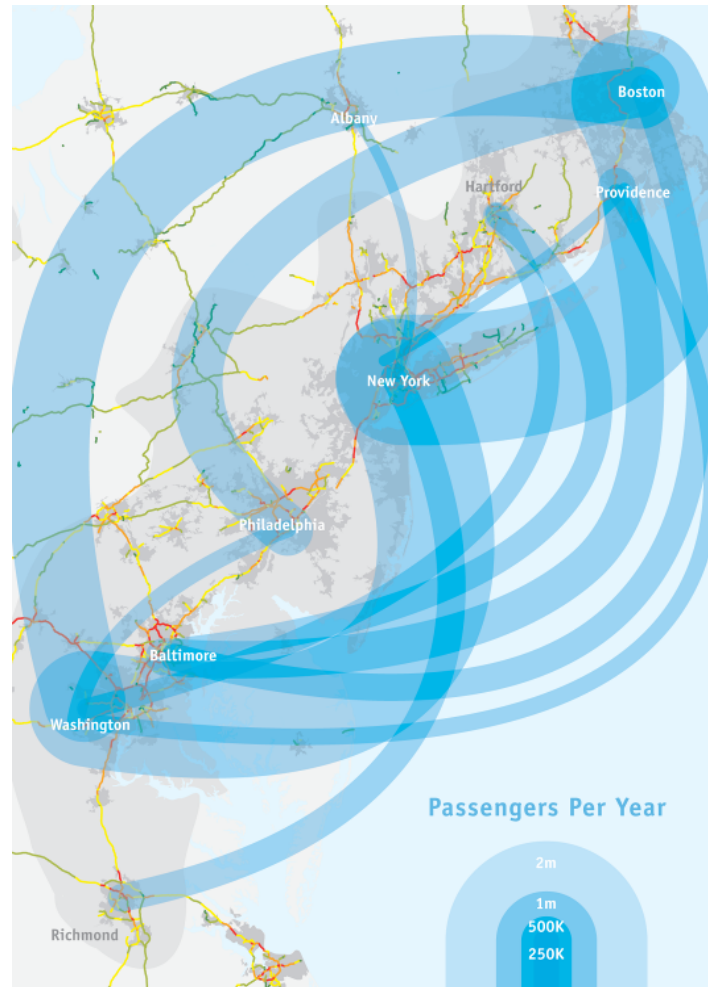


"Two airline industry trends that may have serious implications for air travel in the Northeast Corridor are the well-established move to hub-and-spoke networks and the possible shift to larger airplanes" (Anderson, 2007). In the deregulated hub-and-spoke network, airlines benefit from economies of scale, higher load factors, and the ability to centralize repair and maintenance by designing their network of interconnecting flights around one or more hubs rather than offering a large number of point-to-point services. Consumers benefited from greater air travel opportunities as the number of city pairs served by scheduled flights roughly doubled. However, there are downsides. The scheduling of flights in "banks" to improve connection efficiency has led to higher congestion in hub airports. Also, there is evidence that airlines that become dominant in their hub airport are able to charge a premium on trips that begin and end there.

Whether an airport is an airline hub is based on the proportion of "through" passengers – passengers who pass through an airport but whose trips neither begin nor end at that airport. Given this definition, there are relatively few hub airports in the NEC, so congestion on the corridor is not predominantly the outcome of hub-and-spoke operations (Anderson, 2007). The most likely explanation for the lack of hubs on the NEC is that in order to establish a hub an airline must command a large number of gates in a single airport. This will be possible only where there is either significant slack capacity or the potential for terminal and runway expansion. Neither of these conditions is typical of large airports in the Northeast. Also, a number of the airports have many international flights and within-corridor shuttles, all of which may have crowded out hub operations.

Another possible trend is the move to larger planes, which could relieve congestion by moving more people through a single runway slot (although with longer time turning at the gate). However, the move to larger planes may also require some capital expenditures, especially at gates. Such a large plane would logically fit into a hub-and-spoke rather than point-to-point strategy (Mason, 2007) so it would have little role in domestic traffic within the NEC.

**Intercity Bus Operators**

There are several intercity bus operators in the Boston to Washington, D.C. corridor, including: Boltbus, Greyhound, Peter Pan Bus, DC2NY, Vamoose Bus, Megabus, Washington Deluxe, Eastern Travel, New Century, Yo Bus. These buses tend to provide slower, but much cheaper intercity travel along the highway system of the Northeast Corridor. Although HSR development may affect ridership numbers for these services, it is unlikely that high-speed trains will provide competitive rates to these bus services. Therefore, intercity bus operators may stand to benefit from reduced congestion on highways more than they will suffer loss of customers.

**Freight Railroad Companies**

Currently, seven freight railroads, including Conrail Shared Assets Corporation, Providence and Worcester (P & W), Pan Am Southern, Canadian Pacific, Connecticut Southern, Norfolk Southern and CSX Transportation, have trackage rights over some portion of the NEC, and collectively operate approximately 50 trains per day over the corridor (NEC Future, 2015).

As noted in the description of Commuter Rail Agencies, in the past, concerns have been raised that the requirements of commuter rail agencies and freight rail companies have often not been addressed when considering increases to inter-city passenger service. Operating slower freight trains over the Northeast Corridor poses operational challenges and reduces capacity to run higher-speed trains (Peña-Alcaraz, 2015). In addition, sharing right-of-way with passenger traffic means increased liability and crash-resistance standards for freight operators. This could be avoided if HSR were to develop a completely new, parallel alignment to existing NEC rail

68

(which could then be dedicated to slower commuter and freight traffic). Otherwise, when developing high-speed passenger rail on shared corridors, care must be taken to develop an efficient passenger rail system that does not harm the freight railroads' abilities to move goods efficiently on their networks in order to retain their business and to continue to promote economic growth.

**Trucking Industry**

Private trucking companies that ship to and from areas along the NEC may be impacted by development of high-speed rail. For example, improving NEC passenger rail service could divert auto traffic from nearby highways; thus helping to alleviate congestion faced by trucks traveling between cities. However, improving (or negatively affecting) freight rail service could potentially divert freight traffic from (or to) trucking services. In general, the trucking industry may watch high-speed rail development closely to determine its impact on their market share and the traffic it faces along the corridor, but does not have a direct stake in the system development.

**Banking Industry**

Banking in the United States is regulated in a somewhat fragmented manner by both federal and state governments. On the federal level, the oversight comes mainly from the Federal Reserve System, the Federal Deposit Insurance Corporation (FDIC), the Office of the Comptroller of the Currency, and the Office of Thrift Supervision. The five largest banks in the United States at the end of 2011 were JPMorgan Chase, Bank of America, Citigroup, Wells Fargo, and Goldman Sachs (Lynch, 2012). These five banks together had assets equal to 56 percent of the U.S. economy. The banking industry will be involved in financing any transportation infrastructure investments along the NEC and can be a powerful actor considering their ability to determine interest rates and lines of credit. This will be especially true for financing contributions from the private sector. The banking industry's primary objective in any development initiative is profit maximization and it will have a stake in continued economic growth in the region.

**Insurance Industry**

The U.S. insurance industry net premiums totaled $1.1 trillion in 2014, according to SNL Financial. Insurance carriers and related activities accounted for $421.4 billion, or 2.5 percent, of U.S. gross domestic product in 2013, according to the U.S. Bureau of Economic Analysis. The U.S. insurance industry employed 2.4 million people in 2013, according to the U.S. Department of Labor. There were 6,118 insurance companies in 2014 in the United States (including territories), including property/casualty (2,583), life/annuities (895), health (857), fraternal (85), title (56), risk retention groups (252) and other companies (1,390), according to the National Association of Insurance Commissioners (III, 2016).

The two largest insurance sectors are life/health (L/H) and property/casualty (P/C). The L/H insurance sector consists primarily of annuities and life insurance. In the United States, premiums recorded by life/health (L/H) insurers accounted for $644.5 billion or 56 percent of total insurance premiums in 2014 (III, 2016). The P/C insurance sector consists primarily of auto, home, and commercial insurance. This sector accounted for $502.6 billion or 44 percent of total insurance premiums in 2014 (III, 2016).

As a major sector in the U.S. economy and a large employer, the insurance industry would be interested in the economic impacts of high-speed rail development with a particular focus on security and risk mitigation. The industry would be involved in insuring HSR and transportation infrastructure development as well as the lives and health of construction and transportation employees. A particularly salient role of the insurance industry in these large engineering projects is in the case of catastrophe. P/C insurers paid out $15.5 billion in property losses related to catastrophes in 2014, compared with $12.9 billion in 2013, according to the Property Claims Services division of Verisk Analytics (III, 2016). There were 31 catastrophes in 2014, compared with 28 in 2013. These included major storm and natural events as well as man-made disasters and major accidents, all of which could affect high-speed rail development on the corridor.

**Private Landowners**

The large scope of the NEC system precludes a detailed or individual-level analysis of system stakeholders. However, while we will not evaluate the impact of individual landowners on the development of HSR, private landowners collectively could restrict the ability of the HSR developer to acquire right-of-way. Although governments could use eminent domain to force landowners to sell their property, this tool could significantly extend the length and increase the cost of the project due to litigation. While for the most part, HSR along the NEC should be constructed within existing right-of-ways (NEC Future, 2015), evaluating the impacts of HSR development on private landowners and considering methods to engage them in the planning process is important. Private landowners are primarily concerned about the land use required for the development of new and existing transportation infrastructure, but may also see HSR development as an opportunity for real estate investment.

**Abutters**

In addition to private landowners directly in the path of HSR track alignment, the general public living along the track or near a station will be concerned about the land use required for transportation infrastructure development. In addition, they will be concerned with the short-term impacts of construction on neighboring communities. High-speed rail, although quieter than major highways, still produces noise and light pollution, especially around switches and stations.

HSR track development should try to mitigate negative impacts on abutters and their collective concerns should be included in any stakeholder analysis of the system.

**Labor Unions**

Labor unions are legally recognized as representatives of workers in many industries in the United States. Their activity today centers on collective bargaining over wages, benefits, and working conditions for their membership, and on representing their members in disputes with management over violations of contract provisions. While the primary purpose of labor unions is to represent their members in negotiations with employers, unions also play a significant role in influencing public policy. Their input is considered whenever trade, environment, workplace safety, healthcare, or other key issues are debated. Larger unions also typically engage in lobbying activities and advocacy for candidates and ballot initiatives in elections at the state and federal level. Organized labor usually supports Democratic Party candidates in elections.

In the 21st century, public sector employees such as city employees, government workers, teachers and police, belong to some of the most prominent unions. These public sector unions include many commuter rail agency and urban public transportation workers. Members of unions are disproportionately older, male, and residents of the Northeast, the Midwest, and California. Union workers average 10-30% higher pay than non-union in the United States after controlling for individual, job, and labor market characteristics (Mayer, 2004). Although much smaller compared to their peak membership in the 1950s,[3] American unions remain a political factor, both through mobilization of their own memberships and through coalitions with like-minded activist organizations around issues such as immigrant rights, trade policy, health care, and living wage campaigns.

There are numerous transportation-related workers' unions, with some like the Air Line Pilots Association, National Air Traffic Controllers Association, the American Maritime Officers, or the Brotherhood of Locomotive Engineers catering to only one particular mode (and often only one particular profession within that mode). However, in addition to these unimodal unions, there are more general transportation labor unions such as the Teamster's Union (the most politically active according to total campaign contributions in the fiscal year 2013-2014), United Transportation Union, the Amalgamated Transit Union, and the Transport Workers Union.

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[3]  In 2013 the percentage of workers belonging to a union in the United States (or total labor union "density") was 11.3%, with a total number of 14.5 million members (Bureau of Labor Statistics, 2016).

**Private Consortiums**

The Private Consortiums stakeholder includes individual or groups of investors, contractors, and real estate developers that might be involved in high-speed rail development.[4] Private consortiums may be called upon to finance, design, build, operate and/or maintain NEC high-speed rail depending on the delivery method chosen for infrastructure development (such as different forms of public-private partnership, or PPP). Private consortiums would be primarily interested in the financial viability and profitability of the project and other real estate development and economic growth that might happen around stations as a result of new service.

**Suppliers**

The supplier stakeholder represents the interest of all organizations and companies who sell equipment, infrastructure materials, etc. or contract skilled labor for any HSR development. It might also included consultants, who can be seen as suppliers of technical expertise or knowledge. It is likely that many individual or groups of suppliers will bid on planned HSR projects and that the project will be awarded to the supplier that can guarantee the highest construction or delivery quality and best time-frame at the lowest price. Suppliers will generally look positively on any new HSR infrastructure, as it would create new business opportunities and jobs in the region. Since suppliers take on minimal risk in the planning or construction phases, they are likely to support large development with the possibility of more jobs.

**Political Activists/Lobbyists**

In addition to campaign contributions to elected officials and candidates, companies, labor unions, and other organizations spend billions of dollars each year to lobby Congress and federal agencies. Automobile manufacturers, oil companies, road builders, and car clubs (like AAA) are powerful lobby groups for transportation-related issues in the U.S. They have successfully lobbied for more road building and greater government spending on infrastructure for cars and have steered policy away from public transport towards the private sector. Other powerful activist groups are those concerned with environmental sustainability and the impact of transport development on the climate, including land, water, and air quality. There will be interest and activists groups that both oppose and support aspects of NEC HSR development; it is important to identify those lobbyists with the most salient stake in HSR development and with the financial capabilities to have those claims heard.

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[4] While freight railroads may be interested in joining a private consortium, in order to avoid redundancy and interdependence among stakeholders, they are not explicitly included in this analysis.

**Media**

The media in the United States is controlled by the private sector and faces no political censorship by the government. There is a strong tradition of independent newspapers, magazines, television, radio, and other forms of media publicizing varying opinions, both critical and supportive of government policy. More recently, less traditional forms of social media, such as Twitter, blogs, and networking sites have encouraged the dissemination of generally unsubstantiated and more opinionated information than traditional forms of journalism. By bringing the acts of public officials to light, educating the public about the issues, and deliberately favoring certain candidates and policies, the media can influence policy directly or indirectly by shaping public opinion. In addition to influencing policy, both traditional and social media also provide the main avenue for advertising and marketing (with a growing online sector) for new initiatives. They will be an important ally or opponent when it comes to forming public consensus surround HSR development.

**Intercity Passengers**

The intercity passengers category is intended to represent users of the NEC completing longer trips – for example, trips greater than 75 miles (120 km). This stakeholder includes passengers traveling by rail, personal auto, intercity bus, airplane, or other mode available between city pairs along the corridor. One could easily imagine further dividing this stakeholder into its modal constituencies or by other factor, such as business vs. leisure trips. However, for the purpose and scope of this analysis it is sufficient to group these stakeholders together based on their similar interest in travel time savings, reliability, comfort and convenience, and price of their transportation choices along the corridor. Even for those who are not currently rail passengers, high-speed rail development will mark increased competition among modal operators and help to relieve congestion faced by passengers on all modes.

**Commuters**

The commuter stakeholder is intended to represent users of the NEC completing shorter trips – for example, less than 75 miles (120 km) – who primarily use slower-speed commuter rail services or private automobiles rather than long-distance, high-speed lines. Commuters may not directly benefit from high-speed rail development and will be most concerned about how their urban service is affected by new construction and operation in the short-term.

**Freight Users (Shippers/Receivers)**

The freight user stakeholder represents commercial and industrial users along the NEC that rely on the freight railroads and trucks to ship and deliver their goods and products. They are less likely to have direct demand for high-speed passenger rail, but they have a stake in the state of

good repair and reliability of the existing system. The long-term alleviation of congestion on existing NEC rails and highways as a result of HSR construction could be a positive gain, but short-term disruption of supply chains with construction will be a cause for concern.

After identifying the stakeholders surrounding high-speed rail development on the NEC, it is important to consider the diversity of interests of these stakeholders regarding system development. The following section identifies and discusses the overarching goals and more specific objectives that together capture the priorities and incentives of stakeholders as they relate to HSR development.

## 4.2.2 Developing Goals and Objectives for the NEC HSR System

PCBA requires as its inputs the identification and understanding of both the stakeholders surrounding the system and the objectives of system development. The previous section presented and discussed the 30 stakeholders identified for high-speed rail development on the NEC. Continuing to develop the necessary inputs for PCBA, this section considers the overarching goals and more specific objectives for the transportation system along the NEC. The following section will then map the stakeholders and their interests to the system objectives.

Goals and objectives have been developed using a process typical of performance management approaches in the transportation industry. First, we develop overarching goals that identify the desired future state of the system. Then these goals are broken down into "measurable" objectives, each of which defines an outcome that helps to satisfy an overarching goal (Pickrell & Neumann, 2001).

One of the most significant challenges involved with creating a set of goals and objectives for the NEC is the multimodal context. It is important to consider objectives that capture the overall system performance, but are applicable to each individual mode. In addition to considering the multimodal nature of system improvements, it is also important to consider the tradeoffs associated with addressing each of the objectives in relation to the others. Even though we list objectives that begin with active verbs (such as, "increase," "decrease," "minimize," and "maximize"), we recognize that positively affecting one objective might negatively impact another. As a result, it is important not to focus on one objective (or goal) at the expense of others, but instead to consider how interest in a given objective relates to interest or lack of interest in the other objectives. Therefore, we look at how the different stakeholders on the NEC will be impacted by the net effect of their interests in all the system objectives.

74

In creating the goals and objectives for the NEC, we consider the interests of each of the three stakeholder categories – government stakeholders, private sector stakeholders, and transportation users. We reference two separate strategic documents: the U.S. DOT's *Strategic Plan FY 2012-2016* (2012) and the Northeast Corridor Master Plan Working Group's *NEC Infrastructure Master Plan* (2010) and update (2012).

In order to capture the goals of the United States transportation system as a whole, reflecting many of the interests of federal-level governmental stakeholders, we consider the strategic goals of the U.S. Department of Transportation (2012):

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- **Safety:** Improve public health and safety by reducing transportation-related fatalities and injuries.
- **State of Good Repair (SOGR):** Ensure the U.S. proactively maintains its critical transportation infrastructure in a state of good repair.
- **Economic Competitiveness:** Promote transportation policies and investments that bring lasting and equitable economic benefits to the Nation and its citizens.

- **Livable Communities:** Foster livable communities through place-based policies and investments that increase transportation choices and access to transportation services.
- **Environmental Sustainability:** Advance environmentally sustainable policies and investments that reduce carbon and other harmful emissions from transportation sources.

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While the national goals for the U.S. transportations system are important for certain stakeholders, there are also important considerations at a more regional or local level and for non-government stakeholders. These goals relate more specifically to the existing transportation and urban systems along the NEC. On the regional level, the Northeast Corridor Master Plan Working Group brought together the interests of Amtrak, state transportation agencies, commuter rail agencies, and freight railroad companies to outline the future of the NEC. The resulting *NEC Master Plan* (2010) articulated the need for "providing reliable, efficient, competitive intercity, commuter and freight rail services that (1) benefit the broader Northeast region, (2) are integrated into the regional transportation network to maximize efficiency and reduce congestion, and (3) meet demand for future services." The NEC of the future must provide enhanced mobility options, support regional and local economic development, and improve the quality of life and the environment for residents of the Northeast. Furthermore, given the importance of the NEC to the nation's GDP, growth in the region will have national implications. Many of the goals on the regional level echo the national transportation agenda, with the *NEC Master Plan* outlining the following (2010):

- Support economic growth in the Northeast while simultaneously improving the quality of its environment
- Improve service reliability and reduce travel times to maintain and improve the attractiveness of rail compared to other modes
- Support the states in their vision of broad regional connectivity to destinations throughout the Northeast and beyond
- Maintain, improve, and expand rail infrastructure and intermodal and multimodal connections to facilitate ease of travel, meet demand and improve the overall efficiency of the transportation network
- Accommodate a proposed doubling of intercity and commuter ridership
- Preserve and enhance freight rail access to Northeast ports and local industry

Using the goals of the USDOT and the NEC Master Plan Working Group as a reference, 10 goals were identified for the NEC. Keeping in mind the regional concerns for connectivity and intermodal cooperation and including the needs of transportation users, these 10 goals were further broken down into 28 objectives. The goals and corresponding objectives can be organized into four broad categories that highlight the interconnected nature of transportation systems and their impact on the environment and economic activity:

1. Transportation System Performance,
2. External Impacts of the Transportation System,
3. Financial Viability / Profitability, and
4. Robustness of Transportation System and its Management

The 10 goals and 28 objectives for the NEC are organized by the above four categories in Table 3 through Table 6. It is important to note that the objectives were designed to capture all of the interests of the stakeholders on the institutional sphere, but not every stakeholder will have an interest in each objective. This is why we will need to map the level of stakeholder interest to the objectives in the following section.

Goals and objectives in the Transportation System Performance category focus narrowly on the direct benefits to the transportation system, its operators, and its users that would result from HSR development. Specifically, these objectives further refine goals in safety, capacity, state-of-good-repair, and level of service (see Table 3).

**Table 3.** Goals and objectives for the NEC related to Transportation System Performance.

| Goals | Objectives |
|---|---|
| **1. Improve transportation system safety** | • Reduce the transportation system user fatality rate (on a per user-mile basis)<br>• Reduce the number of non-fatal accidents and injuries on the transportation system |
| **2. Improve capacity and its management** | • Increase the physical capacity of the transportation system<br>• Ensure effective utilization of capacity |
| **3. Return the transportation system to a state-of-good-repair** | • Reduce the backlog of deferred maintenance for each mode (as defined by the infrastructure-condition rating systems used by each mode) |
| **4. Improve level of service for transportation system users (both passenger and freight)** | • Facilitate the interconnection between different transportation modes<br>• Decrease door-to-door trip times[5]<br>• Increase trip time reliability<br>• Reduce congestion<br>• Reduce fares<br>• Provide a comfortable travel experience |

By contrast, goals and objectives under the External Impacts of the Transportation System category are intended to gauge the sustainability of the transportation system more broadly – considering dimensions such as the economy, environment and social equity (see Table 4).

**Table 4.** Goals and objectives for the NEC related to the External Impacts of the Transportation System

| Goals | Objectives |
|---|---|
| **5. Promote economic growth** | • Increase accessibility of labor force participants to firms (jobs); increase accessibility of firms to labor force participants[6]<br>• Increase the productivity of firms in all sectors of the economy as a result of improvements to the transportation system<br>• Promote short- and long-term jobs creation[7]<br>• Stimulate real estate development<br>• Ensure that the net benefits of transportation system improvements are evenly distributed spatially (on local, regional and national scales) and by socioeconomic class |

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[5] A trip considers all travel from origin to destination, not just travel from intercity terminal to intercity terminal. Therefore, trip time is the sum of: travel time from origin to departure terminal (access), waiting time at departure terminal (including check-in time, security time, buffer time, etc.), in-vehicle travel time, waiting time at arrival terminal and travel time from arrival terminal to destination (egress).

[6] There is a correlation between (transportation) agglomeration and productivity (Graham 2007, Westrom 2014).

[7] The intent of this objective is to consider the number of jobs that will be created within the region as a result of transportation investments in the NEC. It does not suggest that the goal of transportation system investment should be to maximize job creation at the expense of generating inefficiencies.

| | |
|---|---|
| **6. Reduce negative environmental impacts** | • Reduce emissions of air pollutants related to the transportation sector<br>• Reduce overall energy consumption[8] by the transportation sector and percentage of energy produced by renewable energy sources<br>• Minimize the spatial footprint of the transportation system, particularly on areas of high-environmental sensitivity |

The Financial Viability and Profitability category is intended to capture goals and objectives that relate to the direct return on investment for both public and private funds and the timescale and magnitude of projected revenue (see Table 5).

**Table 5.** Goals and objectives for the NEC related to Financial Viability and Profitability.

| Goals | Objectives |
|---|---|
| **7. Efficiently use public and private investments to fund the transportation system** | • Maximize benefits from public investments in the transportation system<br>• Maximize profitability for private operators and or infrastructure managers<br>• Foster livable communities through place-based policies and investments that increase transportation choices and access to transportation services |
| **8. Develop an effective organizational and management structure** | • Create an organizational structure that will minimize time and cost required for project implementation<br>• Create an organizational structure that will allow the needs of all NEC infrastructure managers and operators (intercity passenger, commuter and freight) to be considered during transportation investments |

The final set of goals and objectives are placed in the Robustness of Transportation System and its Management category. These goals consider the advantages and disadvantages, including their uncertainties, of implementing different organizational structures and infrastructure construction plans for HSR on the NEC (see Table 6). While to the end user the nature of the NEC organizational structure is largely irrelevant (beyond its ability to deliver rail services effectively), to other actors (such as NEC train operators) and decision-makers, these objectives are important.

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[8] This is consumption of fuel directly by vehicles and for electricity generation for the transportation sector

**Table 6.** Goals and objectives for the NEC related to the Robustness of the Transportation System and its Management

| Goals | Objectives |
|---|---|
| **9. Build flexibility into transportation planning** | • Create a flexible transportation system with a management structure that effectively identifies and mitigates risks |
| **10. Create a resilient transportation system** | • Create a transportation system that can withstand environmental pressures and mitigate the effects of natural disasters<br>• Create a transportation system that can mitigate the effects of human disasters[9]<br>• Transportation system supports efficient evacuation routes |

Collectively, the goals identified under these four categories are congruent with the strategic goals of the U.S. Department of Transportation and contain the key interests of the myriad NEC transportation operators and other stakeholders. Now that the goals and objectives for the development of the NEC HSR and transportation system have been identified, we can match the interests of the many stakeholders to them.

### 4.2.3 The Stakeholder-Objective Matrix for the NEC

We have identified 30 stakeholders for the NEC, including government departments and agencies from the national to the local level, private sector interests, and key user groups. Goals for the development of the transportation system were then identified and further broken down into 28 measurable objectives for high-speed rail development along the NEC. These objectives considered not only the transportation system performance, but also the reduction of external impacts of the transportation system, optimization of the financial viability and profitability of the project, and the robustness of the resulting transportation system and its management.

From the identification and understanding of the stakeholders on the NEC and the objectives for HSR system development, we can create a matrix that maps each stakeholder's interests in future system development to the system objectives as discussed in Section 3.1.3. In this stakeholder-objectives matrix, if an actor does not have an interest or stake in a given objective, the corresponding cell is left blank. If an actor does have an interest in the given objective, this interest is categorized by its strength with "○" indicating weak interest, "◉" indicating medium interest, or "●" indicating strong interest as in Table 7.

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[9]  Human disasters include terrorist attacks and large accidents, such as industrial explosions or hazardous material spills.

**Table 7.** Key for symbolic stakeholder-objective matrix.

| Interest Level | Symbol |
|---|---|
| No interest | |
| Weak stakeholder interest | ○ |
| Medium stakeholder interest | ◉ |
| Strong stakeholder interest | ● |

While one might argue that each stakeholder is indirectly interested in almost all of the objectives for the system, only the most direct links between stakeholders and objectives have been noted in the matrix for the purposes of improved clarity and differentiation. For example, while transportation users such as commuters and intercity travelers may be concerned with reducing the backlog of deferred maintenance, the relationship is somewhat indirect since their real concern is the degradation in trip attributes that might result from poor maintenance (such as longer trip times and worsened reliability and safety). Therefore, only the direct relationships between these users groups and trip attribute objectives have been included in the matrix.

The assignment of stakeholder interests to the system objectives is inherently subjective (Varvasovszky & Brugha, 2000). Following best practice and to reduce any bias from a single analyst's point-of-view, three researchers went through each cell of the matrix first by column (objective) and identified which stakeholders have an interest in that objective and how strong that interest is. Then a second-pass through the matrix was conducted by row (actor), to make sure that each stakeholder's interests in the system objectives together accurately represented their entire agenda when it comes to HSR development along the NEC.

Figure 9 and Figure 10 show the complete stakeholder-objective matrix for HSR development along the Northeast Corridor. This complete, symbolic stakeholder-objective matrix will be reduced in dimension, converted into a set of numeric vectors, and then used as the input for the second and third phases of PCBA.

**Figure 9.** Complete, symbolic stakeholder-objective matrix for the NEC (part 1 of 2).

OBJECTIVES

ACTORS

**Objectives (columns):**

1. Reduce the transportation system user fatality rate
2. Reduce the number of non-fatal accidents and injuries
3. Increase the physical capacity of the transportation system
4. Ensure effective utilization of capacity
5. Reduce the backlog of deferred maintenance for each mode
6. Facilitate the interconnection between different transportation modes
7. Increase trip time reliability
8. Decrease trip times
9. Reduce congestion
10. Reduce fares/fees
11. Provide a comfortable travel experience
12. Increase accessibility of firms to labour force participants

**Transportation System Performance** (1–11)

**External Impacts of the Transportation System** (12–20)

13. Increase the productivity of firms in all sectors
14. Increase accessibility of labour force participants and increase accessibility of firms to firms (jobs)
15. Foster livable communities through place-based policies and investments that increase transportation choices and access to transportation services
16. Promote short- and long-term job creation
17. Stimulate real estate development
18. Ensure that the net benefits of transportation system improvements are evenly distributed spatially and by socioeconomic class
19. Reduce emissions of air pollutants related to the transportation sector
20. Reduce energy consumption by the transportation sector
— Minimize the spatial footprint of the transportation system, particularly on areas of high-environmental sensitivity

**Actors (rows):**

**Government**
1. Congress
2. State Governments
3. Local/Municipal Governments
4. USEPA
5. US Department of Commerce
6. US Department of Energy
7. USDOT
8. Amtrak
9. NEC Commission
10. I-95 Corridor Coalition
11. Port Authorities
12. Commmuter Rail Agencies
13. Urban Public Transportation Organizations
14. Terminals

**Private Sector**
15. Freight Railroad Companies
16. Intercity Bus Operators
17. Trucking Industry
18. Airline Industry
19. Labor Unions
20. Suppliers
21. Private Consortiums (Construction Co./Real Estate Developers)
22. Banking Industry
23. Insurance Industry
24. Private Landowners
25. Abutters
26. Political Activists/Lobbyists
27. Media

**Users**
28. Commuters
29. Intercity Travelers
30. Freight Customers (Shippers/Receivers)

**OBJECTIVES**

Column legend (21–28):

- **Financial Viability / Profitability**
  - 21: Maximize benefits from public investment in the transportation system
  - 22: Maximize profitability for private operators and/or infrastructure managers
- **Robustness of Transportation System and its Management**
  - 23: Create an organizational structure that will minimize the time and cost required for project implementation
  - 24: Create an organizational structure that will allow the needs of all NEC operators to be considered during transportation investments
  - 25: Create an organizational structure with a management structure that effectively identifies and mitigates risks
  - 26: Create a flexible transportation system that can mitigate the effects of environmental pressures and mitigate the effects of natural disasters
  - 27: Create a transportation system that can withstand environmental / human disasters
  - 28: Transportation system supports efficient evacuation routes / Create a transportation system that can mitigate the effects of human disasters

| # | ACTORS | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
|---|--------|----|----|----|----|----|----|----|----|
| | **Government** | | | | | | | | |
| 1 | Congress | ● | | ● | | ○ | | ○ | |
| 2 | State Governments | ○ | | ● | | ○ | ○ | ● | ○ |
| 3 | Local/Municipal Governments | ○ | | ○ | | ○ | ○ | | ○ |
| 4 | USEPA | | | | | | ○ | | |
| 5 | US Department of Commerce | | | | | | | | |
| 6 | US Department of Energy | | | | | | | | |
| 7 | USDOT | ○ | | ○ | ○ | ● | ● | ● | ● |
| 8 | Amtrak | ○ | ○ | | ● | ○ | | | |
| 9 | NEC Commission | | | ○ | ● | ○ | | | |
| 10 | I-95 Corridor Coalition | | | | ○ | ○ | | ○ | ○ |
| 11 | Port Authorities | | | | ○ | | | | ○ |
| 12 | Commuter Rail Agencies | | ○ | ○ | ● | | ○ | | |
| 13 | Urban Public Transportation Organizations | | ○ | | ○ | | | | |
| 14 | Terminals | | | | ○ | | ○ | | |
| | **Private Sector** | | | | | | | | |
| 15 | Freight Railroad Companies | | ● | | ● | | | | |
| 16 | Intercity Bus Operators | | ● | | ● | | | | |
| 17 | Trucking Industry | | ● | | | | | | |
| 18 | Airline Industry | | ● | | ● | | | ● | |
| 19 | Labor Unions | | | | | | | | |
| 20 | Suppliers | | | ○ | | | | | |
| 21 | Private Consortiums (Construction Co./Real Estate Developers) | | | ● | | | | | |
| 22 | Banking Industry | | | | | ● | | | |
| 23 | Insurance Industry | | | | | ● | ○ | ○ | |
| 24 | Private Landowners | | | | | | ○ | | |
| 25 | Abutters | | | | | | | | |
| 26 | Political Activists/Lobbyists | ○ | | | | | | | |
| 27 | Media | ○ | | | | | ○ | ○ | |
| | **Users** | | | | | | | | |
| 28 | Commuters | ○ | | | | | | ○ | |
| 29 | Intercity Travelers | ○ | | | | | | ○ | |
| 30 | Freight Customers (Shippers/Receivers) | | | | | | | | |

While the symbolic or categorical stakeholder-objective matrix shown in Figure 9 and Figure 10 is useful for clarity and review, it is necessary to convert the "no interest," "weak interest," "medium interest," and "strong interest" classification into an "equivalent" numeric system in order to perform clustering. The choice of numeric codes is an important tuning parameter that will affect the output of the clustering in the application of PCBA. In general, best practice from quality function deployment (QFD) literature, suggests that conversion from an ordinal to a cardinal scale utilize a 0-1-3-9, 0-1-3-5, or 0-1-5-9 numeric coding (Franceschini, Galetto & Maisano, 2007; Akao 1998).

For the NEC, we choose to employ the 0-1-3-9 conversions because this provides the greatest (Euclidean) distance and hence differentiation between "medium" and "strong" interests while deemphasizing the difference between no interest and "weak" interest. This numeric coding scheme was chosen to match the fractious stakeholder environment of the NEC in which stakeholders are unlikely to work together on any issue other than those that match their primary (or strongest) interest. Therefore, for each cell in the stakeholder-objective matrix, we assign numeric values according to the conversion key in Table 8.

**Table 8.** Conversion key for the numeric stakeholder-objective matrix for the NEC.

| Interest level | Symbol | # |
|---|---|---|
| No interest | | 0 |
| Weak stakeholder interest | ○ | 1 |
| Medium stakeholder interest | ◉ | 3 |
| Strong stakeholder interest | ● | 9 |

Applying this conversion code to Figure 9 and Figure 10, we obtain the complete, numeric stakeholder-objective matrix for the NEC given in Figure 11.

**Figure 11.** Complete, numeric stakeholder-objective matrix for the NEC.

OBJECTIVES

Objective columns:
1. Reduce the backlog of deferred maintenance for each mode
2. Reduce the physical capacity of the transportation system
3. Increase the physical capacity of the transportation system
4. Ensure effective utilization of capacity
5. Facilitate the interconnection between different transportation modes
6. Decrease trip times
7. Increase trip time reliability
8. Reduce congestion
9. Reduce fares/fees
10. Provide a comfortable travel experience
11. Foster livable communities through place-based policies and investments that increase transportation choices and access to transportation services
12. Increase accessibility of firms to labour force participants and increase accessibility of labour force participants to firms (jobs)
13. Increase the productivity of firms in all sectors
14. Promote short- and long-term job creation
15. Stimulate real estate development
16. Ensure that the net benefits of transportation system improvements are evenly distributed spatially and by socioeconomic class
17. Reduce emissions of air pollutants related to the transportation sector
18. Reduce energy consumption by the transportation sector
19. Minimize the spatial footprint of the transportation system particularly on areas of high environmental sensitivity
20. Maximize benefits from public investment in the transportation system
21. Maximize profitability for private operators in the transportation sector
22. Create an organizational structure that will minimize the time and cost required for project implementation
23. Create an organizational structure that will allow the needs of all NEC operators to be considered during transportation investments
24. Create a flexible transportation system with a management structure that effectively identifies and mitigates risks
25. Create a transportation system that can withstand the effects of natural disasters
26. Create a transportation system that can mitigate the effects of natural pressures and mitigate the effects of environmental/human disasters
27. Transportation system supports efficient evacuation routes
28. (Create efficient evacuation routes)

| STAKEHOLDERS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Congress | 9 | 3 | 9 | 1 | 3 | 1 | 1 | 3 | 9 | 0 | 0 | 0 | 3 | 0 | 9 | 1 | 0 | 1 | 1 | 0 | 9 | 0 | 9 | 0 | 3 | 0 | 3 | 0 |
| 2 State Governments | 9 | 1 | 9 | 9 | 3 | 3 | 3 | 3 | 9 | 0 | 0 | 0 | 3 | 0 | 9 | 1 | 1 | 3 | 0 | 0 | 3 | 0 | 9 | 0 | 3 | 3 | 0 | 1 |
| 3 Local/Municipal Governments | 3 | 0 | 9 | 9 | 3 | 3 | 3 | 3 | 9 | 0 | 0 | 3 | 3 | 0 | 9 | 3 | 1 | 9 | 3 | 3 | 3 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |
| 4 USEPA | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| 5 US Department of Commerce | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 US Department of Energy | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 9 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 7 USDOT | 9 | 9 | 9 | 3 | 9 | 0 | 3 | 3 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 9 | 3 | 9 | 9 | 9 | 9 | 3 |
| 8 Amtrak | 9 | 9 | 3 | 9 | 3 | 1 | 1 | 1 | 1 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 1 | 3 | 3 | 1 | 3 | 9 | 9 | 3 |
| 9 NEC Commission | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 9 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 9 | 9 | 0 | 0 | 0 |
| 10 I-95 Corridor Coalition | 1 | 1 | 9 | 9 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 1 | 0 | 1 | 0 |
| 11 Port Authorities | 1 | 1 | 3 | 1 | 3 | 9 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 12 Commuter Rail Agencies | 3 | 1 | 3 | 1 | 9 | 1 | 9 | 9 | 1 | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 1 | 9 | 0 | 0 | 0 | 0 |
| 13 Urban Public Transportation Organizations | 3 | 1 | 1 | 3 | 3 | 9 | 0 | 9 | 9 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 1 | 1 | 0 | 0 | 0 | 1 |
| 14 Terminals | 0 | 0 | 1 | 1 | 0 | 9 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 1 | 0 | 1 |
| 15 Freight Railroad Companies | 0 | 0 | 3 | 3 | 1 | 9 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 0 | 9 | 0 | 9 | 0 | 0 | 0 | 0 |
| 16 Intercity Bus Operators | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 0 | 9 | 0 | 9 | 0 | 0 | 0 | 0 |
| 17 Trucking Industry | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 9 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 0 | 9 | 0 | 9 | 0 | 0 | 0 | 0 |
| 18 Airline Industry | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 9 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 0 | 9 | 0 | 9 | 0 | 0 | 0 | 0 |
| 19 Labor Unions | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 Suppliers | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 21 Private Consortiums (Construction Co./Real Estate Developers) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| 22 Banking Industry | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 1 |
| 23 Insurance Industry | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 9 | 3 | 3 | 0 |
| 24 Private Landowners | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 Abutters | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 Political Activists/Lobbyists | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 Media | 3 | 1 | 0 | 0 | 0 | 1 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 28 Commuters | 1 | 1 | 3 | 0 | 0 | 3 | 3 | 9 | 9 | 9 | 9 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 Intercity Travelers | 1 | 1 | 3 | 1 | 0 | 3 | 3 | 9 | 9 | 9 | 9 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 30 Freight Customers (Shippers/Receivers) | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 3 | 3 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

With the numeric conversion complete, we can prepare the stakeholder-objective matrix for application of clustering analysis in the second phase of PCBA. In order to avoid using clustering variables (objectives) that have a high degree of dependence, we reduce the number of objectives by combining objectives that are highly correlated. By combining similar objectives, we avoid overrepresentation of these objectives in the clustering result. We calculate the Pearson correlation coefficients among the 28 objectives of the complete, numeric stakeholder-objective matrix for the NEC. For the column vector representing any two objectives, X and Y, the Pearson correlation coefficient is calculated using the general formula:

$$\rho_{X,Y} = \frac{\text{cov}(X,Y)}{\sigma_X \sigma_Y}$$

where cov(X,Y) is the covariance of the two objectives and $\sigma_X$ and $\sigma_Y$ are the standard deviations of objective X and objective Y, respectively. This linear, pairwise correlation yields a value between +1 and -1 inclusive, where +1 is perfect positive correlation, 0 is no correlation, and -1 is perfect negative correlation. Figure 12 shows the correlation map for the 28 objectives of the complete, numeric stakeholder-objective matrix for the NEC. In Figure 12, the more saturated the red in the square, the higher the positive pairwise correlation of the two objectives.

**Figure 12.** Pearson correlation coefficients among the 28 objectives of the full NEC stakeholder-objective matrix.
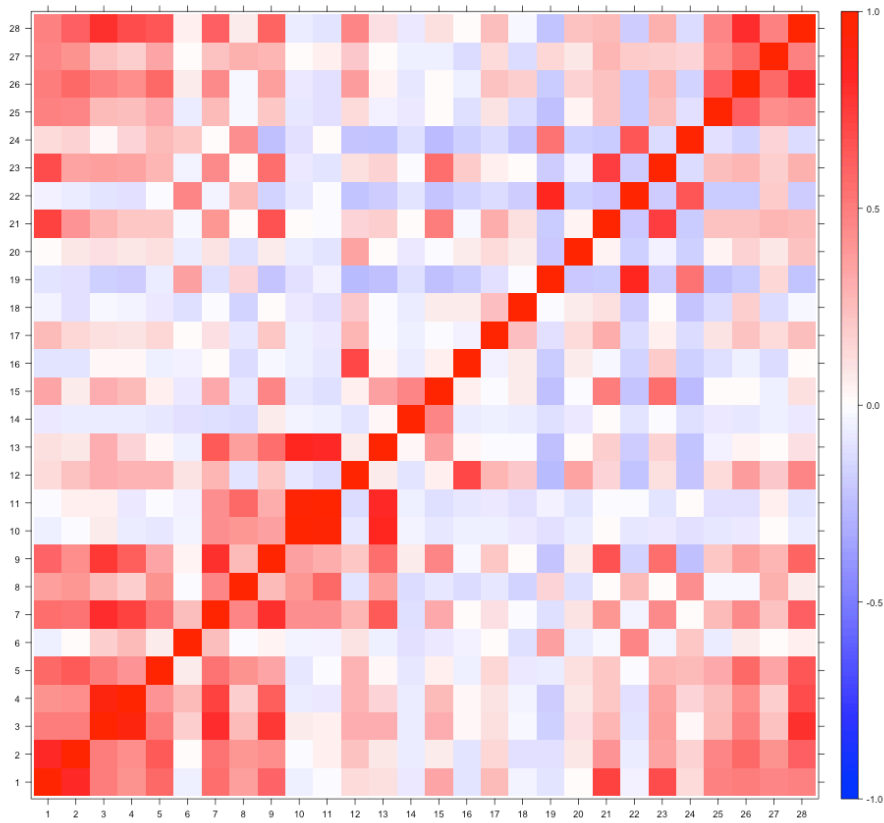
We want to combine pairs of objectives that are similar to one another and also have high correlation. In this way, we can reduce the number of clustering variables (objectives) without losing information that can differentiate among the interests of the actors. Therefore, we review each pair of highly correlated objectives and decide whether or not the two objectives represent the same stake or interest in the development of the system. If the two objectives represent the same stake, we combine them. For example, we see that objectives 1 and 2 – "reduce the transportation system fatality rate" and "reduce the number of non-fatal accidents and injuries" – are highly, positively correlated. It also makes sense that any stakeholder with a stake in general safety will have an interest in both of these objectives. Therefore, they can be combined.

On the other hand, we also see that objectives 1 and 21 – "reduce the transportation system fatality rate" and "maximize benefits from public investment in the transportation system" – have high positive correlation. While it makes sense that many of the public sector actors would have similar interests in both fatality rates and maximizing public benefits, these objectives represent distinct stakes in the system and are therefore not combined.

In this way, we reviewed each highly correlated objective pairs and combined 1 and 2, 3 and 4, 10 and 11, and 26 and 28. Table 9 summarizes the pairs of correlated objectives that are combined to reduce the number of clustering variables (objectives) from 28 to 24.

**Table 9.** Merged pairs of highly correlated objective pairs in the stakeholder-objective matrix for the NEC.

| Objective pair | New combined objective |
|---|---|
| 1 and 2 | Reduce the transportation system user fatality rate and the number of non-fatal accidents and injuries |
| 3 and 4 | Increase the physical capacity of the transportation system and ensure its effective utilization |
| 10 and 11 | Reduce fares/fees and provide a comfortable travel experience |
| 26 and 28 | Create a transportation system that can withstand environmental pressures, mitigate the effects of natural disasters, and support efficient evacuation routes |

When merging a pair of objectives, we must determine each stakeholder's level of interest in the new combined objective. While in many cases, an actor's interest was the same for the two objectives in the pair (hence the high correlation between the objective columns), where an actor had two different levels of interest in the individual objectives, the interest level for the combined objective was taken as the greater interest of the two.[10] For example, in the full actor-

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[10] There is no standard practice for determining the combined level of interest in a matrix of this form. By combining two objectives into one variable, one could argue that we are reducing the weight of the combined stake. In order to balance this, we choose to round the interest up for the combined objective.

objective matrix, Congress has a strong interest in objective 1, "reduce the transportation system fatality rate," and only a medium interest in objective 2, "reduce the number of non-fatal accidents and injuries." Rounding up, they were assigned a strong interest in the combined objective 1 and 2.

Figure 13 shows the reduced, numerically coded stakeholder-objective matrix for the NEC that maps the interests of the 30 actors with the 24 system development objectives resulting from the combinations in Table 9. Now that we have converted the symbolic stakeholder-objective matrix into a numeric code and reduced the dimensionality of the matrix to eliminate significant correlation and double counting of similar objectives, we have the necessary input for the final two phases of PCBA.

**Figure 13.** The numeric, reduced stakeholder-objective matrix for the NEC.

OBJECTIVES (column numbers):

1: Reduce the transportation system user fatality rate and the number of non-fatal accidents and injuries
2: Increase the physical capacity of the transportation system and ensure its effective utilization
3: Reduce the backlog of deferred maintenance for each mode
4: Facilitate the interconnection between different transportation modes
5: Decrease trip times
6: Increase trip time reliability
7: Reduce fares/fees and provide a comfortable travel experience
8: Reduce congestion
9: Foster livable communities through place-based policies and investments that increase transportation choices and access to transportation services
10: Increase accessibility of labour force participants to firms (jobs)
11: Increase accessibility of firms to labour force participants and
12: Increase the productivity of firms in all sectors
13: Promote short- and long-term job creation
14: Stimulate real estate development
15: Ensure that the net benefits of transportation system improvements are evenly distributed spatially and by socioeconomic class
16: Reduce emissions of air pollutants related to the transportation sector
17: Reduce energy consumption by the transportation sector
18: Minimize the spatial footprint of the transportation system, particularly on areas of high-environmental sensitivity
19: Maximize benefits from public investment in the transportation system
20: Maximize profitability for private operators in the transportation system
21: Create an organizational structure that will minimize the time and cost required for project implementation
22: Create an organizational structure that will allow the needs of all NEC operators to be considered during transportation investments
23: Create a flexible transportation system with a management structure that effectively identifies and mitigates risks
24: Create a transportation system that can withstand environmental pressures, mitigate the effects of natural disasters, and support efficient evacuation routes
25/26+28: Create a transportation system that can mitigate the effects of human disasters
27: Create an organizational structure for project implementation and/or infrastructure managers

ACTORS (rows) × OBJECTIVES (columns):

| # | Actor | 1+2 | 3+4 | 5 | 6 | 7 | 8 | 9 | 10+11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26+28 | 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Congress | 9 | 1 | 1 | 1 | 1 | 1 | 9 | 0 | 0 | 1 | 1 | 9 | 0 | 0 | 1 | 1 | 0 | 9 | 9 | 9 | 9 | 3 | 3 | 3 |
| 2 | State Governments | 9 | 9 | 3 | 1 | 3 | 3 | 9 | 0 | 0 | 3 | 0 | 9 | 1 | 1 | 3 | 0 | 3 | 3 | 0 | 9 | 0 | 3 | 3 | 0 |
| 3 | Local/Municipal Governments | 3 | 9 | 3 | 3 | 3 | 3 | 9 | 0 | 3 | 3 | 0 | 9 | 3 | 0 | 3 | 0 | 3 | 3 | 0 | 1 | 0 | 1 | 1 | 0 |
| 4 | USEPA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 9 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| 5 | US Department of Commerce | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 9 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | US Department of Energy | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 1 | 9 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | USDOT | 9 | 9 | 9 | 3 | 3 | 3 | 9 | 1 | 3 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 3 | 3 | 1 | 9 | 9 | 9 |
| 8 | Amtrak | 9 | 3 | 3 | 1 | 1 | 9 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 3 | 3 | 9 | 9 | 0 | 0 |
| 9 | NEC Commission | 0 | 9 | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 |
| 10 | I-95 Corridor Coalition | 1 | 9 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| 11 | Port Authorities | 1 | 3 | 3 | 9 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | Commuter Rail Agencies | 3 | 1 | 1 | 1 | 1 | 9 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 3 | 1 | 9 | 0 | 0 | 0 |
| 13 | Urban Public Transportation Org's | 3 | 1 | 1 | 1 | 0 | 9 | 0 | 1 | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 3 | 1 | 1 | 0 | 0 | 0 |
| 14 | Terminals | 0 | 3 | 0 | 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | Freight Railroad Companies | 0 | 3 | 1 | 9 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 9 | 9 | 0 | 9 | 0 | 0 | 0 |
| 16 | Intercity Bus Operators | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 9 | 9 | 0 | 9 | 0 | 0 | 0 |
| 17 | Trucking Industry | 0 | 1 | 0 | 9 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 9 | 9 | 0 | 0 | 0 | 0 | 0 |
| 18 | Airline Industry | 3 | 0 | 1 | 1 | 0 | 9 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 9 | 0 | 0 | 0 |
| 19 | Labor Unions | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Suppliers | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 21 | Private Consortiums | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 9 | 0 | 0 | 9 | 0 | 0 | 9 | 3 | 9 | 0 | 0 | 0 |
| 22 | Banking Industry | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 9 | 9 | 0 | 0 |
| 23 | Insurance Industry | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 3 | 3 |
| 24 | Private Landowners | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | Abutters | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | Political Activists/Lobbyists | 3 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 9 | 3 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 1 |
| 27 | Media | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | Commuters | 1 | 3 | 0 | 1 | 3 | 9 | 9 | 9 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 29 | Intercity Travelers | 1 | 3 | 1 | 3 | 9 | 3 | 9 | 9 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | Freight Customers | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## 4.3 PCBA PHASE 2: CLUSTERING

As introduced in Chapter 3, the second phase of PCBA employs agglomerative hierarchical clustering on the numerically coded, reduced stakeholder-objective matrix. This phase groups stakeholders based on their interests in the system objectives using Euclidean distance as the dissimilarity measure. While this method is standard across all applications of PCBA, the choice of linkage algorithm – or how the distance from a cluster to a stakeholder or to other clusters is defined – is a tuning parameter chosen to match each specific case.

In order to test which linkage algorithm is most appropriate for the given case, we can run agglomerative hierarchical clustering analysis on the reduced, numeric stakeholder-objective matrix for the NEC in Figure 13 using Euclidean distance as our dissimilarity measure for a number of different linkage algorithms. We perform the analysis using the open source data-mining program, Orange.[11] This produces a series of dendrograms (or tree structures) that can help us visualize which actors are most similar in their interest for the HSR system development on the NEC. Figure 14 through Figure 17 show the dendrograms produced from using single linkage, complete linkage, average linkage, and Ward's method (see Section 3.2.4). We can compare these tree structures to our knowledge of existing stakeholder relationships to choose the linkage algorithm most appropriate for the NEC.

For the NEC, we chose to employ the complete linkage or furthest neighbor algorithm (as in Figure 15) because we do not expect stakeholders to form equally sized clusters, nor do we suspect one large cluster of NEC stakeholders. Employing this linkage algorithm, a stakeholder in one cluster considering a coalition with another cluster will evaluate his or her interests against the stakeholder in the other coalition least alike to them. Because of this, we assert that complete linkage, despite its sensitivity to outliers, best mirrors the history of fragmentation among stakeholders of the NEC.

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[11] http://orange.biolab.si/

**Figure 14.** Hierarchical clustering using single linkage (nearest neighbor) algorithm for the NEC.
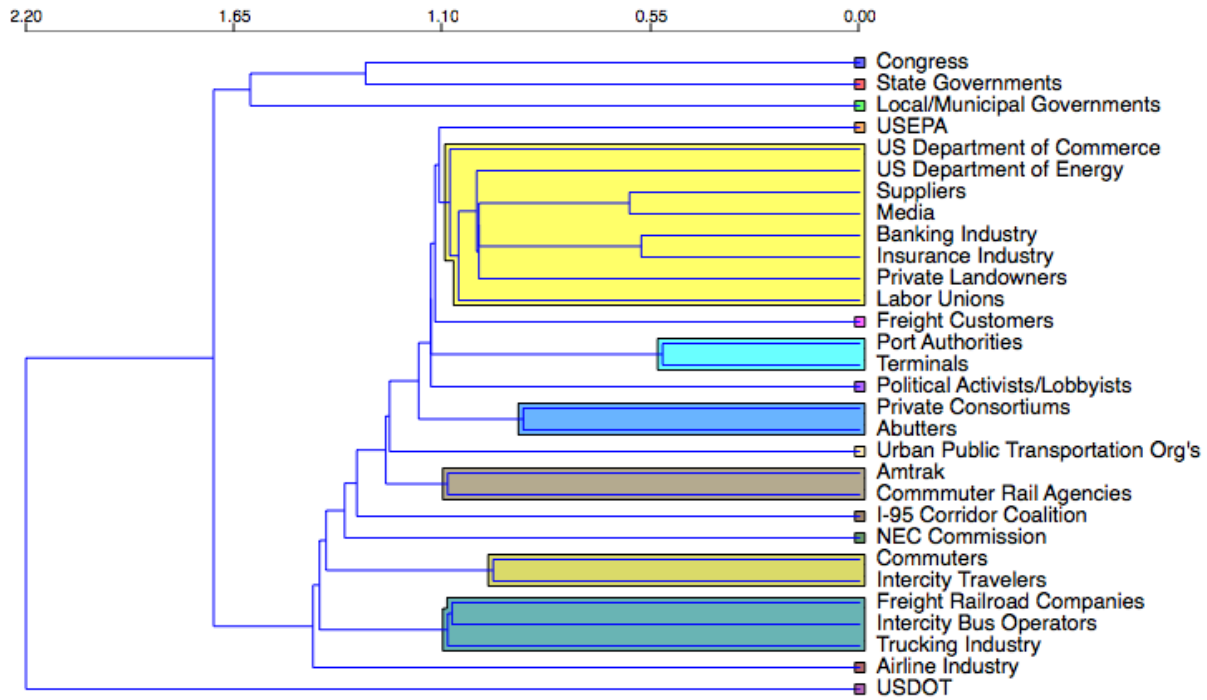


**Figure 15.** Hierarchical clustering using complete linkage (furthest neighbor) algorithm for the NEC.



90
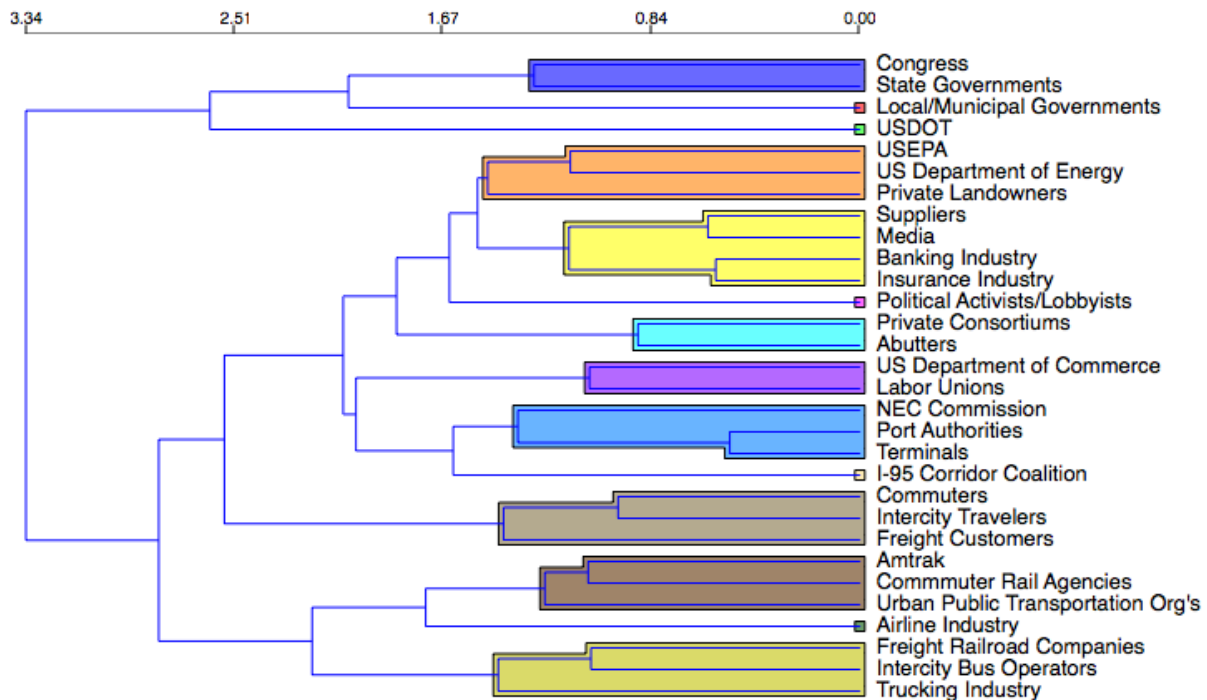
**Figure 16.** Hierarchical clustering using average linkage algorithm for the NEC.
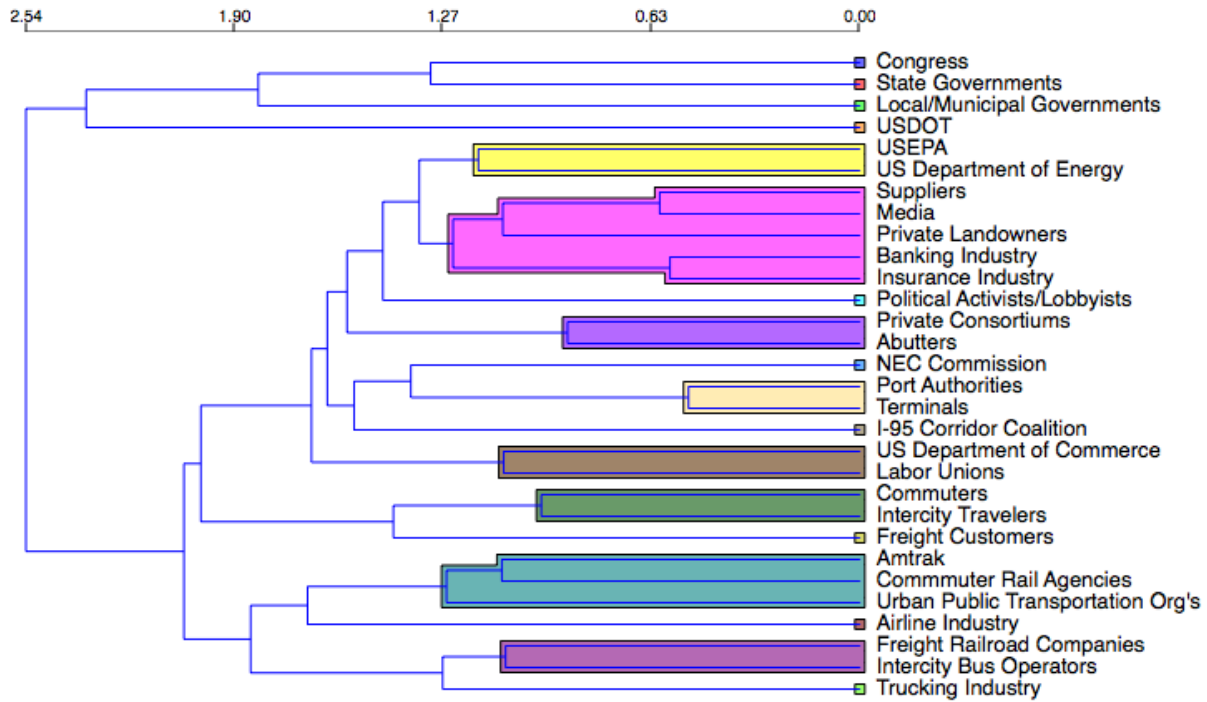


**Figure 17.** Hierarchical clustering using Ward's method for the NEC.
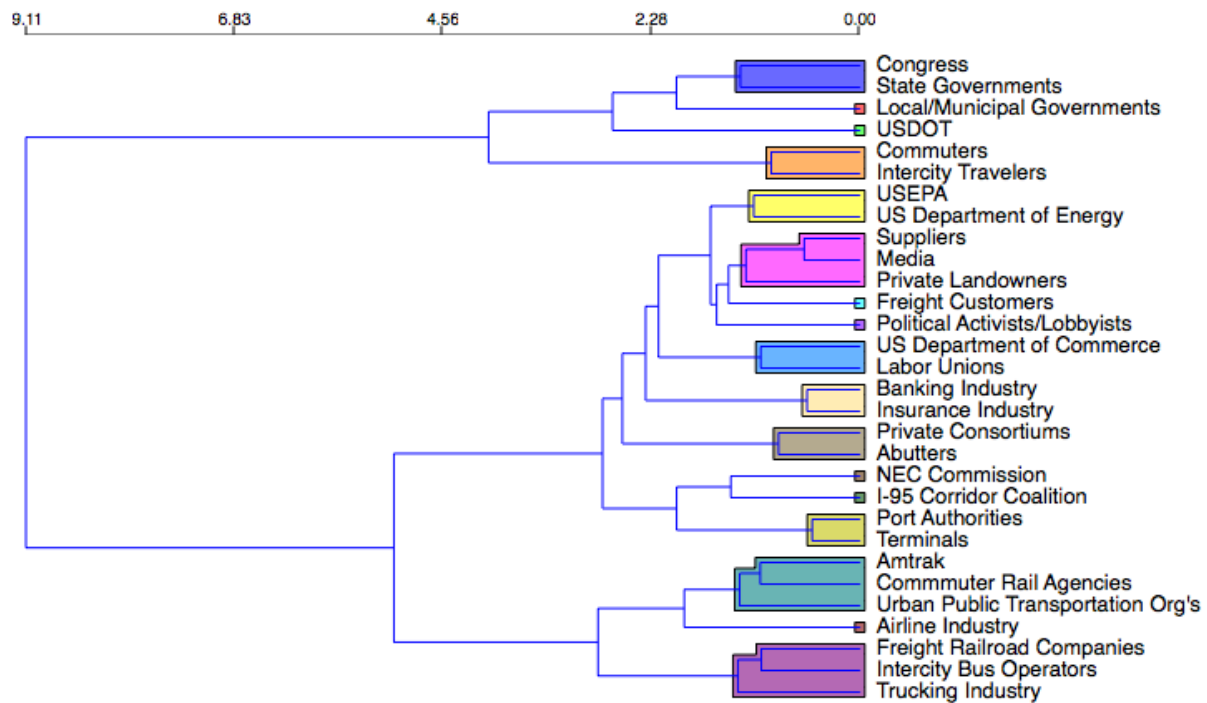
As discussed, we chose to employ the complete linkage or furthest neighbor algorithm for the NEC case (as in Figure 15). Figure 18 reproduces the dendrogram in Figure 15 using hierarchical clustering analysis for the 30 stakeholders of the NEC and labels important nodes among the stakeholders. This structure will serve as the basis for all further PCBA results.

At the far right of the diagram in Figure 18 – at position 0.00 – each stakeholder is placed into their own singleton cluster based on their unique interests in the HSR system development objectives for the NEC. Increasing distance from the right to the left indicates greater dissimilarity of interests. When two branches come together at a node, this indicates that the two stakeholders or stakeholder groups have been clustered together based on their interests in the system objectives. The further to the left this node is located on the diagram, the less-similar the interests of the actors in the cluster are and therefore the less likely the cluster will form according to belief homophily. For example, when comparing the node numbered (1) and the node numbered (5) in Figure 18, we see that Port Authorities and Terminals cluster at (1) with greater similarity in interest than Amtrak and Commuter Rail Agencies at (5).

For our analysis, less similarity among stakeholders indicates the need for more compromise on interest or more effort expended in order to work together and form a coalition. Therefore, in the dendrogram the further left the node where two actors come together, the less likely they are to form a coalition based on their interests.

**Figure 18.** PCBA Phase 2 agglomerative hierarchical clustering analysis results for the NEC.
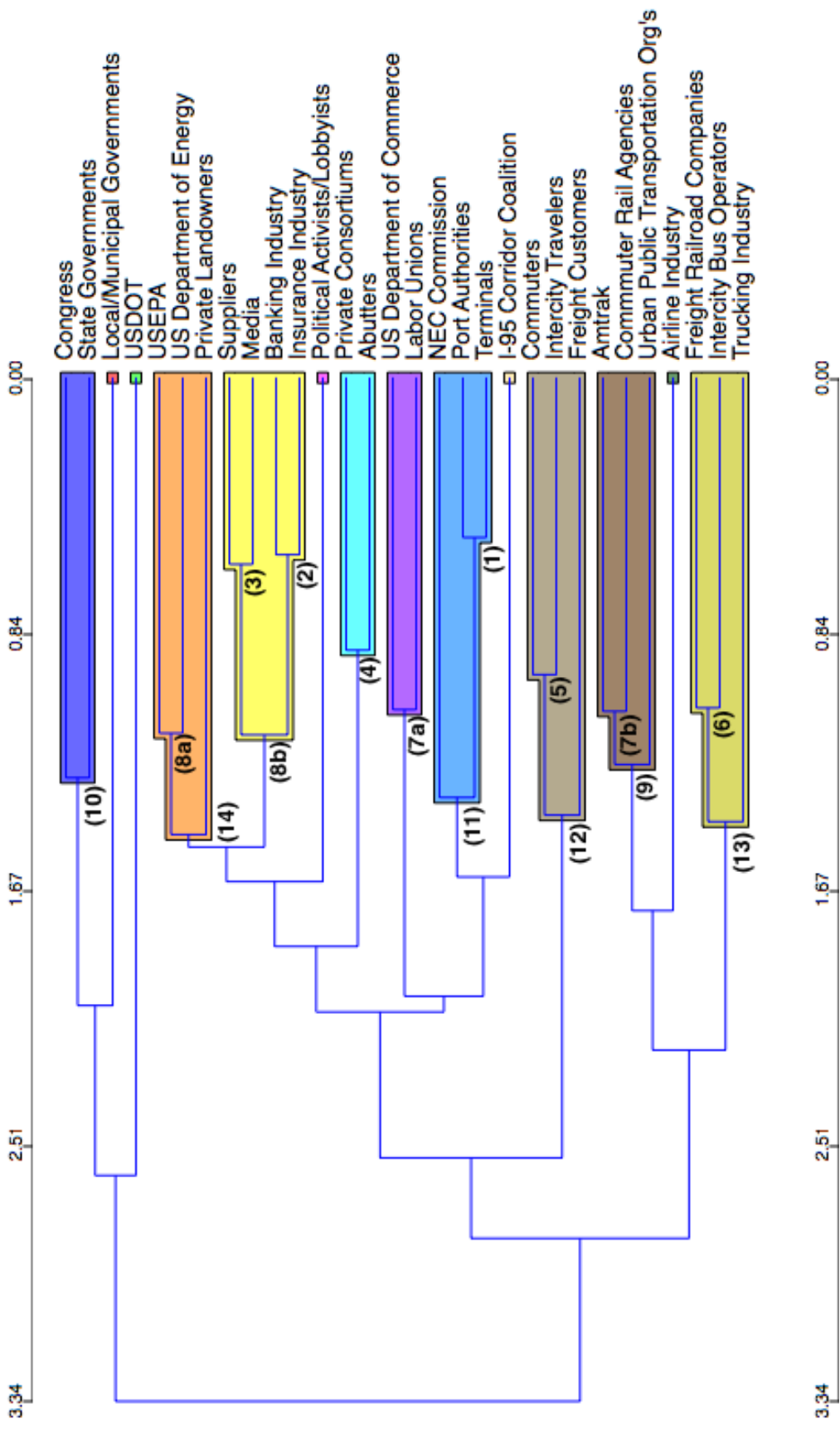
From the dendrogram in Figure 18, we can identify 14 possible clusters or coalitions among the stakeholders of the NEC that share a reasonable level of similarity among interests. Numbered according to which clusters are most to least similar in terms of their interests, the second phase of PCBA identifies the following possible groupings:

(1)   Port Authorities and Terminals
(2)   Banking and Insurance Industries
(3)   Suppliers and the Media
(4)   Private Consortiums and Abutters
(5)   Commuters and Intercity Travelers
(6)   Freight Railroad Companies and Intercity Bus Operators
(7)   a. US Department of Commerce and Labor Unions
       b. Amtrak and Commuter Rail Agencies
(8)   a. US Environmental Protection Agency (USEPA) and US Department of Energy
       b. Suppliers and the Media (3) and the Banking and Insurance Industries (4)
(9)   Amtrak and Commuter Rail Agencies (7a) and Urban Public Transportation Organizations
(10)  Congress and State Governments
(11)  Port Authorities and Terminals (1) and NEC Commission
(12)  Commuters and Intercity Travelers (5) and Freight Customers
(13)  Freight Railroad Companies and Intercity Bus Operators (6) and the Trucking Industry
(14)  USEPA and US Department of Energy (8a) and Private Landowners

Each of these clusters will be examined in more detail and discussed in terms of possible incentives and barriers to working together during the third phase of PCBA. Below we simply discuss the general shape of the dendrogram in Figure 18 and its implications for stakeholder cooperation on the NEC. We can check initial findings against our domain knowledge to make sure that any existing partnerships or trends among stakeholders are well captured in the dendrogram before discussing any predictions based therein. Furthermore, we can identify unintuitive coalitions that demonstrate the utility of using a standardized tool such as PCBA rather than simple ad-hoc professional judgment.

There are many ways in which the visualization of possible stakeholder partnerships in a dendrogram can be useful. First, one can choose a single stakeholder of interest and trace its branch from the right to the left, looking for where it forms nodes with other like-minded stakeholders. In this way, we can see how any particular stakeholder could form stronger coalitions as it reaches out to other actors or actor groups just a branch away. For example, we could explore how Amtrak first clusters with Commuter Rail Agencies at node (5), and then this cluster could form an additional partnership at node (12) with Urban Public Transportation Organizations.

In addition to considering the dendrogram starting from a single stakeholder at the right and moving to the left, it is also meaningful to consider the dendrogram from the left and note where the first branches split off. In the case of the NEC in Figure 18, we see that the first branch split isolates the legislative and administrative government stakeholders (Congress, State Governments, and Local/Municipal Governments) and the USDOT from all other actors. This could reflect how little the legislative and regulatory bodies in the United States, at any level of government, are responsive to the actual interests of transportation operators, other private sector stakeholders, or users. This is an important check that the dendrogram produced through clustering is representative of existing trends among stakeholders in the NEC context, but also might have important implications for HSR development. This disconnect between government and private sector at the legislative level might indicate that public-private partnerships for infrastructure and operations improvements may prove difficult because of the large difference in interests in system development objectives.

Another general lesson that we might draw from the dendrogram is that all of the users (Intercity Travelers, Commuters, and Freight Customers) in cluster (12) are fairly isolated from the interests of other actors. In particular, even the operators that are supposed to be catering to the needs of these passengers (Amtrak, Commuter Rail Agencies, Urban Public Transportation Organizations, Intercity Bus Companies, and the Airline Industry) and freight users (Freight Railroad Companies and the Trucking Industry) are far away in the dendrogram. This indicates that users of the NEC transportation system would need to compromise their interests and expend a lot of energy lobbying other groups if they want to gain a stronger voice for their interests in how the system develops.

The dendrogram helps us identify not just possible coalitions of stakeholders with similar beliefs, but also outliers that have interests far removed from any other stakeholders. We note that there are a number of stakeholders who do not have any other actors with reasonable similarity of interest: Local/Municipal Governments, USDOT, Political Activists/Lobbyists, [12] I-95 Corridor Coalition, and the Airline Industry. This distance from any closest neighbor in terms of interests may reflect the wildcard or fringe nature of these actors and could speak to their unpredictability in coalition forming. One good example of the uncertain reaction of these groups is the Airline Industry. While it does share some interests with other transportation operators along the NEC, such as reducing congestion and expanding capacity, its interests are likely unimodal. Therefore, it is difficult to predict whether the Airline Industry will look on HSR development cooperatively or competitively based on its unique interest in the system objectives. Indeed in another HSR market in the U.S. with similar actors, Texas, airlines have fought both for and against HSR depending on their view of its impact on their business (such as stealing customers vs. providing important access/egress connectivity to the airport).

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[12]

In the final phase of PCBA, each of the 14 identified clusters and the outlier stakeholders will be discussed in turn, with attention paid to incentives for and barriers against collective action. While some of these pairings may be intuitive, others – such as node (3) Suppliers and the Media – represent important insight gleaned from the analysis that may otherwise not have been considered during project planning and implementation.

## 4.4 PCBA PHASE 3: INCENTIVES

The third phase of PCBA considers the output of the hierarchical clustering in the second phase, but applies ideas from the Institutional Analysis and Development (IAD) Framework and Mitchell, Agel, and Wood's stakeholder typology to discuss incentives and barriers to coalition building among the clusters of stakeholders. First we must assign each stakeholder on the NEC any of the attributes of power, legitimacy, and urgency as discussed in Sections 2.3 and 3.3. Table 21 in Appendix A assigns stakeholder attributes to each of the stakeholders on the NEC. According to best practice, a brief description of why an attribute was assigned or withheld accompanies each cell of Table 21. The final column includes the typology for each stakeholder expressed by name and as a triplet – (P L U) – based on whether the stakeholder does or does not have each entry's attribute (Mitchell, Agel, & Wood, 1997).

Many of these assignments are somewhat subjective and will be based on the professional judgment of the analyst(s). Therefore, it is likely that a knowledgeable reader could disagree with the characterization given. While a change in the assigned stakeholder typology could change the discussion of incentives following this table, the transparency of attribute assignment and PCBA in general allow such a reader to consider how the incentives in possible partnerships might change with a change in a stakeholder's typology. In this way, the analysis can adapt to and consider differences in opinion to better understand uncertainties and possible coalitions among the stakeholders surrounding HSR development. Furthermore, none of these attributes nor the interests in the previous phase take into account whether the stakeholder is supportive of HSR development or oppositional. This point is discussed further in Chapter 6.

From the stakeholder attribute and typology assignments, we can arrange the stakeholders of the NEC within a stakeholder typology Venn diagram (see Figure 19). From this analysis, we identify the three most salient stakeholders for the NEC system as it stands today: USDOT, Amtrak, and Commuter Rail Agencies. These *definitive* stakeholders individually possess all three stakeholder attributes and therefore have the greatest influence on the direction of HSR system development.

**Figure 19.** Venn Diagram assigning stakeholder typologies to the 30 stakeholders of the NEC HSR system.
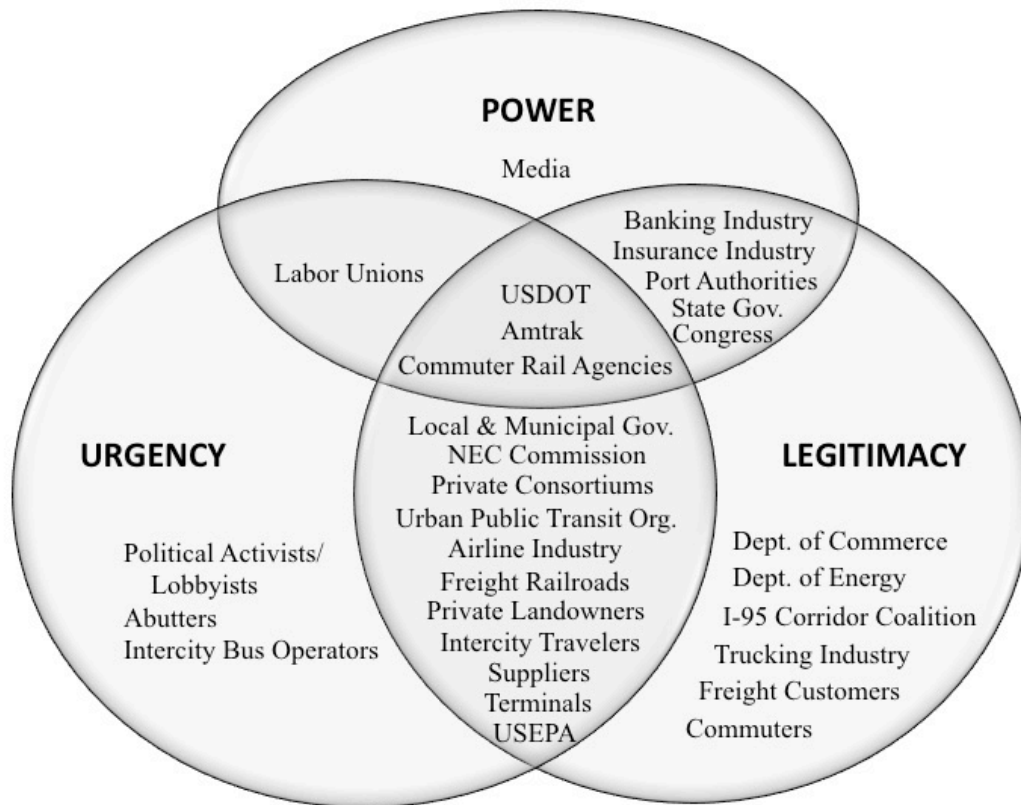


One important conclusion that can be drawn from Figure 19 is that there is a general lack of Power among stakeholders of the NEC. This reflects one of the major dilemmas facing HSR development on the NEC and in the United States in general: a lack of leadership and capital for transportation infrastructure initiatives. Because of this Power vacuum, those stakeholders that do possess Power may have more elevated salience and may be in higher demand as partners in any coalitions due to the scarcity of that attribute.

As discussed in Section 3.3, the stakeholder typology allows prediction about the circumstances under which a stakeholder might attempt to acquire a missing attribute. This is often achieved through partnerships with other stakeholders. Thus the stakeholder can enhance its salience and ability to influence HSR system development by working with another stakeholder. Therefore gaining an additional stakeholder attribute, and hence saliency, is a significant incentive for collective action. However, from public policy literature we know that stakeholders will not partner with just anyone; instead, they will work with whoever they see as having the most similar interests or beliefs. Therefore, we incorporate the Mitchell typology into the cluster hierarchy to help explain which groups of stakeholders with similar interests identified in the second phase of PCBA might or might not work together. Including the Mitchell, Agel, and Wood typology into the PCBA cluster hierarchy, we get Figure 20.

**Figure 20.** PCBA Phase 3 clustering hierarchy incorporating stakeholder typologies for the NEC.
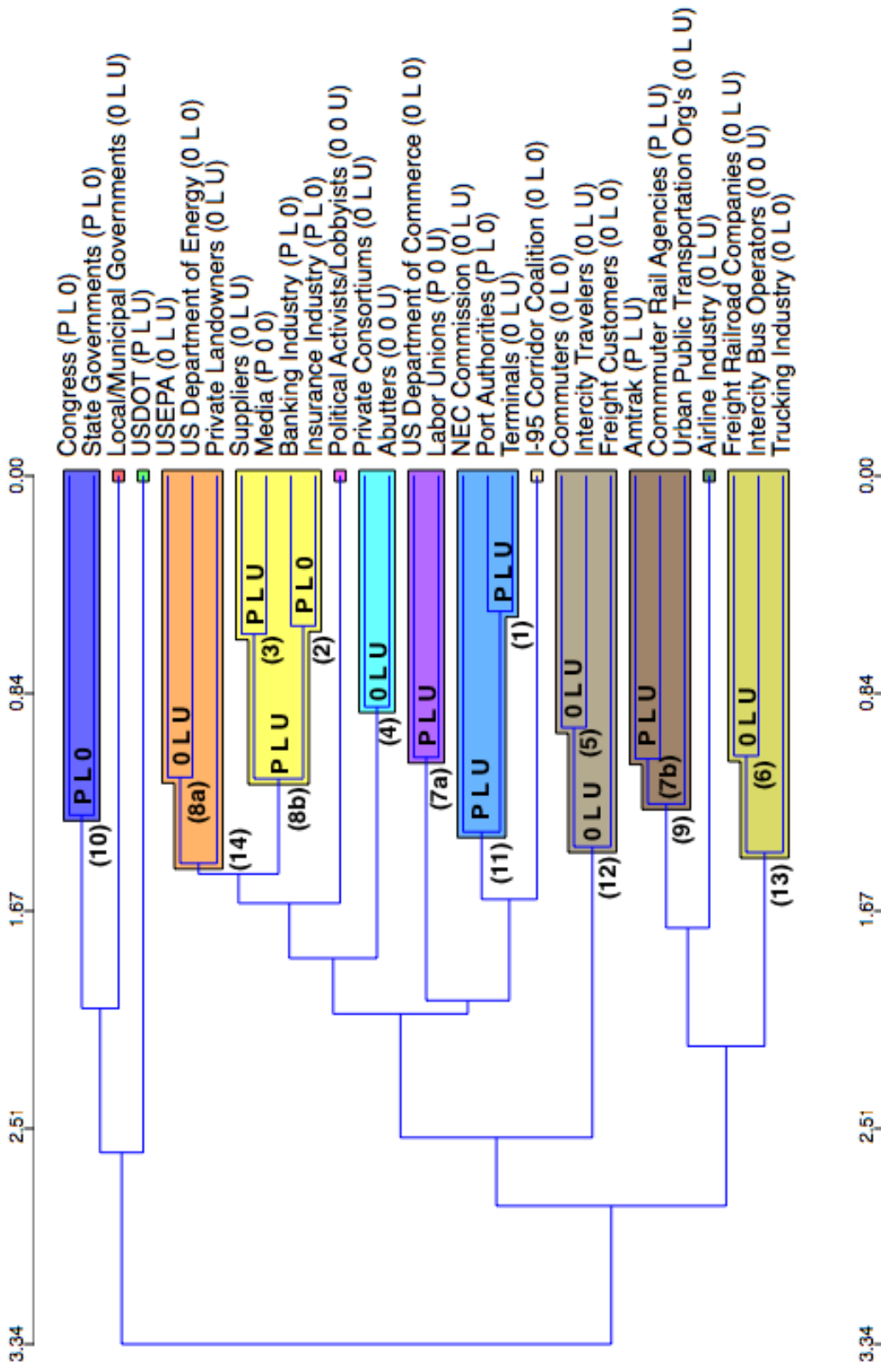
In the following discussion, we consider the incentives that exist among the stakeholders in each of the 14 clusters identified by similarity of interest in the previous phase of PCBA. For each cluster, we note the primary interests around which the coalition might form. Then we draw conclusions about the likelihood of these coalitions forming by considering whether the incentive for partnership by gaining salience through the Mitchell, Agel, and Wood typology is nonexistent, one-sided, or bi-directional. The results are summarized in Table 10.

**Table 10.** Summary of PCBA results: likelihood of partnerships among stakeholders of the NEC.

| (#) | Actor Pairing or Grouping | Cluster Typology | Likelihood of Partnership |
|-----|---------------------------|------------------|---------------------------|
| (1) | Port Authorities and Terminals | (P L U) | Highly likely |
| (2) | Banking and Insurance Industries | (P L 0) | Unlikely |
| (3) | Suppliers and the Media | (P L U) | Likely |
| (4) | Private Consortiums and Abutters | (0 L U) | Unlikely |
| (5) | Commuters and Intercity Travelers | (0 L U) | Likely |
| (6) | Freight Railroad Companies and Intercity Bus Operators | (0 L U) | Unlikely |
| (7a) | U.S. Department of Commerce and Labor Unions | (P L U) | Highly likely |
| (7b) | Amtrak and Commuter Rail Agencies | (P L U) | Mildly likely |
| (8a) | USEPA and U.S. Department of Energy | (0 L U) | Likely |
| (8b) | Suppliers and the Media (3) and the Banking and Insurance Industries (2) | (P L U) | Highly unlikely |
| (9) | Amtrak and Commuter Rail Agencies (7b) and Urban Public Transportation Organizations | (P L U) | Unlikely |
| (10) | Congress and State Governments | (P L 0) | Mildly likely |
| (11) | Port Authorities and Terminals (1) and NEC Commission | (P L U) | Unlikely |
| (12) | Commuters and Intercity Travelers (5) and Freight Customers | (0 L U) | Unlikely |
| (13) | Freight Railroad Companies and Intercity Bus Operators (6) and the Trucking Industry | (0 L U) | Mildly likely |
| (14) | USEPA and U.S. Department of Energy (8a) and Private Landowners | (0 L U) | Unlikely |
| | Political Activists/Lobbyists and the Banking and Insurance Industries (2) | (P L U) | Likely |

Note that by working together many of the likely clusters gain full saliency and become *definitive* stakeholders in the development of the HSR on the NEC. Therefore, not only are these coalitions likely to form, but were they to form they would command significant attention from project managers in determining the development of HSR along the corridor. Thus it is important for project managers to carefully monitor the relationships between these stakeholders and perhaps to incentivize certain partnerships to gain political will and form a larger coalition toward successful implementation of the project.

Each of these possible coalitions is discussed below, with the sections labeled 4.4(#), where (#) identifies the node from the PCBA dendrogram as in Figure 20 and in Table 10.

### 4.4(1) PORT AUTHORITIES, TERMINALS, AND NEC COMMISSION

The most similar pairing in terms of interests is cluster (1), Port Authorities and Terminals. This is a natural pairing given that Port Authorities often oversee airports, large intermodal terminals at waterfronts, and key bridges and interchanges that would be affected by HSR development and capacity expansion in similar ways to other rail terminals. Not only are these two actors the most similar in terms of interest, but they are also both motivated to work together toward their common objectives. Port Authorities can lend Terminals power through sharing of financial and technical resources, while Terminals can lend Port Authorities urgency by highlighting the importance of HSR development to regional connectivity. Therefore, both actors in the partnership gain saliency through cooperation, resulting in a coalition that is a *definitive* stakeholder with all attributes (P L U). Therefore, this is one of the most likely partnerships among the stakeholders of the NEC HSR system.

The next-nearest neighbor in terms of interests to cluster (1) is the NEC Commission at node (11). From Figure 20 we see that there is a significant gap in interests between the Port Authorities and Terminals in (1) and the NEC Commission, so significant compromise on objectives would be necessary for this cooperation, making it less likely. Furthermore, we note that although the NEC Commission could gain power from this partnership, cluster (1) has already gained all of the stakeholder attributes and is a *definitive* stakeholder so the incentive is only one-sided. Therefore, cluster (11) is an unlikely coalition.

### 4.4(2) BANKING AND INSURANCE INDUSTRIES

The second natural pairing is between Banking and Insurance Industries, who have similar interests in the financial viability of the project. The Insurance Industry has additional interest in the fatality rate on the system and its resiliency to environmental and human disasters after project completion. Despite their similar interests, we note that both the Banking and Insurance industries are assigned a stakeholder typology of (0 L U). Since neither party can gain power nor salience by working together, there is little incentive on either side to cooperate beyond the traditional links between these two industries dictated by the financial structure of the country. In fact there are additional legislative barriers to forming this coalition not captured in the clustering analysis on the *objective* variable to forming such a coalition. Therefore, both the banking industry and the insurance industry are likely to remain singleton, dominant actors unless an outside force mandates or convinces them to combine forces.

### 4.4(3) SUPPLIERS AND THE MEDIA

The third cluster identified by similarity of interest is that between Suppliers and the Media (3). At first glance this may seem like a less intuitive pairing than many of the others in the dendrogram; however it may be indicative of the power of advertising and positive media coverage when a supplier is trying to sell its specific brand or product. When we consider the

stakeholder typology, we see that both sides are incentivized to work together since Suppliers can gain power from working with the Media and the Media can gain both legitimacy and urgency by working with established Suppliers in the market. Therefore, these parties may be highly motivated to collaborate and form cluster (3), which would be a *definitive* stakeholder in the market.

4.4(4) PRIVATE CONSORTIUMS AND ABUTTERS

Cluster (4) pairs Private Consortiums (construction companies and real estate developers) with Abutters. While Private Consortiums likely do not share the same concerns about noise and air pollution adjacent to new transportation development as Abutters, both groups could benefit from transit-oriented development around new or expanded HSR stations and the agglomerative benefits that could result from expanding rail passenger service along the corridor. Their interests, therefore, align mostly around possible station-area improvements. Considering their incentives, we see that Abutters could gain legitimacy from working with Private Consortiums, but Private Consortiums would not gain additional salience from the partnership. Therefore the incentive towards cooperation is one-sided and thus the energy and compromise required for partnership would need to come from Abutters. Given the fact that Abutters are dispersed and an unorganized actor group, this is unlikely.

4.4(5) COMMUTERS, INTERCITY TRAVELERS, AND FREIGHT CUSTOMERS

The dendrogram (Figure 20) also shows the similarity between the interests of Commuters and those of Intercity Travelers (5). This pairing is intuitive as both user groups have similar needs in terms of quality of service and will likely be impacted in much the same way by any improvements to the existing NEC. We see that the incentive for working together comes from the side of the Commuters, who would gain urgency from working with Intercity Travelers. Because of the agglomerative effects of HSR on economic development and travel patterns, it is likely that, despite the one-sided nature of this coalition, these two groups will end up working together, if not effectively blending together should people begin to commute between intercity pairs by HSR (Westrom, 2014).

The next-nearest neighbor to the Commuter and Intercity Traveler cluster (5) are the Freight Customers (shippers and receivers), the final user group identified on the NEC. While these groups all share interests as users, level of service concerns for freight are less about comfort and travel time when compared with the concerns of passengers. We see that Freight Customers could gain urgency from joining the Commuter and Intercity Traveler coalition (5), however this incentive is one-sided. The more salient cluster has little incentive to work with freight users because they do not gain their missing attribute, power. Furthermore, there are few existing channels for cooperation among freight and passenger users, who each are made up of an extremely disperse and diverse set of individuals. Therefore, we find that Freight Customers are unlikely to join the passenger users in a coalition. Even if freight users were to make the

compromises in their interests to create a user coalition, this coalition would still lack full saliency. This shows that users of the NEC system, even if they all come together, will not have the power needed to have their interests fully attended.

4.4(6) FREIGHT RAILROAD COMPANIES, INTERCITY BUSES, AND THE TRUCKING INDUSTRY

Moving from users to private sector actors, we consider Cluster (6). This node pairs Freight Railroad Companies with Intercity Bus Operators. This similarity is informative and speaks to the fact that both the rail and highway corridors face capacity constraints on the existing NEC infrastructure that could be relieved by the development of high-speed intercity passenger rail. In this way, both actors could see benefits in travel time and reliability from reduced traffic with the introduction of HSR on the NEC. Additionally, intercity bus operators may be negatively impacted when considering HSR as a competitive passenger mode, who could steal customer market share, while Freight Railroad Companies may view HSR as a competitive mode for limited infrastructure capacity and scheduling on any shared track. Intercity Bus Operators could gain legitimacy by working with Freight Railroad Companies, but the incentives for partnership are one-sided and the coalition if it were to form would still lack power to influence HSR development along the corridor. Therefore, this coalition is less likely than some others.

Looking at the next-nearest neighbor, we see that the Trucking Industry has similar interests to both Freight Railroad Companies and Intercity Bus Operators. This similarity of interest is likely multi-faceted, with the Trucking Industry and Freight Railroad Companies having similar concerns about the impacts of congestion on freight movements along the corridor and the Trucking Industry and Intercity Bus Operators having similar concerns about the capacity expansion and state of good repair of the highway systems that they share. The Trucking Industry has only legitimacy to offer to a potential partner, so it has only a one-sided incentive to work with the Freight Railroad Companies. In fact, because they may often compete for particular freight customers along the corridor, this pairing is even less likely. On the other hand, the incentive for the Trucking Industry to work with Intercity Bus Operators is bi-directional. The Trucking Industry could gain urgency from Intercity Bus Operators who might emphasize the negative impacts of growing highway congestion on travel time and reliability. Intercity Bus Operator might gain legitimacy from the Trucking Industry, which has well-established political and lobbying connections that protect their stake in interstate highway development. Therefore, this coalition may be mildly likely.

4.4(7A) U.S. DEPARTMENT OF COMMERCE AND LABOR UNIONS

Now we consider cluster (7a), pairing the U.S. Department of Commerce and Labor Unions. Both of these actors have similar interests when it comes to creating jobs, expanding accessibility (to trade and jobs), as well as expanding productivity in many sectors of the economy. Not only do these actors have a similar and concentrated set of interests, but they also have complementary stakeholder typologies. By working together, the U.S. Department of

Commerce can gain urgency and Labor Unions can gain legitimacy. The incentive for partnership is therefore bi-direction and would result in a coalition that would act as a fully salient *definitive* stakeholder in the development of the system. Therefore, this coalition represents a very likely partnership among the stakeholders of the NEC HSR system.

4.4(7B) AMTRAK, COMMUTER RAIL AGENCIES, AND URBAN PUBLIC TRANSPORTATION ORG'S

Amtrak and Commuter Rail Agencies also have fairly similar interests and would form cluster (7b). This is because these two actors currently share the same rail infrastructure along the NEC and therefore face the same limited capacity and deferred maintenance issues which result in lower levels of service. In fact, any form of HSR development along the corridor – regardless of alignment or dedicated vs. shared use of track – would see state-of-good repair improvements on the current rail system and new capacity allocation and fund-sharing mechanisms that would benefit each of these actors. However, since Amtrak owns the majority of the infrastructure along the NEC and they would likely be directly involved in intercity HSR operations along the corridor, their interests are slightly different. Considering stakeholder typologies, we note that this possible cluster is unique in that it contains two of the three actors who are definitive, fully salient stakeholders on their own. Amtrak and commuter rail agencies are the owners of the existing NEC rail infrastructure and as such will have prominent voices in any rail infrastructure expansion. Because of their full salience, there is little incentive on either side to work together. Therefore, Amtrak and Commuter Rail Agencies may need additional incentives, such as regulation requiring coordinated capacity usage and fund allocation (similar to PRIIA) to work together on HSR development.

Considering other stakeholders with similar interests to those in cluster (7b), we see that Urban Public Transportation Organizations are the next-closest neighbor with Amtrak and Commuter Rail Agencies at node (9). The small difference in interests could be attributed to the narrower geographic scope and multi-modalism of the Urban Public Transportation Organizations compared with the longer-distance passenger rail operators. While cluster (7b) contains two *definitive* stakeholders who may not be incentivized to work together, let alone with another actor, Urban Public Transportation Organizations could gain power and hence full saliency by collaborating with either Amtrak or Commuter Rail Agencies. If proper incentives were set in place, this coalition could provide a larger, more diverse voice on how intercity rail improvements should connect to other transportation networks and address the important last-mile problem.

4.4(8A) USEPA, U.S. DEPARTMENT OF ENERGY, AND PRIVATE LANDOWNERS

Cluster (8a) brings together the US Environmental Protection Agency (USEPA) and the U.S. Department of Energy. This pairing is rather intuitive since both governmental actors have similar roles in terms of administration and regulation of policy and both have stakes in the energy use of the transportation sector. The actors are dissimilar because the EPA's interests

extend beyond the energy use of the transportation sector to include air and water quality as well as issues of environmentally sensitive land use. Considering their typologies, we see that the U.S. Department of Energy can gain urgency from partnering with the USEPA, but this incentive is one-sided. However, since their interests are fairly similar and they both play a similar regulatory role, the compromise and energy needed to form this relationship could be reasonable, making a coalition likely.

With only a little more compromise on interests, cluster (8a) of the US Department of Energy and the USEPA could also work with Private Landowners along the proposed alignment of the NEC to form cluster (14). The limited overlap in interests is likely due to the land use concerns of the USEPA. In fact, private landowners often use regulation from these government entities to fight transportation infrastructure development through their land. However, when we consider the incentive structure of the partnership, we see that cluster (8a) and Private Landowners both already have legitimacy and urgency. Therefore it is unlikely that they would make the compromise necessary to work together, since there is no clear gain in saliency for either party.

4.4(8B) SUPPLIERS, THE MEDIA, AND BANKING AND INSURANCE INDUSTRIES

Cluster (8b) represents a large group of actors, bringing together Suppliers and the Media (3) and the Banking and Insurance Industries (4). In our earlier discussion, we found that cluster (3) was likely because both actors would achieve full salience. On the other hand, we found that the Banking and Insurance Industries  (cluster 4) face legal barriers as well as a lack of incentive to work together more closely than they already do. Despite fairly similar interests among all four of these actors, because cluster 3 has already achieved full salience it is unlikely to expend the additional energy and compromise its interests to bring additional actors into its coalition. Furthermore, because the Banking and Insurance Industries lack urgency, it is unlikely that they will explicitly seek out this partnership. Therefore there is little incentive on either side to work together.

Furthermore, it is important to note that the more parties involved in possible collective action, often the more difficult it is to find common ground for successful partnership (Ostrom, 1991; Witbreuk, 2000). Therefore, no matter the similarity of overall interests, there are likely just too many stakeholders in this cluster to make it a likely coalition. Because of the number of stakeholders and the lack of incentive, we conclude that cluster (8b) is highly unlikely.

4.4(10) CONGRESS AND STATE GOVERNMENTS

The final cluster that was identified in Figure 20 was that between Congress and State Governments (10). While it makes sense that the legislative bodies at the federal and state level have similar, larger-scale interests in the transportation network, it also makes sense that both of these actors lack urgency when it comes to HSR development. With such a diverse agenda of issues in front of them, it may be hard for these two actors to prioritize HSR despite their many

interests in the potential benefits. Because they share a similar typology, Congress and State Governments are not highly incentivized to work together. However, existing match-grant structures (that require State Governments to guarantee some portion of initial capital investment in order to receive federal funding) and other institutional relationships make it likely that they will continue to work together to a limited degree to improve the transportation system along the NEC.

In addition to the discussion of possible coalitions, it is also important to consider the implications of the stakeholder typologies assigned to the wildcard actors (or interest outliers) that appear in Figure 20. Singleton actors on the NEC include the USDOT, Local/Municipal Governments, Political Activists/Lobbyists, I-95 Corridor Coalition, and the Airline Industry. Depending on their stakeholder typologies and interests in the system development objectives, these stakeholders might be inert – or unlikely to disturb the dendrogram structure – or could represent a source of uncertainty in the institutional context of HSR development.

The U.S. Department of Transportation is unique among this group of singleton actors because it is already a *definitive* stakeholder (although perhaps with slightly less urgency than Amtrak and Commuter Rail Agencies). The USDOT by itself commands full salience to influence system development. Therefore it does not have much incentive to compromise its unique interests to work with others. It is likely that this actor will remain a singleton.

Local and Municipal Governments have urgency and legitimacy, but will have to significantly compromise their interests to gain power by working with their closest neighbors: State Governments and Congress. If this coalition could be formed, Local and Municipal Governments could lend urgency to the legislative and administrative actors at the state and federal level. While this one-way incentive structure may be good for larger scale, long-term projects that put regional and national needs above those of cities, it may make development less responsive to certain local needs. These government actors are far removed from the interests of any other stakeholders, so even if a partnership were to form they are unlikely to disturb the rest of the dendrogram structure.

Next we consider the outlier Political Activists/Lobbyists. We first must acknowledge that political activists and lobbyists are by no means homogeneous. There are political lobby groups on both sides of most issues. However, our clustering analysis considers which objectives these actors are interested in as a whole and not how they are interested in them (such as opposed or supportive). With this characterization, the stakeholder as a collective has similar interests to a large group of actors, including the USEPA and the U.S. Department of Energy (8a), Private Landowners, Suppliers and the Media (3), and the Banking and Insurance Industries (2). However, Political Activists/Lobbyists only have the stakeholder attribute of urgency to add to a partnership, which is a fairly common attribute among the stakeholders on the NEC. In particular, the environmental interests of the USEPA, the U.S. Department of Energy, and

Private Landowners are already urgent and therefore may have little incentive to compromise interests and work with Political Activists/Lobbyists. However, one possible and unexpected agitation to the institutional context of the NEC might be if Political Lobbyists/Activists reach out to the Banking and Insurance Industries. By lending these industries urgency and in the process gaining both power and legitimacy, all parties would become fully salient stakeholders with this single relationship. This could be a bi-directional incentive despite the disparity in interests. This presents one possible break from the "status quo" that could disrupt the current stakeholder structure surrounding the NEC transportation system.

The final two singleton stakeholders, the I-95 Corridor Coalition and the Airline Industry, both possess only legitimacy. This stakeholder attribute is shared by their nearest-neighbors. Therefore, unless these actors are to reach out to stakeholders further away in terms of interest, it is unlikely that they will be able to catalyze any major coalitions beyond those identified by PCBA.

This concludes the discussion of the 14 possible clusters and outlier stakeholders identified through PCBA. The visual, transparent, and predictive nature of PCBA differentiate it from other methods that exist for exploring possible stakeholder relationships surrounding large infrastructure projects. While the previous sections explored the application of the method to the case study of the NEC to provide new domain insights, the final two sections of this chapter will explore the sensitivity and validity of the technique in this case. First, we will discuss the impact of certain pattern breaks or perturbations to the institutional context of the NEC. In particular, we will explore how PCBA can handle the addition of a new stakeholder or the changing of a particular stakeholder's interests. Then we will compare the results outlined above to results obtained through the application of Multi-Stakeholder Trade Space Exploration (MSTSE) to the NEC as a way to validate our general findings and to discuss the relative merits of PCBA.


## 4.5 SENSITIVITY TESTS FOR ROBUSTNESS

In this section, we explore how PCBA responds to institutional pattern breaks, particularly in the number or interests of stakeholders on the NEC. For PCBA to be a useful tool for planners and project managers, it must be sensitive enough to react to and capture the effect of small changes, but robust enough to maintain the overall structural integrity of the institutional hierarchy. To explore the sensitivity and robustness of the tool, we consider the entrance of a private sector HSR developer – such as the East Japan Railway Company (JR East) – into the institutional context of the NEC.

In order to include JR East as a stakeholder in PCBA for the NEC, we must determine JR East's interests in the system objectives (for the second phase) and JR East's stakeholder typology (for the third phase). For the purposes of this hypothetical analysis, we evaluate JR East in each of these business roles as if they have already signed a contract so that they are not possible, but

actual stakeholders in the NEC market. Both JR East's interests and its stakeholder typology will depend on the company's business role, or how they are involved in the market. For example, if JR East is involved in HSR development along the NEC as a consultant, its place within the institutional context of the NEC would be very different from its place should it privately finance, build, and operate a new, dedicated HSR system. With increasing level of involvement, we explore the impact of JR East as a stakeholder in the NEC as (1) a consultant, (2) an operator under concession along the NEC, and (3) an owner and operator of an entirely private HSR development.

Figure 21 summarizes the company's interests in the reduced objectives for the NEC system. These interests in the system objectives change depending on JR East's business role. For example, if JR East is simply providing engineering consulting, it may be more interested in objectives regarding the construction phase, such as objective 22 – "create an organizational structure that will minimize the time and cost required for project implementation" – rather than objectives related to system operation once their role is complete. On the other hand, if JR East is operating a system under concession, JR East may not be involved in the project until after design and construction, so it would be more concerned with objectives such as 10+11 – "reducing fares/fees and providing a comfortable travel experience" – that relate to operations.

JR East's level of interest in each of the objectives in Figure 21 is coded according to the same 0-1-3-9 numeric code – indicating "no interest," "weak interest," "medium interest," and "strong interest" – used for the NEC stakeholder-objective matrix (see Section 4.2.3). The strength of JR East's interest in each objective is evaluated from the viewpoint of JR East in its particular business role.

**Figure 21.** Stakeholder-objective matrix for JR East in its different business roles in the NEC.

| | | | Provide engineering or operations consulting | Operate a system under concession | Finance, construct, and operate a private HSR system |
|---|---|---|---|---|---|
| **Objectives** | 1+2 | Reduce the transportation system user fatality rate and the number of non-fatal accidents and injuries | 0 | 9 | 9 |
| | 3+4 | Increase the physical capacity of the transportation system and ensure its effective utilization | 0 | 3 | 9 |
| | 5 | Reduce the backlog of deferred maintenance for each mode | 0 | 3 | 9 |
| | 6 | Facilitate the interconnection between different transportation modes | 0 | 1 | 3 |
| | 7 | Decrease trip times | 0 | 1 | 3 |
| | 8 | Increase trip time reliability | 0 | 9 | 3 |
| | 9 | Reduce congestion | 0 | 1 | 0 |
| | 10+11 | Reduce fares and provide a comfortable travel experience | 0 | 1 | 0 |
| | 12 | Foster livable communities through place-based policies and investments that increase transportation choices and access to transportation services | 1 | 0 | 9 |
| | 13 | Increase accessibility of labour force participants to firms (jobs)); increase accessibility of firms to labour force participants | 0 | 0 | 0 |
| | 14 | Increase the productivity of firms in all sectors | 0 | 0 | 0 |
| | 15 | Promote short- and long-term job creation | 0 | 0 | 0 |
| | 16 | Stimulate real estate development | 0 | 0 | 3 |
| | 17 | Ensure that the net benefits of transportation system improvements are evenly distributed spatially and by socioeconomic class | 0 | 0 | 0 |
| | 18 | Reduce emissions of air pollutants related to the transportation sector | 0 | 0 | 3 |
| | 19 | Reduce energy consumption by the transportation sector | 0 | 3 | 3 |
| | 20 | Minimize the spatial footprint of the transportation sector, particularly in areas of high-environmental sensitivity | 0 | 0 | 3 |
| | 21 | Maximize benefits from public investment in the transportation system | 0 | 1 | 0 |
| | 22 | Maximize profitability for private operators and/or infrastructure managers | 0 | 3 | 9 |
| | 23 | Create an organizational structure that will minimize the time and cost required for project implementation | 3 | 0 | 9 |
| | 24 | Create an organizational structure that will allow the needs of all NEC operators to be considered during transportation investments | 0 | 9 | 0 |
| | 25 | Create a flexible transportation system with a management structure that effectively identifies and mitigates risks | 9 | 9 | 9 |
| | 26+28 | Create a transportation system that can withstand environmental pressures, mitigate the effects of natural disasters, and support efficient evacuation routes. | 0 | 0 | 9 |
| | 27 | Create a transportation system that can mitigate the effects of human disasters | 0 | 0 | 9 |

For a complete application of all three phases of PCBA, we also need to determine JR East's stakeholder typology for each of its business roles (Table 11). We note that as a consultant, operator, and private HSR developer, JR East will have legitimacy through its business contracts (since we have assumed that JR East has already entered the NEC market). In its role as a consultant, JR East will have little financial or coercive power to influence HSR development and will not have urgency since its role is small and contractually defined. In this role, JR East would not have a significant stake in the lifecycle outcomes of the project and faces little risk in

its success. As an operator under concession, JR East will not be involved in the project until the development of HSR infrastructure is complete. Therefore, the company has little power or urgency to influence early stages of design and construction. Therefore, in its role as a consultant or operator, JR East is a *discretionary* stakeholder, with a typology of (0 L 0).

In its third and final role – financing, constructing, and operating a private HSR system – JR East is a *definitive* stakeholder with a typology of (P L U). Since the company would mobilize its own financing it would have significant power in determining the alternatives adopted during HSR development. JR East is assigned the power for this business role given that its role is evaluated once the system client has 'bought into' the JR East system. Only at this point would JR East have the money and expertise to participate in the private development. JR East is also assigned urgency in this role because the company would assume all of the risk for the design, construction, and operations phases of the project as a private developer. Therefore, JR East would look to complete costly design and construction and commence revenue service as quickly as possible.

**Table 11.** Stakeholder typology for JR East depending on its business role in the NEC.

| JR East Business Role | Power | Legitimacy | Urgency | Type (P L U) |
|---|---|---|---|---|
| 1. Provide engineering or operations consulting | X | √ | X | Discretionary (0 L 0) |
| 2. Operate an HSR system under concession | X | √ | X | Discretionary (0 L 0) |
| 3. Finance, construct, and operate a private HSR system | √ | √ | √ | Definitive (P L U) |

For each of the business roles, we incorporate JR East's interests and stakeholder typology into the reduced, numeric stakeholder-objective matrix for the NEC (Figure 13) and re-run the hierarchical clustering analysis. No other stakeholders or their interests are changed. We then discuss the implications of the resulting dendrogram, paying special attention to what PCBA might say regarding possible partnerships available for JR East in its given role and any disruptions to the overall structure of the institutional context of the NEC.

## 4.5.1 Provide Engineering and Operations Consulting

We first consider a very limited role for JR East as an additional stakeholder in the NEC. In this case, JR East provides engineering or operations consulting on HSR development on the NEC. Given that its role is only in the conceptual design and construction phases of the project, JR East has limited interests in many of the full life-cycle objectives of the system (see Figure 21). Performing PCBA with JR East as a consultant yields the dendrogram in Figure 22. We note that while the institutional context contains a new stakeholder, there is very little disruption to the overall structure of the hierarchy (as compared with Figure 18 and Figure 20). While it does

isolate the Banking Industry and Insurance Industry from its possible (but unlikely) coalition with Suppliers and the Media, in its limited role as a consultant JR East does not affect any other available partnerships for the stakeholders of the NEC in the dendrogram.

**Figure 22.** Hierarchical clustering results for the NEC with JR East providing consulting services.
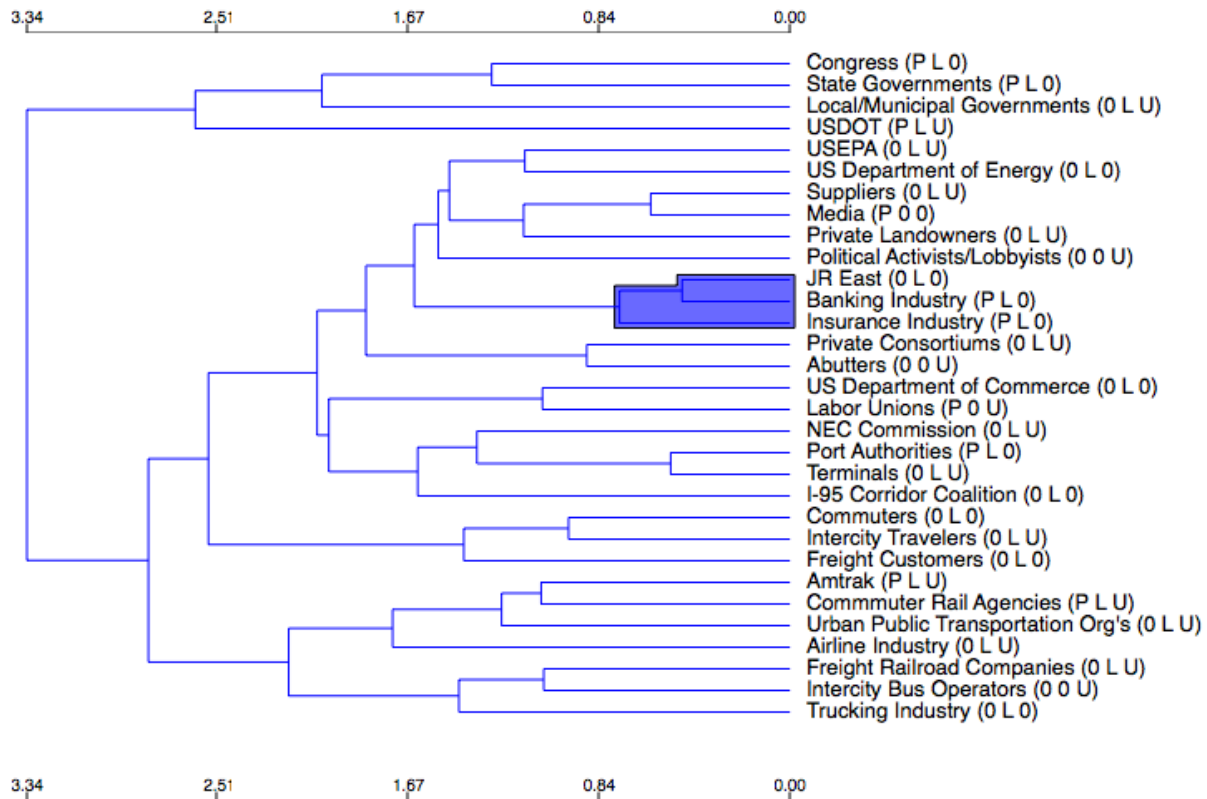


We see that the NEC stakeholders with the most similar interests to those of JR East are the Banking Industry and Insurance Industry. This makes sense given the shorter-term nature of JR East's interests in this business role – the company's main concern as a consultant would likely be in fulfilling the terms of its contract and encouraging the project to be completed on time and on budget. These monetary and construction-phase concerns are echoed by banks and, to a lesser extent, by the insurance industry. The insurance industry differs from the other two stakeholders in the possible coalition because it has some concerns for mitigating longer-term risks that are not shared by the banking industry and JR East in its consulting role.

From Table 11 we know that JR East in its role as a consultant is a *discretionary* stakeholder with a typology of (0 L 0). And in previous application of PCBA to the NEC we have identified that both the Banking Industry and the Insurance Industry are *dominant* stakeholders with a typology of (P L 0). Therefore, JR East could gain saliency by acquiring the attribute of power through partnership with either the banking or the insurance industry. However, because both of these stakeholders already have legitimacy, there is no incentive for partnership from their side. Because the incentive to form partnership is one-sided, this coalition is only somewhat likely.

110

This case clearly shows how PCBA can capture a small perturbation, such as the insertion of an additional stakeholder with a limited role in the project, without necessitating any re-calibration of NEC stakeholder inputs. The dendrogram and analysis are sensitive enough to capture changes in the institutional context (such as JR East pulling the Banking and Insurance industries away from Suppliers and the Media) without disrupting the overall structure of stakeholder relationships and coalitions surrounding HSR development on the NEC. In considering two additional roles, we increase the level of JR East's involvement and hence the magnitude of the perturbation. We also show how changing the interests (or role) of a given stakeholder affects the overall structure of the institutional context surrounding the NEC.

## 4.5.2 Operate an HSR System under Concession

Next we consider JR East as an operator of HSR service under concession. In this case, JR East has no role in the design or construction phases of the project and will simple commence operations on whatever infrastructure is implemented. Therefore, the company's concerns are related to quality and level of service as well as lifecycle properties of the system (see Figure 21). Including these new interests in the stakeholder-objective matrix for the NEC, PCBA yields the dendrogram in Figure 23.

By changing the interests of JR East as a stakeholder to those representing a consulting business role to those representing an operations business role, we see that JR East's position in the dendrogram changes. In its role as an operator, JR East's interests are more closely aligned with those of other public and private sector operators. In Figure 23, the NEC stakeholder with the most similar interests to those of JR East as a concessionaire is Amtrak, followed by Commuter Rail Agencies and Urban Public Transportation Organizations. The similarity in interest between JR East and Amtrak is logical because, as a concessionaire, JR East would likely adopt Amtrak's existing role as the intercity operator on the HSR development along the NEC. While Amtrak is not under concession, its regulation and subsidization by the government may be similar to some of the terms in a lease of operation on an upgraded NEC. The interests of Commuter Rail Agencies and Urban Public Transportation Organizations represent other transportation providers that might be sharing track along some but not all of the HSR alignment or providing important connections for intercity passengers on JR East's HSR service.

**Figure 23.** Hierarchical clustering results for the NEC with JR East as concessionaire.
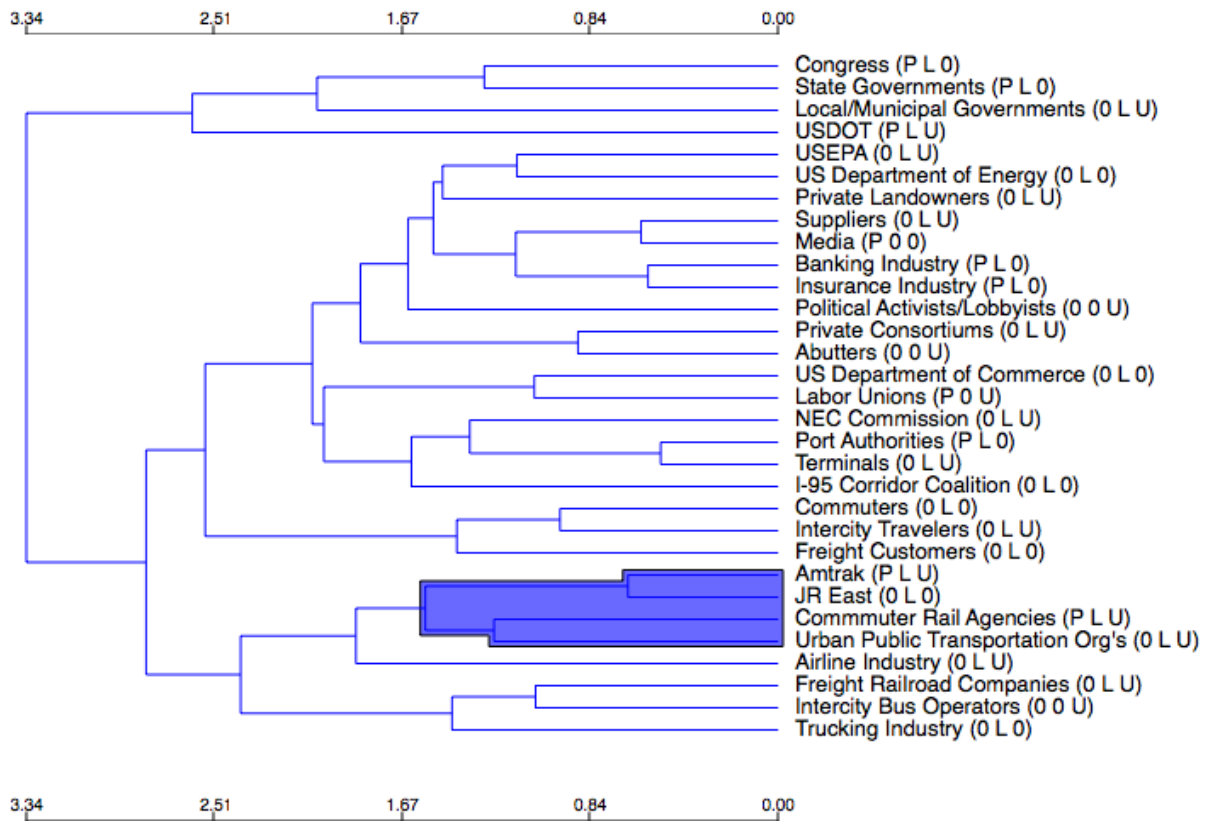


In its business role of operating service under concession, JR East is a *discretionary* stakeholder with typology (0 L 0). On the other hand, its closest interest neighbors, Amtrak and Commuter Rail Agencies, are each *definitive* stakeholders with the power, legitimacy, and urgency (P L U) to strongly influence HSR development along the NEC by themselves. Therefore, they have no clear incentive to work with JR East even though JR East could gain power and urgency from a partnership. Urban Public Transportation Organizations are *dependent* stakeholders (0 L U) who also have no incentive to partner with JR East. While the incentive to form partnerships is one-sided, there are multiple possible partnerships available to JR East. Furthermore, depending on the lease arrangement for the concession, there may be certain levels of cooperation mandated among these difference operators to ensure smooth intermodal connectivity.

### 4.5.3 Finance, Construct, and Operate a Private HSR System

We now consider JR East in its role of financing, constructing, and operating an entirely private HSR system. In this highly engaged role, JR East has strong interest in almost all of the system objectives since it is assuming all of the risk and reward of the project. Including such an involved private sector stakeholder in the institutional context of the NEC yields the dendrogram in Figure 24. We note that this is the most disruptive role for JR East since it enters the hierarchy

112

as an outlier and fundamentally changes parts of the cooperative structure of the NEC. By aligning its interests with the U.S. DOT on both infrastructure- and operations-related objectives, JR East pulls them out of the cluster with government actors and further away from other possible partnerships. While the U.S. DOT becomes more isolated, the other government actors come closer to private sector and user stakeholders within the dendrogram for the NEC. In particular, we see that Local and Municipal Governments become the nearest interest neighbor to the I-95 Corridor Coalition.

**Figure 24.** Hierarchical clustering results for the NEC with JR East as a private HSR developer.
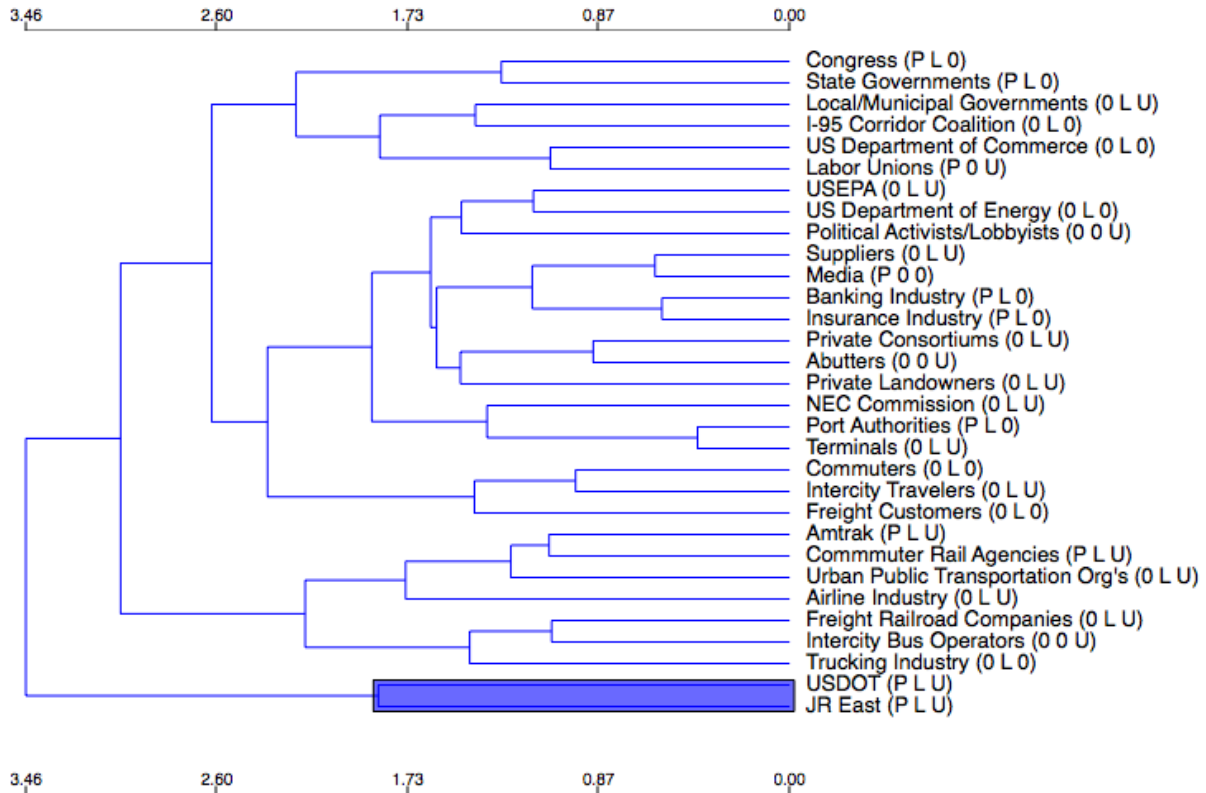


Because of its overarching interest in system infrastructure and operations, JR East's interests on the NEC best align with the U.S. Department of Transportation. Because JR East is a *definitive* stakeholder in the market and possesses the rare attribute of power, it is likely that many stakeholders wish to partner with them based on their stakeholder typology. However, because these stakeholders are far-removed in the cluster hierarchy, it suggests that this partnership not only has a one-sided incentive, but would also require a significant compromise of the interests of other NEC stakeholders.

This final case illustrates the magnitude of disruption JR East could cause in its role as a foreign, private company entering the US market and constructing and operating its own international-quality HSR system. This may suggest a high degree of uncertainty in the future structure of the

113

NEC if JR East or another private company, such as U.S. HSR or NEC Maglev, is to enter in this business role with the financial means to begin implementation.

The three cases in this section demonstrate both the sensitivity and robustness of PCBA in capturing the addition of stakeholders and the changing of stakeholder interests in the system development objectives. Unlike many other stakeholder analysis tools that require the development or re-calibration of objective functions and other complex inputs to explore possible future scenarios, PCBA provides quick and transparent exploration of institutional uncertainties surrounding large infrastructure projects. Using HSR development along the NEC as a case study, we have demonstrated that PCBA can capture the effects of institutional perturbations while still maintaining its structural integrity.

In the next section, we supplement this discussion of the sensitivity and robustness of PCBA by exploring the relative merits and limitations of PCBA as compared to another technique for understanding multi-stakeholder problems surrounding complex infrastructure decisions.

## 4.6 COMPARISON OF PCBA RESULTS WITH MULTI-STAKEHOLDER TRADE SPACE EXPLORATION

In this section, we compare the results of PCBA on the NEC to insights obtained through Multi-Stakeholder Trade Space Exploration (MSTSE). MSTSE is an extension of traditional Trade Space Exploration (TSE) that seeks to move away from point design analysis to better understand technical design problems by expanding the "solution set" of alternatives. MSTSE explores the additional complexity of having multiple stakeholders to better understand institutional relationships surrounding the design alternatives (Fitzgerald, 2016).

While it is useful to compare the results of PCBA to MSTSE as a way to validate the structural hierarchy produced by interest clustering in relation to other techniques, it is important to note that these techniques have fundamentally different goals. MSTSE is an outcome-focused, prescriptive technique that suggests how stakeholders should work together toward a design solution (Fitzgerald, 2016). On the other hand, PCBA is an exploratory and predictive technique that discusses the possibility of different coalitions, but does not make any specific judgments or recommendations on the outcome.

In this section we summarize the findings of MSTSE as applied to the NEC and compare the results and insights to those obtained by PCBA in previous sections. We find that one of the major benefits of a technique such as MSTSE is that it explores the stakeholder relationships around specific design alternatives, while these connections are not explicit in PCBA (see Section 6.1.2 for further discussion of this limitation). This allows MSTSE to explore and identify mutually beneficial design alternatives. However, we note that a much larger set of assumptions and calibrated input models are necessary for MSTSE compared with PCBA.

114

Therefore, we highlight how PCBA allows a broader and more inclusive definition of stakeholders and improves the transparency of stakeholder objectives and inputs. All of these features make it appropriate for project managers and planners interested in providing a plain, understandable, and level "playing field" to discuss and evaluate possible coalitions among project stakeholders. While beyond the scope of this thesis, these coalitions and the primary objectives around which their interests align, can then be connected to specific design alternatives that will meet those objectives (see Section 6.1.2).

### 4.6.1 Defining Stakeholders for the NEC

Application of MSTSE to the NEC utilized the same identification of initial stakeholders as PCBA (described in Section 4.2.1), but must reduce the number from 30 to 10 due to the level of detail of available value models and data sources. The 10 stakeholders identified in MSTSE application to the NEC are depicted by dark red dots in Figure 25 and are listed in Table 12. The selection of which stakeholders to carry into MSTSE and which to discard was performed using the following four criteria: aggregation, elimination of degenerate (in the mathematical sense) stakeholders, elimination of competitors, and simplification (Fitzgerald, 2016). While required for application of MSTSE, this reduction in the number of stakeholders also necessarily reduces the number of institutional relationships that one can explore with the technique.

**Figure 25.** Elimination and combination of NEC stakeholders for application of MSTSE.
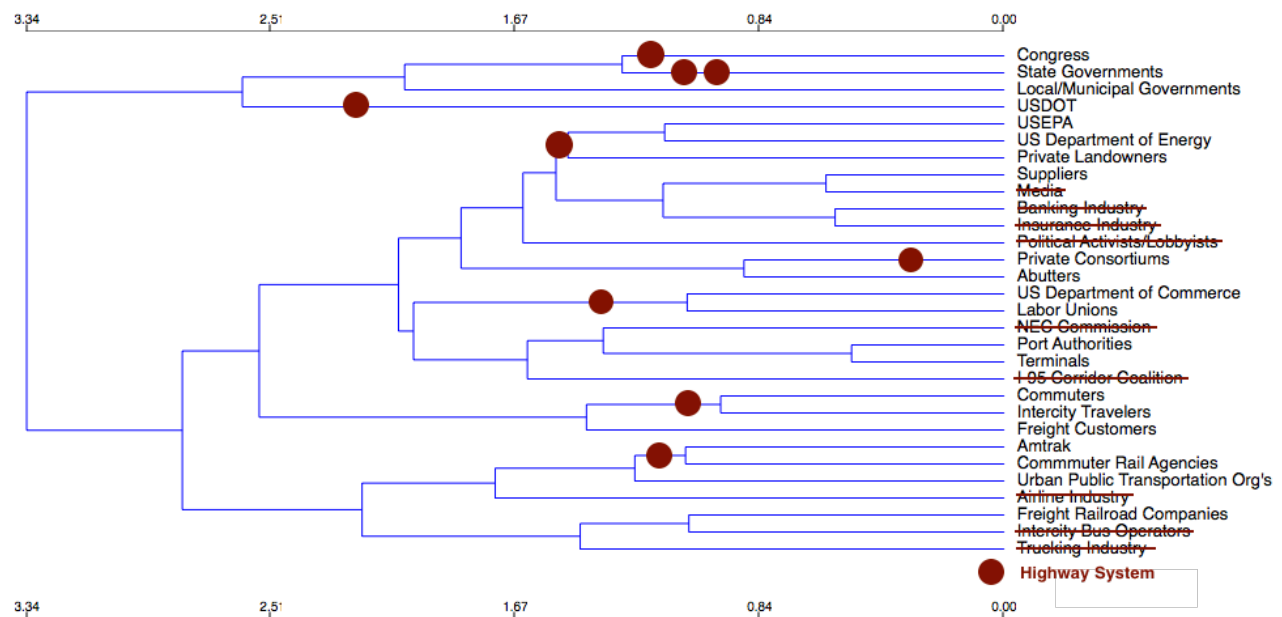


The first criterion used to reduce the number of stakeholders is *aggregation* – the combining of stakeholders that appear to have similar interests. Using an earlier iteration of the interest-based clustering hierarchy in Section 4.3, some stakeholders with similar interests were grouped together. This aggregation is necessary for MSTSE because the level of detail available in the

value models makes it difficult to meaningfully quantify the differences in the needs of stakeholders who are clustered closely (Fitzgerald, 2016). However, this aggregation presupposes that stakeholders of similar interests will approach the design alternatives for HSR development the same way (and therefore would work together in a negotiation towards that design). This fails to take into account whether or not there is incentive for these stakeholders to form such a partnership and work together. Unlike MSTSE's aggregation, PCBA considers not just similarity of interest, but also the presence or lack of incentives for and barriers to collective action before asserting that a cluster of stakeholders actually represents a single actor or coalition.

Some of the aggregations in MSTSE correspond with likely coalitions in PCBA. For example, in MSTSE application to the NEC stakeholders at node (5) – Commuters and Intercity Travelers – were combined into a single stakeholder (see Figure 25). On the other hand, many other stakeholders aggregated in MSTSE were characterized by PCBA as unlikely coalitions due to the lack of incentive to work together and barriers such as the large size and dispersed nature of these stakeholders. These unlikely MSTSE aggregations occurred at node (14) – the U.S. Environmental Protection Agency (USEPA) and the U.S. Department of Energy (8a) and Private Landowners – and at node (9) – Amtrak and Commuter Rail Agencies (7b) and Urban Public Transportation Organizations (see Figure 25). Aggregating the interests of these unlikely coalitions into one entity for application of MSTSE may assume collective action where it will not manifest and precludes the possibility of exploring the relationships among the different stakeholders grouped together. If these coalitions are in fact unlikely, planners may not have the opportunity to understand the nuances among these constituent stakeholders or to negotiate their individual interests.

In addition to aggregation of stakeholders, MSTSE also eliminates the inclusion of *degenerate* stakeholders (Fitzgerald, 2016). Because MSTSE looks at stakeholder relationships surrounding design alternatives, stakeholders who have interests that are functionally equivalent across all possible development alternatives do not present the opportunity for meaningful or interesting tradeoffs. Therefore, they are removed from the analysis. For example, the banking and insurance industries would perform the same functions and would have the same objectives regardless of what type of system were to develop; therefore they do not add depth to the negotiation that is the focus of MSTSE. However, by not including these stakeholders, the analysis may overlook stakeholders that would be supportive of or opposed to system development of any kind. For example, project managers may be interested in bringing the banking industry into a consensus group by highlighting how the project could satisfy their specific interests. Unlike MSTSE, PCBA does not consider interests as they relate to specific design alternatives; therefore, PCBA can consider these stakeholders who have interest in overall system development but are degenerate across alternatives.

116

MSTSE eliminates not only degenerate stakeholders, but also oppositional or *competitive* ones. Since MSTSE has been scoped to support cooperative negotiation and is based on the principle of Full, Open, and Truthful Exchange (Raiffa, Richardson, & Metcalfe, 2002), it excludes the inclusion of direct competitors to the services that HSR might offer. Therefore, intercity bus operators, the trucking industry, and the airline industry were removed as stakeholders in this analysis. While the Highway System was added to the list of NEC stakeholders to represent another mode of travel while still being cooperative, this elimination of key oppositional stakeholders from the analysis prevents project managers using the tool from considering the interests of those who might fight to stop the project. Conversely, PCBA includes these stakeholders to see how they may work together (against the project) so that project managers can learn how they might reach out to these stakeholders and satisfy their objections.

The final criterion used by MSTSE to reduce the number of stakeholders on the NEC is *simplification* – the elimination of stakeholders that are too heterogeneous or collective in nature. To some extend, all of the decisions to reduce the 30 stakeholders on the NEC to 10 are simplifications of the larger stakeholder problem. Some stakeholders, such as Political Activists/Lobbyists and the Media, were left out of the analysis because they are such heterogeneous groups that they have motivations too complex to be captured at the available level of detail. Furthermore, in order to avoid redundancy and to eliminate the challenge of ascribing a single set of needs to collective stakeholders, the analysis also excludes the NEC Commission and the I-95 Corridor Coalition, which serve as a collection of different interests already represented by other stakeholders.

In addition to using the above four categories to reduce the number of stakeholders, application of MSTSE to the NEC also divided the State Governments stakeholder into two: northern states (New York and north) and southern states (New Jersey and south). This division was necessitated by the potential alternatives available for HSR development along the NEC, which consider different level of improvements and service between these two areas (NEC Future, 2015). Thus, their interests in both benefits and costs were kept separate in order to capture the inter-stakeholder tension inherent in these alternatives (Fitzgerald, 2016).

In general, we use the comparison of stakeholder identification in MSTSE and PCBA to highlight the importance of an inclusive and broad definition of stakeholders. This allows project managers to understand and explore relationships among *all* groups and individuals affected by the project, not just those that might support it. Furthermore, research has shown that many strategic decisions and projects fail (were not implemented, were only partially implemented, or otherwise produced poor results), in large part because decision makers failed to attend to interests and information held by key stakeholders (Nutt, 2002). Therefore, having a more comprehensive picture of stakeholders and the overall institutional context of a project helps avoid the error of failing to consider stakeholders that can significantly influence the success of a project.

## 4.6.2 Analysis Inputs: Stakeholder Value Models

After identifying the 10 stakeholders for application of MSTSE to the NEC, a value model must be developed for each stakeholders (Fitzgerald, 2016). The MSTSE value model assigns (1) a benefit function using a Kenney-Raiffa multi-attribute utility function (1993), and (2) a cost attribute representative of their interests. Table 12 shows a list of the ten stakeholders and a summary of the attributes in their benefit and cost functions. A detailed description of the attribute definitions and assumptions, basis functions, and estimated weights are available as an appendix in the original case (Fitzgerald, 2016).

**Table 12.** Summary of NEC stakeholder value models for application of MSTSE (Fitzgerald, 2016).

| Stakeholder | Benefit Function | Cost Function |
|---|---|---|
| U.S. Department of Transportation (USDOT) | Quality of service;[13] Road congestion; Emissions | Public funding |
| Amtrak and rail agencies | Discounted financial returns; Quality of service | Private funding |
| Congress | Economic returns; Discounted financial returns | Public funding |
| Northern corridor states | Economic returns; Passengers (North); Quality of service (North) | North state funding |
| Southern corridor states | Economic returns; Passengers (South); Quality of service (South) | South state funding |
| EPA and landowners | Emissions; Environmental mitigation | Land use |
| Private consortiums | Private financial returns; Payback period | Private funding |
| Suppliers and labor unions | Construction cost; Duration of construction | (none) |
| Highway system | Road congestion | Diversion |
| Travelers | Quality of service | Fares |

The cost and benefit (utility) functions for each stakeholder must be estimated and calibrated using detailed data on project implementation schedules, projected ridership and revenues, projected costs, etc. for each development alternative. Therefore, significant back-and-forth is required with each individual project stakeholder and domain experts to develop the value models prior to implementation of MSTSE during negotiations. As the tool is used in practice, these inputs (which include a large number of assumptions) remain largely behind the scenes.

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[13] Note that "quality of service" is a superset of three benefit functions related to the effectiveness of passenger transport on the NEC: on-time performance, safety, and time savings (as compared to the current system) (Fitzgerald, 2016).

In contrast to application of MSTSE, application of PCBA involves relatively few assumptions that are transparently carried through to the final discussion and findings of the analysis. This allows stakeholders and planners with diverse backgrounds to participate collectively on a level playing field. Furthermore, unlike the inputs of MSTSE that require extensive calibration prior to the negotiation analysis, the inputs of PCBA – namely, the stakeholder-objective matrix – can be developed collectively and in real-time by a group of analysis or the stakeholders themselves. This improves the approachability of PCBA as a tool that fits within existing project management and planning practice.

### 4.6.3 Resulting Coalitions

Rather than using similarity of interest and incentives to determine coalitions as in PCBA, MSTSE considers similarity in cost and benefit functions (value models) and preferred design alternatives. By correlating the cost and benefit functions of the stakeholders, MSTSE suggests that the issue of "who pays" for the NEC is more contentious than what constitutes a "good" system, since most (supportive) stakeholders would derive benefit from development of high-speed rail (Fitzgerald, 2016). The analysis then considers which stakeholders agree about the "best value" designs by correlating the alternatives closest to each stakeholder's Pareto front – the set of optimal outcomes. By allowing a tolerance around this set, MSTSE can correlate the Fuzzy Pareto Number (FPN) between the ten stakeholders as in Figure 26 (Fitzgerald, 2016). The pairwise correlations in the heat map are calculated using Spearman's rank correlation, a nonparametric measure of statistical dependence between two sets of data (in this case the set of design alternatives on the Fuzzy Pareto front for each stakeholder).

From MSTSE analysis three main groups of stakeholders emerge as potential coalitions: 1) the U.S. Department of Transportation, Amtrak, and Congress, 2) Northern and Southern States, and 3) Suppliers & Labor and Travelers (Fitzgerald, 2016). Coalition 3 is weakly correlated with both other coalitions, but interestingly Coalitions 1 and 2 are opposed, as indicated by the light blue rectangles adjacent to them in Figure 26. The outlier stakeholders include the Private Consortiums and the EPA and Highway System. Private Consortiums are distinct because of their different utility (based on pay back period) compared to the other stakeholders. Furthermore, the EPA and Highway System have minimal costs outweighed by benefits for all valid designs on the Pareto front; thus, they have no variability in FPN with which to perform a rank-order correlation. Because the EPA and Highway System benefit from any design alternative in the tradespace, they could presumably ally with any coalition. As no single coalition has enough member stakeholders to force through an agreement, the resolution of this negotiation requires identification of a design alternative that is acceptable to more than one coalition, specifically one that has the proper balance of funding pools (Fitzgerald, 2016).

**Figure 26.** Correlation of FPN among NEC stakeholders, with three main coalitions highlighted (Fitzgerald, 2016).
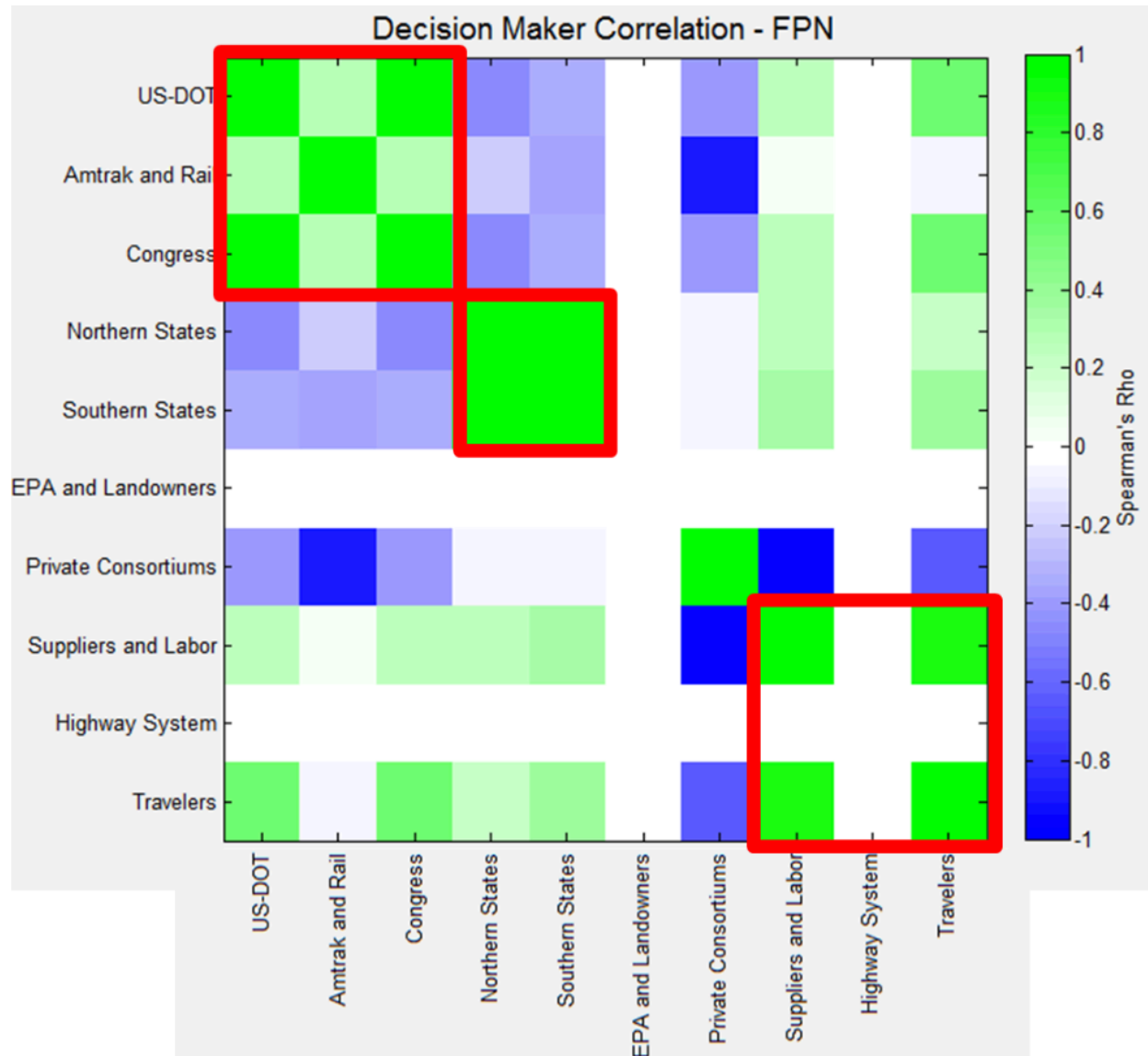


We considering MSTSE's first emergent coalition: the U.S. Department of Transportation, Amtrak (which includes other rail operators), and Congress. PCBA suggests that these stakeholders have different levels of interest in the system objectives (see Figure 20). In particular, PCBA found that Amtrak and rail operators were far removed from the interests of the federal government. It is clear that the different analytic approaches and assumptions in MSTSE and PCBA lead to different results, but there is no empirical data to test which characterization of stakeholder relationships is more accurate.

The second MSTSE coalition is that between Northern and Southern States. PCBA considered these two stakeholders as a single State Governments stakeholder: an assumption that seems to be justified given their similar interests in the design alternatives illustrated by MSTSE. We note

that this second MSTSE coalition of states is negatively correlated with the coalition of U.S. DOT, Amtrak, and Congress (see Figure 26). While PCBA's found that the coalition between Congress and State Governments was "mildly likely," it also shows significant divergence of interests between State Governments and Amtrak and other rail operators (see Figure 20). While MSTSE attributes this negative correlation to a disagreement about the source of funding (based on the costs in each stakeholder's value model), PCBA also corroborate this lack of agreement.

Finally, MSTSE identifies a coalition among Suppliers & Labor and Travelers. This coalition likely emerged from MSTSE since these groups would all benefit from significant HSR development without directly bearing the cost of planning and construction (Fitzgerald, 2016). However, this pairing does not take into account the different interests of these two groups in terms of system performance nor does it discuss the practicality of a collective arrangement. PCBA suggests that Suppliers & Labor would be interested in the economic impacts of HSR development while a mildly likely coalition of Intercity and Commuter Travelers would be interested in capacity and quality of transportation service. These stakeholders, among many other private sector stakeholders, show only mild similarity within the PCBA clustering hierarchy (see Figure 20).

It is difficult to compare these MSTSE emergent coalitions to those identified by PCBA due to the different characterization of stakeholders and the difference in evaluation method. Therefore, this discussion is not meant to be a validation of the results of either technique, but simply a way to weigh the relative merits and limitations of PCBA (and MSTSE). While MSTSE considers coalitions that would agree on the "best-value" design alternatives, PCBA looks at coalitions of stakeholders who have similar interests in overall system objectives (independent of any specific alternative) and incentives to work together. Even though PCBA does not directly consider stakeholders in relation to specific HSR design alternatives, analysts can benefit from its more inclusive and comprehensive definition of stakeholders and its discussion of incentive and barriers to collective action in addition to similarity of interest.

This comparison concludes the discussion of the first case study on the Northeast Corridor of the United States. The next chapter presents a second case study: the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori, Japan. In contrast to the NEC which is an HSR development in its planning infancy, the Tōhoku Shinkansen extension is a system already constructed and in revenue service. By looking at a completed case, we can again highlight the value of the PCBA framework and also test the (predictive) validity of PCBA results.

# CHAPTER 5.

# CASE STUDY II: TŌHOKU SHINKANSEN EXTENSION IN JAPAN

In this chapter we present the application of Predictive Coalition Building Analysis to the historical case study of the extension of the Tōhoku Shinkansen line from Hachinohe to Shin-Aomori, Japan. After a brief introduction to the regional context and motivation of this specific case (Section 5.1), we present the initial data collection phase of PCBA (Section 5.2). In this phase, we identify the stakeholders of the system, including government departments and agencies from the national to the local level, private sector interests, and key user groups (Section 5.2.1). Then goals for the Tōhoku Shinkansen extension project are identified and further broken down into measurable objectives (Section 5.2.2). And we create the stakeholder-objective matrix by mapping the strength of each stakeholder's interests to the system objectives (Section 5.2.3).

We then apply the second phase of PCBA to the stakeholder-objective matrix and discuss implications of the output clusters of stakeholders (Section 5.3). Next stakeholder attributes and typologies are assigned to each of the stakeholders and the implications of the third phase of PCBA are discussed for the Tōhoku Shinkansen extension (Section 5.4). Based on the results of PCBA, we present general conclusions about how coalitions may have formed around the Tōhoku Shinkansen extension.

In the final section of the chapter, we address the predictive validity of the results of PCBA as it applies to the case study of the Tōhoku Shinkansen extension (Section 5.5). Since the Tōhoku Shinkansen extension is a historical project, we can compare the results obtained from PCBA with what actually transpired during the project planning, construction, and initial years of operation (1994-2012) (see the timeline of the project included as Table 24 in Appendix D). In this way, we can highlight not only the additional insight gained throughout the case study by applying PCBA to understand stakeholder relationships, but also can begin to validate the predictive nature of the methodology.

## 5.1 INTRODUCTION TO THE TŌHOKU REGION AND ITS SHINKANSEN DEVELOPMENT

The Tōhoku (東北) region of Japan consists of the northeastern portion of the main island of Honshu. This region consists of six prefectures: Fukushima, Yamagata, Miyagi, Akita, Iwate, and Aomori (see Figure 27). Tōhoku retains its reputation as a remote, scenic region with a harsh climate. Despite the fact that the Tōhoku region occupies nearly one-fifth of Japan's total area, it contains less than one-tenth of the country's total population (Nussbaum & Roth, 2005). Tōhoku is cut by the Ōu Mountains and large rivers running north to south, so much of its population is concentrated in the region's inland lowlands (Encyclopedia Britannica, 2016). Coupled with coastlines that do not favor seaport development, this settlement pattern resulted in a much greater than usual dependence on land and rail transportation than much of the rest of Japan.

**Figure 27.** Map of the Tōhoku region (and its Prefectures) at the north of the main island of Honshu (adapted from Wikipedia, 2005)
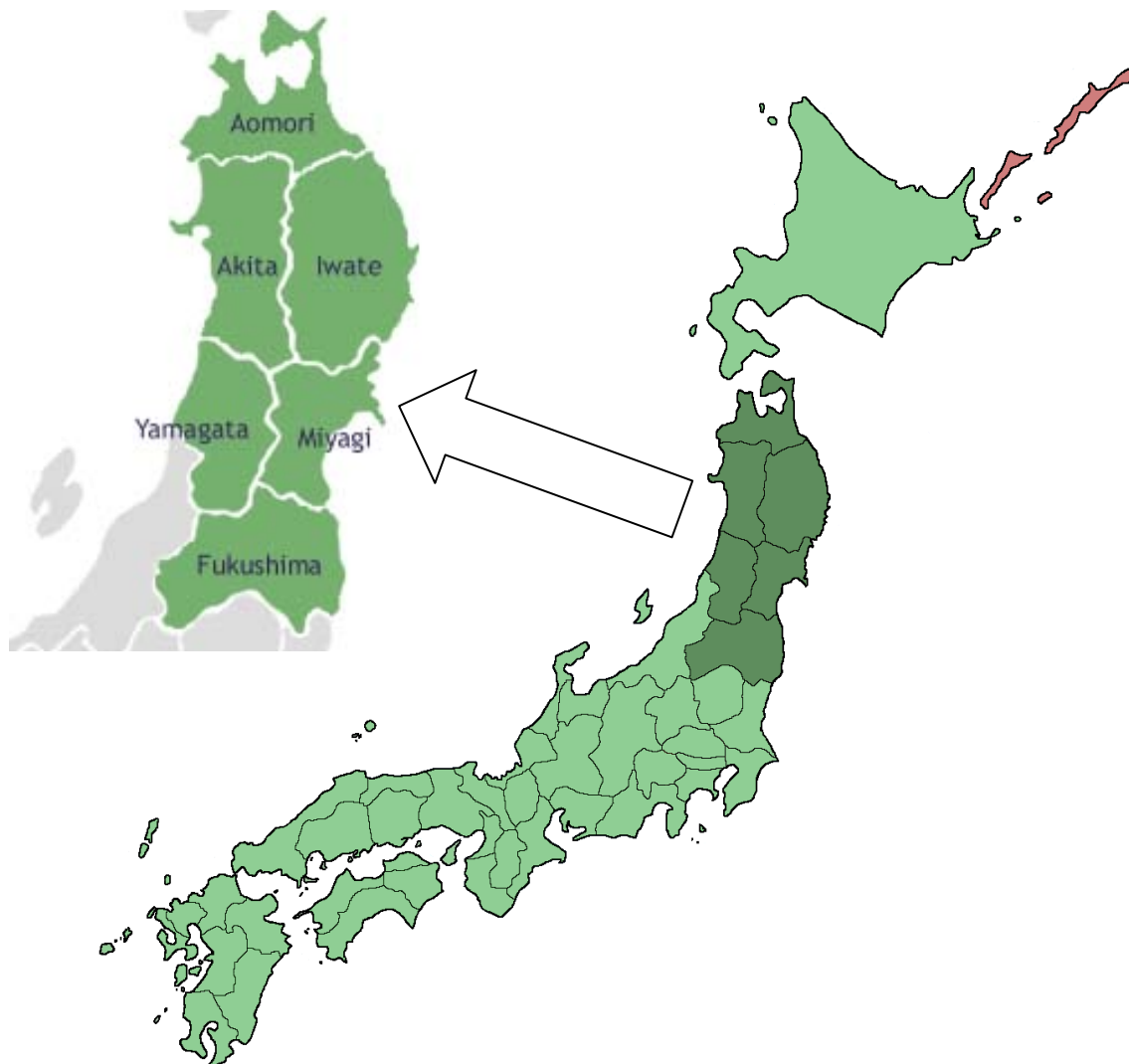
Despite its relatively harsh climate that permits only one crop a year on paddy fields, Tōhoku was traditionally considered the granary of Japan because it supplied the Tokyo metropolitan area and much of the main island with rice and other farming commodities (Encyclopedia Britannica, 2016). In the 1960s, iron, steel, cement, chemical, pulp, and petroleum refining industries began to develop, supported by freight rail. However, in the latter part of the 20th century many of these heavier industries have declined and tourism has become a major industry in the Tōhoku region due to its several national parks and numerous hot springs. Much of this recent service industry growth has been supported by improved and expanded passenger rail service.

The Tōhoku Shinkansen line runs from the northern reaches of Honshu, the main island, to the Tokyo Metropolitan region in the south (see Figure 28). The Shinkansen line was constructed in stages, connecting major city pairs and extending service incrementally. The mountainous terrain that the rail lines pass through has necessitated heavy reliance on tunnels, making implementation costly and time-consuming. Construction began on the line in November 1971 and it was not until June 1982 that the Ōmiya-Morioka section opened. In March 1985, the Ueno-Ōmiya section was opened and in June 1991, Ueno was connected to Tokyo and high-speed service ran from the capital through Fukushima, Miyagi, and Iwate Prefectures. On December 2002, the Morioka-Hachinohe section opened, bringing the Tōhoku line to the border of Aomori Prefecture.

Only after service began to Hachinohe was the extension from Hachinohe to Shin-Aomori considered. It is this extension to the northern tip of Honshu that will be the subject of our historical case study. While this route was specified in the Nationwide Shinkansen Railway Development Act as early as 1970, we will consider the extension at the time when it was being carefully planned in detail through construction – from 1994 to 2010. The Tōhoku extension between Hachinohe and Shin-Aomori does not cross prefectural boundaries; it is contained wholly within Aomori Prefecture (青森県). Aomori Prefecture is the northernmost prefecture of the main island of Honshu and the Tōhoku Region, facing Hokkaidō across the Tsuguru Strait. Aomori Prefecture borders Akita and Iwate Prefectures in the south. Like much of the Tōhoku Region, Aomori Prefecture remains dominated by traditional industries such as farming, forestry, and fishing, as well as more recent tourism-related service industries.

The extension from Hachinohe to Shin-Aomori that is the subject of this case study opened for service in December 2010 (JR East, 2010). With its completion it takes only about three hours to travel the 670 kilometers (416 miles) from Tokyo to the northern tip of Honshu (Kitagawa, 2005). Service is regular with more than 100 trains in each direction every day.

From Shin-Aomori, construction is underway to continue the line to Shin-Hakodate in Hokkaidō, an additional distance of 148.9 km (92.5 mi). This newest extension that opened in March 2016 passes through the world's longest undersea railway tunnel, the Seikan Tunnel, to connect the

main island of Honshu with the northern island of Hokkaidō. There is a further 211.3 km (131.3 mi) Shinkansen extension proposed to Sapporo, the capital of Hokkaidō Prefecture, with completion planned by 2030.

**Figure 28.** Map of Tōhoku Shinkansen main spine and spurs (Wikipedia, 2010).



As of March 2013, the maximum line speed for the Tōhoku Shinkansen spine was 110 km/h (70 mph) between Tokyo and Ōmiya, 275 km/h (170 mph) between Ōmiya and Utsunomiya, 320 km/h (200 mph) between Utsunomiya and Morioka, and 260 km/h (160 mph) between Morioka and Shin-Aomori. In October 2012, JR East announced that it is pursuing research and development to increase speeds to 360 km/h (224 mph) on the Tōhoku Shinkansen by 2020 and this consideration likely factored into JR East decision-making at the time of the Tōhoku Shinkansen extension (JR East Group, 2012).

The main spine of the Tōhoku line has two spurs, known as the Yamagata and Akita Shinkansen lines. The trains on the Akita and Yamagata Shinkansen lines run on the Tōhoku Shinkansen

tracks until branching off at Morioka and Fukushima respectively (see Figure 28). The services on these spurs is called "mini-Shinkansen" given that the trains run at higher speed on shared track with conventional rail rather than the traditional dedicated, high-speed lines for the rest of the Shinkansen system.

## 5.2 PCBA PHASE 1: DATA COLLECTION

### 5.2.1 Identifying and Describing Stakeholders of the Tōhoku Shinkansen Extension

When identifying stakeholders for a sociotechnical system, one of the challenges is determining the boundary of the analysis. Since many of these sociotechnical systems are large, interconnected, open, and complex, there may be many groups or individuals who are indirectly or tangentially affected by the development of the system. Defining the boundary of analysis comes with particular tradeoffs, since a narrow scope often allows the analyst to go into more detail while a larger scope tends to only lead to general conclusions.

When considering the Tōhoku Shinkansen extension, we debated whether to limit the analysis to the narrow geographic area of the extension – namely from Hachinohe to Shin-Aomori – or to consider a larger part of the national Shinkansen network. We decided to expand the boundary beyond the intercity pair of the extension to include the full extent of the planned Tōhoku Shinkansen spine[14] from Tokyo through Shin-Aomori to a planned Hokkaidō Shinkansen connection. This decision was made for two primary reasons. First, much of the forecasted ridership for the extension comes from passengers traveling up or down the entire length of the Tōhoku Shinkansen spine rather than between the two terminals of the extension. Furthermore, far-future ridership was based on planned construction and completion of a connection to the Hokkaidō Shinkansen (up to Sapporo). Second, service decisions on other parts of the line will undoubtedly affect the service along the extension tracks and therefore pressures from adjacent regional stakeholders could influence the project construction and operations.

With this boundary in mind, stakeholders for the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori were identified for three main categories:

1. Government
2. Private Sector
3. Transportation Users

A preliminary list of stakeholders was identified for the system through systematic review of newspaper articles and formal reports regarding the Tōhoku Shinkansen extension from

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[14] Unless otherwise noted, this analysis does not include the Akita and Yamagata "mini-Shinkansen" branches from the main Tōhoku spine.

Hachinohe to Shin-Aomori. From these articles, we were able to ascertain many of the private sector stakeholders and user groups interested in the extension. We choose to break up the third category of transport users based on their demand for certain trip-lengths and types of transport activities. However, it is important to note that each of these actors comprise many demographics. It is likely that there will be difference in stakeholder interests within each of these groups based on characteristics like the age, presence of a disability, and socioeconomic level of the user, which is not captured at this level of analysis.

This review of news articles, reports, and websites was supplemented by careful reading of the Nationwide Shinkansen Railway Development Act of 1970 (updated in 2002) and internal JNR and JR East documents to identify relevant government departments and agencies. The Japanese government structure consists of particularly complex hierarchies in comparison to other national governments. On a fine level of detail, there are many distinct bureaus and government officials with discrete powers. However, given the definition of the system boundary for the Tōhoku Shinkansen extension, we have focused our analysis of government stakeholders on those higher-level government ministries that have fairly direct influence over the feasibility, cost, or objectives of HSR construction or operation.

The preliminary list of stakeholders for the Tōhoku Shinkansen extension was used to lead a brainstorming workshops in October, 2015 with Japanese railway professionals to finalize a list of agencies, companies, industries, groups of individuals, etc. that had some stake in Shinkansen development at the time when the extension from Hachinohe to Shin-Aomori was being considered (around 1994) through to the start of revenue service (in 2010). The final list of actors is depicted in Figure 29 and each is described in more detail in the following text.

**Figure 29.** Stakeholders identified for the Tōhoku Shinkansen extension.
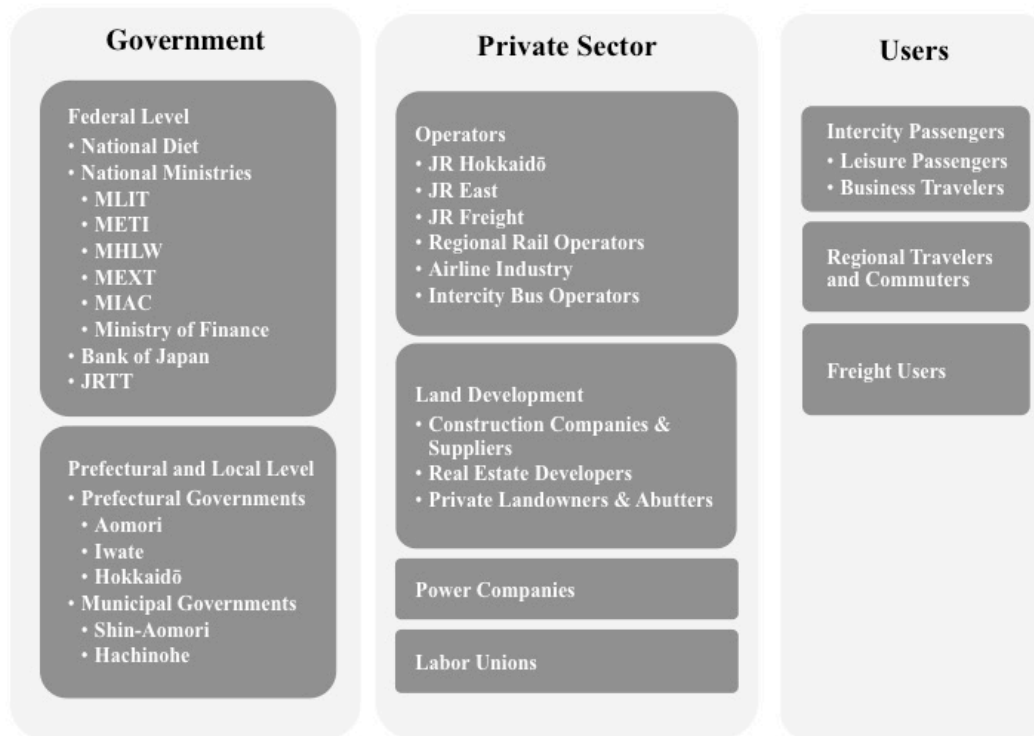


## National Diet

The National Diet is Japan's bicameral legislature. It is composed of a lower house, called the House of Representatives, and an upper house, called the House of Councilors. Both houses of the Diet are directly elected under parallel voting systems. The Diet's primary responsibilities include the making of laws, the approval of the annual national budget that the government submits, and the ratification of treaties. It can also initiate draft constitutional amendments, which, if approved, must be presented to the people in a referendum. The National Diet is also responsible for designating the Prime Minister, who appoints and dismisses the ministers of the executive Cabinet. However, these appointed ministers are responsible to the elected Diet.

## Ministry of Land, Infrastructure, Transport, and Tourism (MLIT)

The Ministry of Land, Infrastructure, Transport, and Tourism was established as part of the Japanese central government administrative reforms of 2001, which merged the Ministry of Transport, the Ministry of Construction, the Hokkaidō Development Agency, and the National Land Agency. It generates approximately one-third of all legislation on the national level and is the largest Japanese ministry in terms of employees. The Ministry of Land, Infrastructure, Transport, and Tourism oversees numerous bodies. Within its purview are the Japanese Coast

Guard, tourism and meteorological agencies, as well as research institute and colleges dedicated to the subjects in its title: transport, housing, policy, and development (MLIT, 2015).

Regarding Shinkansen railway construction, the Nationwide Shinkansen Railway Development Act stipulates that the minister of Land, Infrastructure, Transportation, and Tourism will develop national land development policies and railway priorities based on transportation demand. MLIT will update the routes included in the Nationwide Shinkansen Railway Development Act of 1970 and suggest where and when construction should commence (MLIT, 2002). The ministry also designates the person or entity responsible for the construction (usually JRTT) and operation of any new line (MLIT, 2002). According to the same law, the ministry also dictates construction cost allocation, right-of-way use, revenue source measures, and numerous stipulations concerning the stakeholders involved in the construction and operation of Shinkansen lines.

**Ministry of Economy, Trade, and Industry (METI)**

The Ministry of Economy, Trade, and Industry was formed in 2001 as a result of the reorganization of the Ministry of International Trade and Industry (METI). The ministry oversees international economic relationships, including new efforts by the Japanese government to export Japanese rail technology abroad. Therefore, JR East will have to comply with the regulations and international standards set by the ministry in order to expand into the international market for high-speed rail.

In terms of domestic involvement in high speed rail, METI's Agency for Natural Resources and Energy as well as the Electricity Markets Surveillance Commission oversee and regulate the electricity generation and transmission used by high speed rail lines.

**Ministry of Health, Labour, and Welfare (MHLW)**

The Ministry of Health, Labour, and Welfare is a large, complex organization formed from the merger of the former Ministry of Health and Welfare and the Ministry of Labour. Bureaus related to health and welfare within the ministry provide standards and regulations for health care, food, and drugs. While these functions of the ministry are not directly related to high-speed rail development, the labor functions of the ministry are important. Other bureaus within the ministry control pension policy, human resource development standards, and equal employment regulations.

The Labour Standards Inspections Offices, a regional bureau within the purview of the Ministry of Health, Labour, and Welfare, includes the Industrial Safety and Health Department as well as the Worker's Compensation Department, which helps standardize and negotiate labor contracts. This bureau provides "supervision so that working conditions prescribed in the Labour Standards Act are ensured" and are in charge of "improving the wage system, reducing working hours, preventive measures against occupational accidents, and payment of labour insurance" (MHLW,

2015). Therefore, standards and regulations put forth by the Ministry of Health, Labour, and Welfare will affect the labor costs of both constructing and operating any Shinkansen system.

**Ministry of Education, Culture, Sports, Science, and Technology (MEXT)**

The Ministry of Education, Culture, Sports, Science, and Technology's main function is to regulate the educational process and allocate funding for research and cultural exchange initiatives. The ministry promotes the research and development for earthquake and disaster prevention studies. The Great East Japan Earthquake, which occurred in the region of the Tōhoku Shinkansen, has spurred significant investments in building infrastructure robust enough to withstand tremors of equal or greater magnitude (MEXT, 2013).

**Ministry of Internal Affairs and Communication (MIAC)**

The Ministry of Internal Affairs and Communication (MIAC) oversees the Japanese administrative system, manages local governments, elections, telecommunication, post, and governmental statistics. The main functions of the Ministry are contained within the Personnel and Pension Bureau, the Information and Communications Bureau, and the Bureaus of Local Public Finance, Local Tax, and Local Public Administration. The Ministry also houses the Statistics Bureau, which administers the national census and regulates statistical policy and survey planning (MIAC, 2014). While the ministry does not have an outright connection to the Shinkansen extension, it may be involved in HSR development through its connection with Prefectural governments.

**Ministry of Finance**

The Ministry of Finance has long been regarded as the most powerful ministry in the Japanese government because it historically controlled the monetary and fiscal policies of Japan. The Ministry of Finance oversees national property, the Fiscal Investment and Loan Program, and "matters concerning international organizations related to economic cooperation or development; matters concerning overseas loans and investment" (Ministry of Finance, n.d.). The Nationwide Shinkansen Railway Development Act stipulates that the national government should implement any necessary measures for local governments to secure the funding required for their cost-match for Shinkansen construction.

**Japan Railway Construction, Transport, and Technology Agency (JRTT)**

The "Reorganization and Rationalization Plan for Public Corporations (2001)" passed by the National Diet led to the founding of the Japan Railway Construction, Transport and Technology Agency (JRTT) on October 1, 2003. JRTT was established "as an Independent Administrative Agency by integrating the Japan Railway Construction Public Corporation (JRCC) and the Corporation for Advanced Transport and Technology (CATT)" (JRTT, 2008). JRTT states the following as its objectives: "to establish a transportation system founded on mass transit

infrastructures for maintaining and enhancing regional developments and urban functions" and "to promote various research in the field of transportation for establishing smooth transportation on the ground, on the ocean and in the air" (JRTT, 2008). The agency's five functions are railway construction, subsidies for railways, research and development, the settlement of JNR privatization (discussed below), and joint ownership of coastal shipbuilding.

JRTT is currently the parent entity of the following JR Group companies: Hokkaidō Railway Company (JR Hokkaidō), Shikoku Railway Company, Kyushu Railway Company, and Japan Freight Railway Company. In 2011, the Japanese National Diet passed legislation requiring JRTT to use its retained earnings from other businesses for the purpose of Shinkansen construction and capital expenditures at its subsidiary railway companies.

> **Japan Railway Construction Public Corporation** (dissolved in 2003): The Japan Railway Construction Public Corporation was formed in 1963 and assumed control of the Japanese National Railways Settlement Corporation in 1986. JRCC provided railway construction services and services for the settlement of JNR (JRTT, 2008).

> **Corporation for Advanced Transport and Technology** (dissolved in 2003): The Corporation for Advanced Transport and Technology (CATT) was formed in 1997 by integrating the Maritime Credit Corporation and the Railway Development Fund. The CATT provided financial and technical support to coastal shipping companies through joint ownership schemes, subsidy services for railways, advanced ship technology services, and services for fundamental transport research (JRTT, 2008).

> **JNR Settlement Headquarters (JNRSH)**: JNRSH pays expenses "associated with pensions for employees of the former Japanese National Railways (JNR) and sells land acquired from JNR and shares in the Japan railway group (JRs) to meet expenses" (JRTT, 2007). JNRSH was established in 1998 within JRCC. In 2003, when JRCC was dissolved and taken over by JRTT, "the disposition of land and shares taken over by the JRTT from the JRCC was very different in both content and objective from the other work performed by the JRTT" as it was temporary work performed according to the Law for Disposal of Debts and Liabilities (JRTT, 2007).

**Bank of Japan**

As of 1998, the National Bank is no longer under the direct control of the Ministry of Finance. According to its charter, the main missions of the Bank of Japan are: the issuance and management of banknotes, implementation of monetary policy, providing settlement services and ensuring the stability of the financial system, and treasury and government securities-related operations. Therefore, the Bank of Japan controls interest rates and serves as a consolidated banking and insurance industry for public works.

The Bank of Japan provides the Railway Development Fund (via the Ministry of Land, Infrastructure, Transport, and Tourism) with funds to provide railway companies "with subsidies, grants, interest-free loans, and other support to help them improve railway facilities and develop their business" (Ono, 1997).

**Aomori Prefecture**

Aomori Prefecture is the northernmost prefecture in the Tōhoku Region of the Japanese main island of Honshu. To the north of Aomori lies Hokkaidō across the Tsugaru Strait. The prefecture borders Akita and Iwate Prefectures to the southwest and southeast, respectively. Like most areas in the Tōhoku Region, Aomori Prefecture remains dominated by traditional industries such as farming, forestry, and fishing.

Prior to the extension of the Tōhoku Shinkansen from Hachinohe to Shin-Aomori, high-speed rail services terminated at Hachinohe, a city just within the Aomori Prefectural limits bordering Iwate to the south. While conventional rail service existed throughout the prefecture, HSR service did not extend far enough North to serve the majority of the prefectural population. The extension of the Tōhoku Shinkansen from Hachinohe to Shin-Aomori would extend service through the prefecture. Within the prefectural government, the departments of Planning and Policies, Environment and Public Affairs, and Land and Infrastructure will be involved Shinkansen implementation (Aomori Prefectural Government).

The Nationwide Shinkansen Railway Development Act of 1970 holds both the national and prefectural governments responsible for costs required for Shinkansen railway construction implemented by the Japan Railway Construction, Transport and Technology Agency (JRTT). The law also allows a prefectural government to raise a portion of these funds from municipalities within the prefecture that would benefit from the construction of the Shinkansen Railway (MLIT, 2002).

> **Municipal Governments of Hachinohe and Shin-Aomori:** Municipal governments within Aomori Prefecture, particularly the cities of Hachinohe and Shin-Aomori, are largely subject to the rules of the prefecture regarding HSR development. According to the Nationwide Shinkansen Railway Development Act, the Prefecture can require municipalities who benefit from new rail service to pay part of the Prefecture's portion of the development costs. While Hachinohe was already connected to the main spine, Shin-Aomori likely stood to benefit from high-speed connection to other cities along the Tōhoku spine and the Tokyo metropolitan region.

**Hokkaidō Prefecture**

Hokkaidō is the largest and northernmost prefecture in Japan. Agriculture and other primary industries play a large role in Hokkaidō's economy. Hokkaidō has nearly one fourth of Japan's

total arable land. It ranks first in the nation in the production of a host of agricultural products, including wheat, soybeans, potatoes, sugar beet, onions, pumpkins, corn, raw milk, beef, and many marine products. Hokkaidō also accounts for 22% of Japan's forests with a sizable timber industry. In addition to agriculture there is some light industry (most notably paper milling and beer brewing) with the rest of the population employed by the service and public sectors.

Hokkaidō has the lowest population density of any of Japan's 47 prefectures and has the highest rate of depopulation in Japan, with over 70% of Hokkaidō's 212 municipalities shrinking since the year 2000. The largest city of Hokkaidō is its capital, Sapporo, which is home to the prefectural government offices. The Tsugaru Strait separates the island of Hokkaidō from Honshu, the largest and most populous island of Japan. Hokkaidō's only land link to the rest of Japan is the Seikan Tunnel, which serves conventional rail but no high-speed service at the time of the Hachinohe-Shin-Aomori extension.[15] Therefore, most visitors to the island come by air.

Within the prefectural government, the Department of Construction and the Department of Policy Planning and Coordination will be involved in Shinkansen implementation. The former body houses the Land Expropriation Commission, which may be involved in matter concerning Shinkansen right-of-way. The latter body contains the Bureau of Bullet Train and Transportation Policy Promotion, the Regional Transportation Division, and the Office of Bullet Train Promotion (Hokkaidō Prefecture).

**Iwate Prefecture**

Iwate Prefecture is a prefecture of Japan located in the Tōhoku region in the northeast of the main island of Honshu. In the past Iwate has been famous for its mineral wealth of gold, iron, coal and sulfur, but many of these are no longer produced. There is still an abundance of hot water for hot springs, which combined with a great number of historical sites is the basis of a thriving tourism industry. The forests of the prefecture are another valuable resource.

Iwate has the lowest population density of any prefecture outside Hokkaidō and has its capital in Morioka. High-speed rail service along the Tōhoku Shinkansen has run from Tokyo to Morioka since 1991. In 2002, the Morioka-Hachinohe section of the line opened to service, allowing traffic to run through the entirety of Iwate Prefecture to the border with Aomori Prefecture in the north.

Within the prefectural government, the departments of General Affairs, Policy and Regional Affairs, Environmental and Residential Life, Health and Welfare, and Prefectural Land Development will be involved with high-speed rail implementation in the prefecture. The

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[15] A high-speed connection through the Seikan Tunnel to Hokkaidō is called for in the Nationwide Shinkansen Railway Development Act. Since the completion of the Hachinohe to Shin-Aomori extension, construction has begun to allow high-speed trains to mix with freight through the tunnel and then on to Hakodate in Hokkaidō (opened in March 2016).

Morioka Regional Development Bureau is "responsible for the development of the central Iwate region, and works together with both the cities and rural areas in the region to position the area as a hub for Northern Tōhoku" (Iwate Prefecture, 2014).

**JR East**

East Japan Railway Company (JR East) is the largest passenger railway company in Japan and one of the seven Japan Railways Group companies formed in 1987 with the privatization of JNR. It has an integrated vertical organizational structure, with JR East managing both infrastructure and operations for 7,458 km of track. Its railway lines primarily serve the Kanto and Tōhoku regions, along with adjacent areas in the Koshinetsu region (Niigata, Nagano, and Yamanashi Prefectures) and Shizuoka Prefecture.

JR East operates all of the high-speed Shinkansen rail lines north of Tokyo: Tōhoku Shinkansen (Tokyo - Hachinohe - Shin-Aomori), Joetsu Shinkansen (Tokyo - Niigata; Echigo-Yuzawa - Gala Yuzawa), Hokuriku Shinkansen (Tokyo - Nagano - Kanazawa), Yamagata Shinkansen (Tokyo - Shinjo), and Akita Shinkansen (Tokyo – Akita). In addition to its high-speed rail services, JR East runs many regional lines within the Tōhoku region, including but not limited to: Hachinohe Line (Hachinohe – Kuji), Ōu Main Line (Fukushima - Aomori), Tōhoku Main Line (Kuroiso - Morioka; Iwakiri - Rifu), and Tsugaru Line (Aomori – Mimmaya) as part of Tsugaru-Kaikyo Line. Including its Tokyo metropolitan area service, JR East serves 17.1 million passengers per day, the largest number of passengers in the world. See Figure 30 for a map of JR East's service area and rail lines.

In addition to local and high-speed rail service, JR East also has a research and development arm that pursues "'extreme safety levels' by means such as 'building a railway capable of withstanding natural disasters' and 'development of railways that passengers can utilize reliably'," and promotes "technological innovation" in various fields where JR East puts particular emphasis on establishing energy and environmental strategies, utilizing information and communications technologies (ICT), and operating Shinkansen at faster speeds (JR East, 2015). JR East invests in real estate developments, which generate revenues.

As the operator of the planned service on the Tōhoku extension, JR East will pay a lease fee for use of the track, but will not pay for the capital costs of the infrastructure (which will be paid for by the National and Prefectural governments as discussed above).

**Figure 30.** JR East service area, with JRE Shinkansen lines in green, JRE/JRW Shinkansen lines in purple, JRE mini-Shinkansen lines in red, and longer-distance conventional tracks in black (Ogata, 2015).
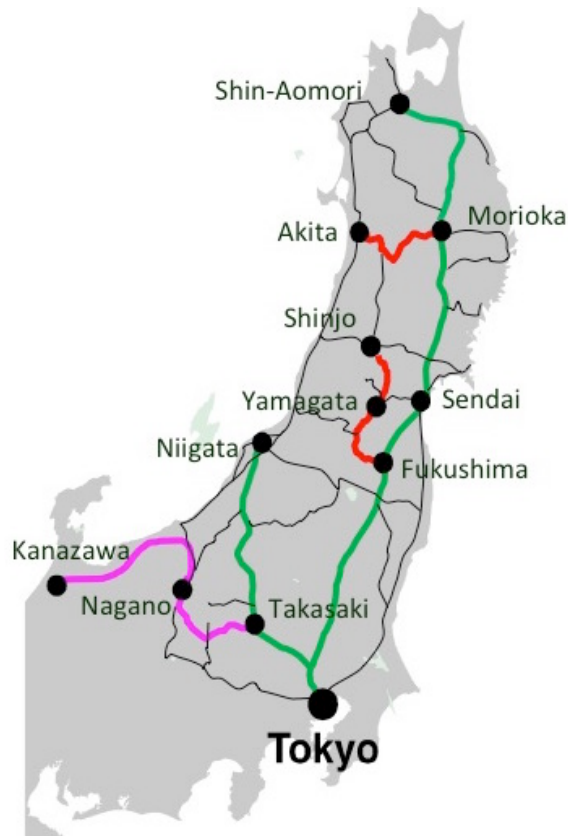


## JR Hokkaidō

The Hokkaidō Railway Company (JR Hokkaidō) is one of the constituent companies of Japan Railways Group created in the privatization of JNR. JR Hokkaidō currently operates conventional (but not high-speed) intercity rail and bus services on the island of Hokkaidō. At the time of its privatization in 1987, JR Hokkaidō operated 21 railway lines totaling 3,176.6 km (1,973.8 mi) of narrow-gauge (1,067 mm or 3ft 6in) track, as well as a ferry service to Aomori. Since then, that number has dwindled to just below 2,500 km (1,600 mi), as unprofitable lines have been shut down or spun off to be separately and privately operated (as in the case of the Hokkaidō Chihoku Kōgen Railway). The Seikan Tunnel has also replaced the ferry service.

The first section of Hokkaidō Shinkansen from Shin-Aomori to Shin-Hakodate-Hokuto is scheduled to open in 2016. The introduction of high-speed rail service to the Hokkaidō island was in many ways contingent on the completion of the Tōhoku extension from Hachinohe to Shin-Aomori on the mainland.

**JR Freight**

Japan Freight Railway Company (or JR Freight) is one of the constituent companies of Japan Railways Group. It provides transportation of cargo nationwide. Formerly part of JNR, freight operations were not divided by region like passenger services during privatization because there was and continues to be much less freight movement on the rails relative to passenger traffic. JR Freight primarily operates on track owned by the JR passenger railways and other private, regional railroads. The company owns only about fifty kilometers of track in all of Japan. JR Freight operates on the 575.7 km (358 mi) Tōhoku Main Line operated by JR East. The line originally extended to Aomori, but was truncated upon the extension of the Tōhoku Shinkansen beyond Morioka. The Tōhoku Main Line for conventional and freight rail mostly parallels the alignment of the Tōhoku Shinkansen.

Between Hachinohe and Shin-Aomori, much of the freight and conventional service continued on the Aoimori Railway conventional lines parallel to the Tōhoku Shinkansen's new tracks. JR East transferred ownership of these old tracks to the private operator upon completion of the Shinkansen extension.

**Regional Rail Operators**

Numerous private regional rail operators independent of JR East provide conventional rail service in Tōhoku and particularly in Aomori Prefecture (see the "non-JR" green rail lines in Figure 31 paralleling the red Shinkansen north from Morioka through Hachinohe to Shin-Aomori). In and around the area of the Hachinohe to Shin-Aomori extension the two most important of these private operators are Aoimori Railway and Hachinohe Rinkai Railway. Aoimori Railway is a narrow-gauge (1,067mm) passenger railway between Sannohe and Aomori. The 122 km (76 mi) line serves 26 stations and is used by some JR local passenger service as well as JR Freight trains (Nagafuchi, 2011). The Hachinohe Rinkai Railway is an 8km narrow-gauge railway that is exclusively used for freight.

In considering the Tōhoku Shinkansen extension, it is important not to interrupt local services that already exist between Hachinohe and Shin-Aomori. Therefore, working with Aoimori Railway and negotiating parallel right-of-way, would have been an important planning, construction, and service consideration for the HSR extension.

**Figure 31.** Stylized railroad map of local and high-speed service in the Tōhoku region (Japan Guide).
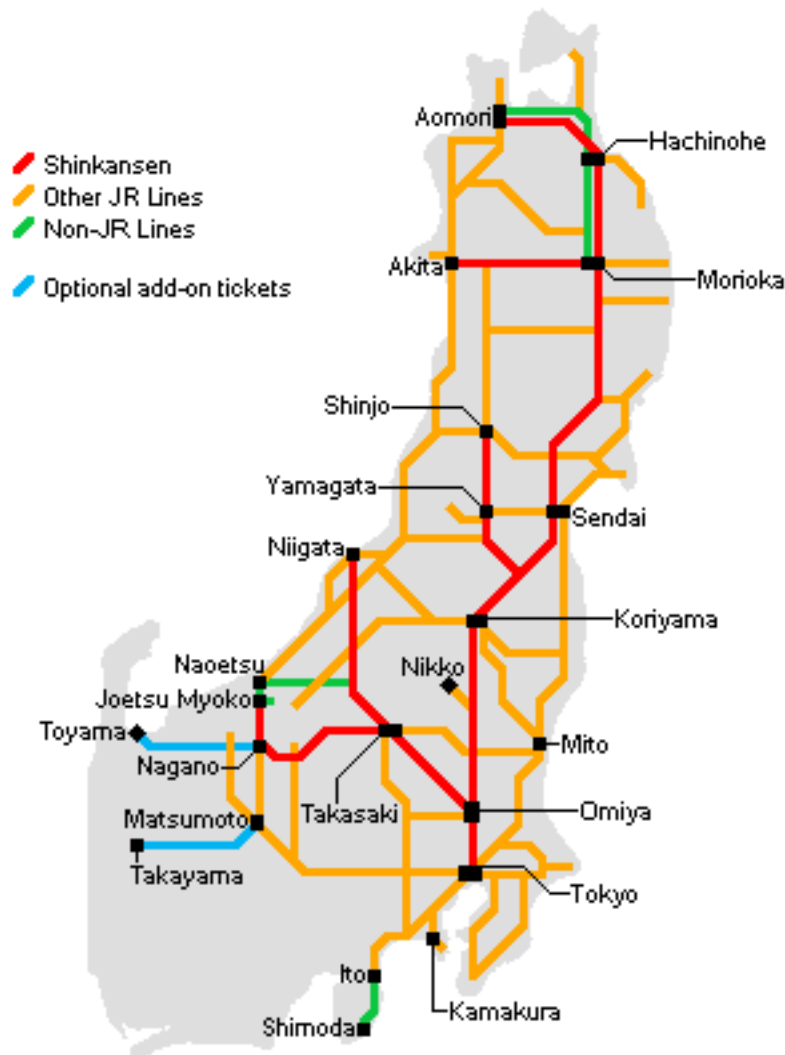


## Airline Industry

The term "airline industry" as used here includes both commercial and general aviation in the Tōhoku region, including both carriers and airports. Airlines operating flights between cities where Shinkansen is a viable substitute transport mode may face competition with high-speed rail operators. Japan Airlines and All Nippon Airways, the two largest airlines in Japan, provide short-haul and long-haul intercity airline service. However, the mode share of airlines for domestic travel along the spine of the Tōhoku Shinkansen is small in comparison to rail and automobile (see Figure 32). When considering trips beyond Honshu to Hokkaidō, airline mode share grows substantially and may be more threatened by future connection between Aomori and JR Hokkaidō Shinkansen service.

**Figure 32.** Market shares of JR East and Airlines (JR East, 2013).
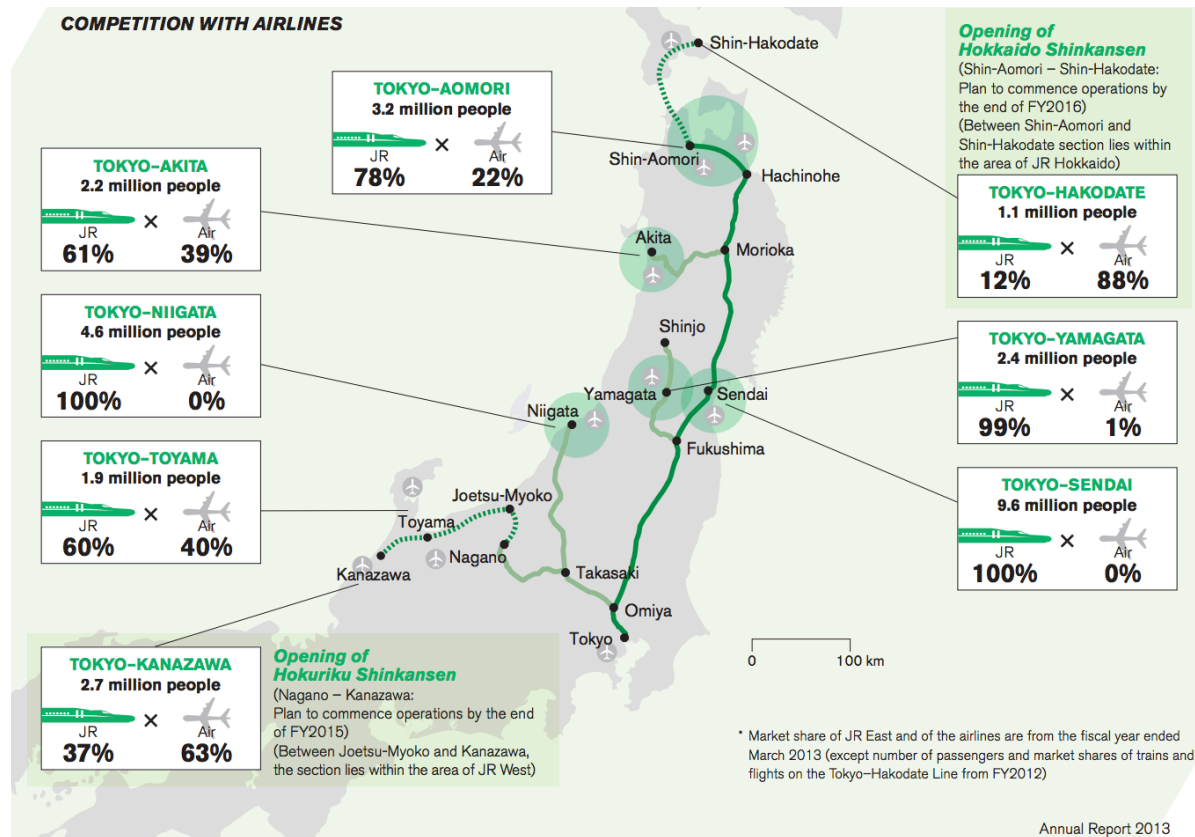


While there are a number of small airports in the Tōhoku Region, these generally serve only connections and domestic passengers. Most international travelers arrive via Tokyo, with some exceptions from Korea and Russia. Traveling north along the Tōhoku Shinkansen spine, there is the Sendai airport, the Iwate Hanamaki airport outside of Morioka, and two airports within Aomori Prefecture: Misawa Airport outside of Hachinohe and Aomori Airport (see Figure 33).

**Figure 33.** Airports in the Tōhoku region (WikiTravel, 2011).



## Intercity Buses

JR Bus collectively refers to the bus operations of Japan Railways Group (JR Group) companies in Japan. JR Bus is operated by eight regional companies, each owned by a JR railway company. In general, JR Bus companies provide regional, long-distance, and chartered bus services. JR Bus Tōhoku is a subsidiary of JR East that operates inter-city and regional bus services throughout the Tōhoku region, connecting it to the Tokyo metropolitan area.[16]

In addition to JR Bus Tōhoku, there are numerous private intercity bus operators such as: Highway Bus, Keihan Bus, Star Express, and Willer Express.[17] While intercity bus travel tends to be cheaper than rail services, the travel times are longer. Therefore intercity buses often cater to a different market of customers (with lower value of time) in the region. As a result, Shinkansen development is not likely to significantly impact ridership numbers for these services. In fact, intercity bus operators may stand to benefit from reduced congestion on highways more than they will suffer loss of customers to rail.

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[16] http://www.jrbustohoku.co.jp/
[17] http://willerexpress.com/en/#

**Labor Unions**

The Labour Union Act of 1945 promotes collective bargaining on the principle of equal industrial relationship and defends workers' voluntary organization and association in labor unions (MHLW, 2013). In addition, the postwar constitution of Japan (1947) includes article 28, which guarantees the right of workers to participate in a trade union (Japan Institute for Labour Policy and Training, 2015). Therefore, national law protects the right for workers to form unions. Any new labor regulation or negotiation is under the purview of the Ministry of Health, Labour, and Welfare (MHLW).

The rate of labor union membership has declined considerably since its postwar high. In fact, union participation was down to 18.5% of workers as of 2010 (Statistics Bureau, 2012; Japan Institute for Labour Policy and Training, 2012). However, there remain a number of powerful union confederations, particularly in the heavy industries, construction, and transportation. In order to gain political clout and more negotiating power, smaller Japanese unions often align themselves with national trade union centers, which function as labor umbrella organizations. The three most powerful of these national trade union centers are (in order of strength): The Japanese Trade Union Confederation (RENGO), The National Confederation of Trade Unions (*Zenroren*), and National Trade Union Council (*Zenrōkyō*).

The Japanese Trade Union Confederation (JTUC-RENGO) is the largest national trade union center in Japan, with over six million members as of 2011. As of July 2012 it has 54 affiliate unions and 47 local organizations (one within each of Japan's prefectures) (2016a). RENGO is aligned with the Democratic Party of Japan and has as affiliate unions a number of smaller transport- and rail-related organizations, summarized in Table 13 (2016b).

**Table 13.** Abbreviated list of RENGO-affiliated transportation unions.

| Japanese Name | English Name | Membership (as of 2009) |
|---|---|---|
| *Shitetsu Soren* | General Federation of Private Railway & Bus Workers' Unions of Japan | 111,944 |
| *Unyu Roren* | All Japan Federation of Transport Workers' Unions | 128,407 |
| *JR Rengo* | Japan Railway Trade Unions Confederation (JRTU) | 63,000 |
| *JR Soren* | Japan Confederation of Railway Workers' Unions (JRU) | 55,046 |
| *Kotsu-Roren* | Japan Federation of Transport Workers' Unions (JFT) | 53,835 |

The National Confederation of Trade Unions, commonly known in Japanese as *Zenroren*, is a national trade union center with no specific political party affiliation. *Zenroren* claims about 1.2 million members and has local organizations in all 47 prefectures of Japan (2006). Among its affiliates, *Zenroren* counts the All Japan Construction, Transport, and General Workers' Union (CTG), or *Kenkoro*, which incorporates the former JNR National Railway Locomotive Engineers' Union.

The National Trade Union Council, or *Zenrōkyō*, is much smaller than Rengo and Zenroren in terms of membership. Politically, *Zenrōkyō* has had a close relation with leftist-leaning members of the Social Democratic Party, and it also supports the New Socialist Party. Zenryoku has both the Railroad Industrial Labor Association, *Tetsusanro*, and the National Railway Workers' Union (NRU) as affiliates (2003). As of 2011, the NRU, or Kokurō in Japanese, had only 13,000 members as of 2011 but has a greater historical significance than its membership may indicate at first glance. Kokurō was a major union in post-war Japan, representing many workers who worked for the Japanese National Railways (JNR). When the privatization of JNR was proposed in the mid-1980s, Kokurō were strongly opposed and the roughly 200,000 members campaigned against it. When JNR was replaced by the JR Railways Group, there was substantial pressure on union members to leave their unions and Kokurō membership fell markedly. Workers who had supported the privatization or those who left Kokuro were hired at substantially higher rates than Kokuro members (Kyodo News, 2008; Kyodo News, 2010).

While the motivations of these labor unions with respect to HSR are complex, many of them would support the extension of service and the creation of jobs that comes with infrastructure development.

**Construction Companies & Suppliers**

Construction Companies and Suppliers will contract with JRTT, who oversees the finance, design, construction, and maintenance of the rail line. However, Construction Companies & Suppliers as a collective stakeholder represents the interest of all organizations and companies who sell equipment, infrastructure materials, and skilled labor for any HSR development. It may also include outside consultant groups who supply specialized knowledge. It is likely that many such Construction Companies and Suppliers bid on planned Shinkansen projects and the project will be awarded to the supplier that can guarantee highest construction or delivery quality and time-frame at the lowest price.

**Power Companies**

In extending HSR service, it is important to consider the additional electricity demands and to work with regional power companies to expand electricity generation and transmission infrastructure so as not to jeopardize the area power grid. JR East owns its own hydroelectric and thermal power plants and generate 100% of their own power for its rail services in the Tokyo Metropolitan area. Over its entire network, JR East generates 56% (or 33,000 GWh) of its energy needs, but purchases the remaining 44% (25,500 GWh) from other providers, particularly in the north of the country in the area of the Tōhoku extension (Ogata, 2015). Because JR East did not have plans to expand its power operations in the north of Honshu, it was assumed at the time of extension that any additional power would need to be purchased from the regional power provider.

Tōhoku Electric Power Co., Inc. is an electric utility servicing 7.6 million individuals and corporate customers in six prefectures in the Tōhoku region plus Niigata Prefecture. It provides electricity at 100 V (50 Hz) in most areas. Tōhoku Electric Power Co. is the fourth-largest electric utility in Japan in terms of revenue, behind TEPCO, KEPCO, and Chubu Electric Power. The Tōhoku Shinkansen relies on the Tōhoku Electric Power Co. to supply a 25 kV AC, 50 Hz, overhead catenary for its main high-speed rail service. Thee mini-Shinkansen spurs, the Yamagata and Akita lines, run on 20 kV AC.

The Tokyo Electric Power Company (TEPCO) provides thermal, hydroelectric, nuclear, solar, and wind power to Kanto Region, Yamanashi Prefecture, and part of Shizuoka Prefecture (TEPCO, 2016). TEPCO provides only a marginal amount of the power for JR East Shinkansen service through the aforementioned jurisdictions near the south of the Tōhoku line.

**Real Estate Developers**

Real Estate Developers often support high-speed rail service extension, because it provides service to areas with development potential. JR East, the operator of the Tōhoku Shinkansen, has its own land development pursuits, particularly around new and existing HSR rail stations. In addition to JR East, other railway operators are also land developers. For example, Tokyu Corporation and Tokyo Metro Co., Ltd. have entered into contracts with JR East at sites like Shibuya Station in Tokyo where the three operators provide rail service (Proposals for the Urban Development Project in the Area of Shibuya Station and its Surroundings, 2013). There are also non-rail real estate developers who may serve as advocates for HSR extension, but competitors with JR East for development rights at particular sites. Among these non-rail real estate developers, Sekiwa Real Estate Tōhoku, Ltd. is a major player in the regional market (REAJ, 2016).

**Private Landowners & Abutters**

Private landowners and abutters are subject to prefectural laws governing land use. Right-of-way and environmental concerns regarding Shinkansen development will be addressed with respect to the law. Private landowners directly in the path of HSR track alignment and the general public living along the track or near a station may be impacted by construction and rail operation. High-speed rail, although quieter than major highways, still produces a certain amount of noise and light pollution, especially around switches and stations. HSR track development should try to mitigate negative impacts on landowners and abutters (with methods to engage them in the planning process an important consideration).

The Nationwide Shinkansen Railway Development Act gives the minister of Land, Infrastructure, Transportation, and Tourism the right to grant the constructor of any approved railway line the right to entry and temporary use of land occupied by other persons. In addition,

MLIT or any approved authority can seize land for construction of the Shinkansen line as long as any party that incurs damage is compensated according to the Eminent Domain Act of 1951.

**Intercity Passengers (Business vs. Leisure)**

The intercity passenger's category is intended to represent users of the Tōhoku Shinkansen completing longer trips – for example, trips greater than 120 km (75 mi) – with particular attention paid to those trips that travel between Aomori Prefecture and the Tokyo Metropolitan Area. While the focus is on projected high-speed rail passengers, this category could include passengers traveling by rail, personal auto, intercity bus, or airplane along the same corridor.

This category is further divided based on the intercity passenger's trip purpose. It has been shown that travellers respond differently based on whether the trip is for work or for pleasure – for instance, they may have very different willingness to pay for travel time savings.

**Regional Passengers & Commuters**

The regional passengers category is intended to represent users of the within Aomori Prefecture and the greater Tōhoku region completing shorter trips – for example, those trips that are less than 120 km (75 mi). These regional passengers primarily use slower-speed commuter or regional rail services or private autos rather than long-distance, high-speed lines. This would include passengers who ride on the Tōhoku extension just between Hachinohe and Shin-Aomori: a maximum distance of approximately 70 km (43 mi).

**Freight Users**

The freight user category is intended to represent commercial and industrial users along the Tōhoku spine that rely on JR Freight to ship and deliver their goods and products. They are less likely to have direct demand for high-speed passenger rail, but they have a direct stake in the increased availability of capacity and reliability of the existing rail system should new dedicated HSR passenger track be constructed. The alleviation of congestion on existing rails (for freight rail) and highways (for trucks) as a result of HSR extension could be a positive gain.

## 5.2.2 Development of Goals and Objectives for the Tōhoku Shinkansen Extension

As previously explained, PCBA requires as its inputs identification and understanding of both the stakeholders surrounding the system and the objectives of system development. The previous section presented and discussed the stakeholders identified for the Tōhoku Shinkansen system; this section considers the goals and objectives for the high-speed rail extension from Hachinohe to Shin-Aomori and continued operations of the entire Tōhoku Shinkansen spine.

As in Case Study I. The Northeast Corridor of the United States, goals and objectives have been developed using a process typical of performance management approaches in the transportation

144

industry. First, the researcher develops overarching goals that identify the desired future state of the system. Then these goals are broken down into "measurable" objectives, each of which defines an outcome that helps to satisfy an overarching goal (Pickrell & Neumann, 2001).

It important to consider the tradeoffs associated with addressing each of the objectives in relation to the others. Even though we list objectives that begin with active verbs such as, "increase," "decrease," "minimize," and "maximize," we recognize that positively affecting one objective might negatively impact another. As a result, it is important not to focus on only one objective (or goal) at the expense of the others. Rather, we will consider how interest in a given objective relates to interest or lack of interest in the other objectives, and by extension, how the different stakeholders will be impacted by the net effect of these interests.

In creating the goals and objectives for the Tōhoku Shinkansen extension, we have first considered the national or wider public interests. For this, we identified three main goals cited in the Nationwide Shinkansen Railway Development Act of 1970 and its update in 2002, which is the key legislation for public sector actors including the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) and the Japan Railway Construction, Transport and Technology Agency (JRTT). In translation from Japanese to English, the three overarching goals enumerated in Article 1. Purpose are:

1. Promote local and national economic growth
2. Extend mobility to improve the lives of all Japanese citizens
3. Revitalize and connect local communities

While many of the interests of more local or regional level public sector actors, such as Aomori Prefecture, will be similar to those of the national government actors, the local interests are likely to be more urgent for a geographically limited project such as the Tōhoku extension from Hachinohe to Shin-Aomori. However, in evaluating even a relatively small high-speed rail extension project, it is important to consider not just the link performance, but also the overall network impacts. This highlights the importance of considering larger national or system-wide goals (as represented in the National Shinkansen Railway Development Act).

In addition to considering national public-sector interests, the R/HSR group also reviewed the interests of JR East. Toward this end, the R/HSR group considered the JR East Group Management Vision V – Ever Onward (2012), which represents the interests of a social responsible private sector rail operator. While this document is not specific to the Tōhoku extension project, it outlines the most recent goals of JR East as a company and these main goals are meant to infuse every action that the company undertakes. In particular, this document outlines three "basic principles:"

1. Together with customers and communities: The heart of the company is in providing good service and living up to customers' and communities' expectations.
2. Enhancing safety and [service] quality
3. Pursuing the unlimited potential of the JR East Group

This JR East Group Management Vision V – Ever Onward also includes the "six basic courses of action for the Group" (see Figure 34) that support an eternal mission of continued excellence and the pursuit of unlimited potential. For more details on how JR East plans to achieve these six courses of action, see Appendix B.

**Figure 34.** Two important pillars and six basic courses of action for the Group (JR East, 2012).
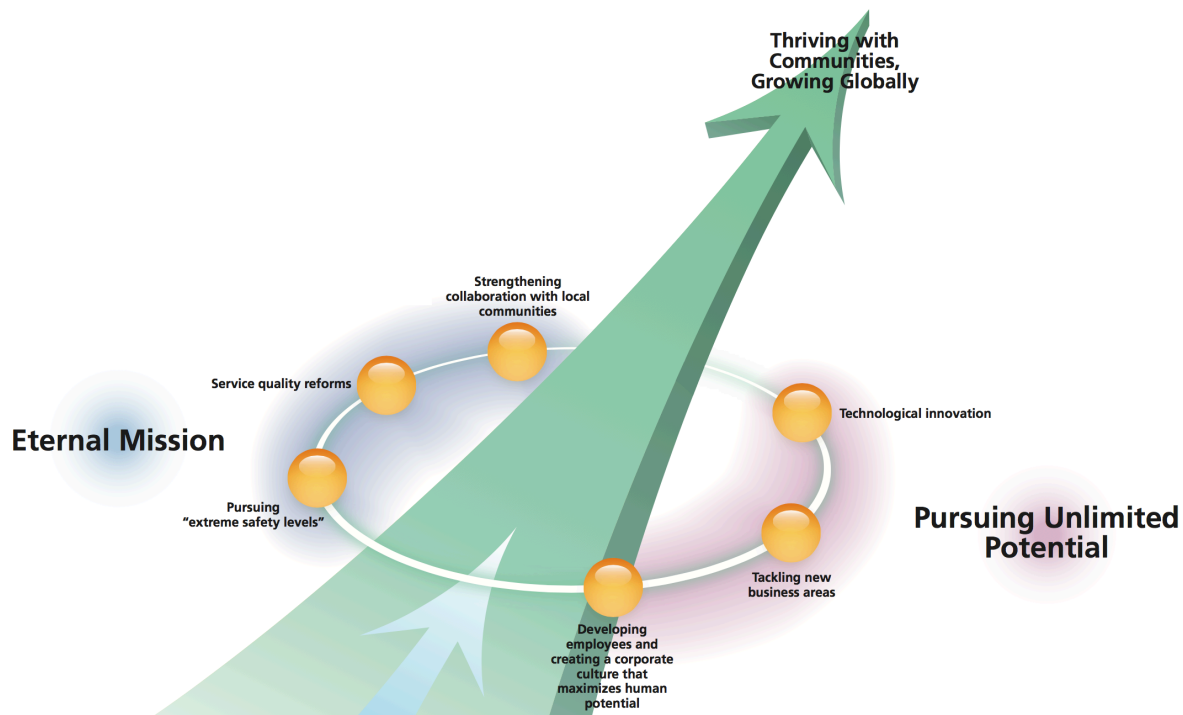


Finally, to identify goals and objectives for the Tōhoku Shinkansen extension, we conducted a structured brainstorming workshop at MIT with professionals from East Japan Railway Company in October 2015. Table 14 shows the ideas (a mixture of both overarching goals and more detailed objectives) identified by the end of the workshop. These ideas were combined with the national-level goals from the National Shinkansen Railway Development Act and the private operator objectives outlined in JR East Management Vision V to come up with a composite list of goals and objectives for the Tōhoku Shinkansen extension.

**Table 14.** Notes from the Tōhoku goals and objectives brainstorming session at MIT in October 2015.

| | |
|---|---|
| 1. Shorten travel time / productive use of travel time | 14. Service for disabled and elderly |
| 2. More capacity for freight rail | 15. Build relationships with local communities |
| 3. Reduce noise/vibration and other environmental impacts | 16. Equity of accessibility |
| 4. Reduce auto traffic and accidents | 17. Promote tourism |
| 5. ** Promote local and national economic growth | 18. Opportunity for new R&D |
| 6. Improve seasonal reliability (especially during winter) | 19. Reduce maintenance cost (new rails cheaper to maintain than older system) |
| 7. Future connectivity to Hokkaidō | 20. Increase liquidity of assets |
| 8. ** Extend mobility (provide greater mode choice) | 21. Capitalize on local voters / political will |
| 9. ** Local community revitalization | 22. Improve level of service (punctuality, reliability, etc...) |
| 10. Create additional cash flow for JR East | 23. Improve overall transportation safety (diversion of passengers from car to rail greatly reduces injuries/fatalities) |
| 11. Improve resiliency against natural disaster (redundancy in the network) | 24. Maximize public benefit-to-cost ratio |
| 12. Reduce energy consumption | 25. Improve quality of life of citizens |
| 13. Expand brand (both domestic and international) | 26. Temporary economic benefits (job creation) |

Note: ** indicates a priority of the Nationwide Shinkansen Railway Development Plan of 1970.

The many ideas that were generated through this collaboration were identified as either larger goals or individual objectives, grouped together, and then compared and combined with the other goals and objectives identified through the review of national and local public interests as well as private operator concerns. Using the goals of both the Japanese national government (representing public interests) and East Japan Railway Company (representing a socially-responsible private interest) as an overarching framework, while keeping in mind the regional concerns for connectivity and intermodal cooperation, the author proposes nine goals for the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori. While the goals are numbered for ease of reference, the order in which they appear does not imply any particular priority. Each of these nine goals is then broken down into a number of supporting, measurable objectives.

1. Improve transportation system safety
2. Create a resilient transportation system
3. Improve capacity
4. Enhance quality of passenger service
5. Promote economic growth
6. Revitalize local communities
7. Extend mobility to all citizens
8. Minimize negative environmental impacts
9. Pursue JR East expansion potential

When considering goals and objectives for high-speed rail systems in general, and the Tōhoku Shinkansen extension in particular, it important to consider the performance of all modes and their interconnections within the transportation system as well as external impacts of the

transportation system. These external impacts can be environmental, economic, as well as social. Given that the Tōhoku Shinkansen will involve a private operator, namely JR East, the financial viability of the extension from a public-sector standpoint should also be considered.

Goals and objectives that focus on the performance of the transportation system look at the direct benefits to the transportation system and its users that would result from an investment in high-speed rail. Specifically, they will attempt to relate reliable mobility, capacity and safety of the transportation system to the investment required for any new developments. By contrast, goals, objectives and performance measures related to the external impacts of the transportation system are intended to gauge the sustainability of the transportation system more broadly considering the economy, the environment and social equity. Objectives and performance measures relating to the financial viability of the extension for JR East are intended to capture the direct return on investment for private funds, the timescale and magnitude of projected revenue, and the value of expanding the brand.

Table 15 lists the goals and objectives synthesized by the author for the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori are documented in the subsequent text. Footnotes regarding the goals and objectives have been listed where appropriate for additional explanation.

**Table 15.** Goals and objectives for the Tōhoku Shinkansen extension.

| Goals | Objectives |
|---|---|
| **1. Improve transportation system safety** | 1.1 Reduce the transportation system user fatality rate (per user-mile)<br>• Maintain zero-fatality reputation on Shinkansen system<br>• Reduce auto traffic and accidents<br>1.2 Reduce the number of non-fatal accidents and injuries on the transportation system |
| **2. Create a resilient transportation system** | 2.1 Create a transportation system that can withstand environmental pressures and mitigate the effects of natural disasters<br>2.2 Introduce redundancy in the transportation network<br>2.3 Supports efficient evacuation routes |
| **3. Improve capacity** | 3.1 Increase the physical capacity of the transportation system<br>3.2 Ensure effective utilization of capacity |
| **4. Enhance quality of passenger service** | 4.1 Decrease door-to-door trip times[18]<br>4.2 Increase trip time reliability and punctuality<br>4.3 Reduce congestion on all modes<br>4.4 Provide a comfortable travel experience[19] |

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[18] A trip considers all travel from origin to destination, not just travel from intercity terminal to intercity terminal. Therefore, trip time is the sum of: travel time from origin to departure terminal, waiting time at departure terminal (including check-in time, security time, buffer time, etc.), in-vehicle travel time, waiting time at arrival terminal and travel time from arrival terminal to destination.

[19] Comfort cannot be measured directly in a quantitative way (although surveys of users can give qualitative feedback), but we can use proxy measures of comfort on a per-mode basis and then sum over the time in each mode for the value for the entire trip.

| | 4.5 Encourage productive use of travel time |
|---|---|
| **5. Promote economic growth** | 5.1 Increase accessibility of labor force participants to firms (jobs); increase accessibility of firms to labor force participants[20] |
| | 5.2 Increase the productivity of firms in all sectors of the economy as a result of improvements to the transportation system |
| | 5.3 Promote short- and long-term jobs creation (as a result of transportation system investments)[21] |
| | 5.4 Stimulate real estate development |
| **6. Revitalize local communities** | 6.1 Maximize benefits from public investments in the transportation infrastructure |
| | 6.2 Lay the foundation for future connectivity to Hokkaidō |
| | 6.3 Promote tourism and local businesses in Aomori Prefecture and along the rest of the Tōhoku line |
| | 6.4 Increase accessibility for rural inhabitants to large metropolitan centers, including Tokyo |
| | 6.5 Improved accessibility and livability within the region |
| **7. Extend mobility to all citizens** | 7.1 Provide greater mode choice |
| | 7.2 Facilitate the interconnection between different transportation modes |
| | 7.3 Expand service for the disabled and elderly |
| | 7.4 Ensure that the net benefits of transportation system improvements are evenly distributed spatially (on local, regional and national scales) and by population segment (often by socioeconomic class) |
| **8. Minimize negative environmental impacts** | 8.1 Reduce emissions of air pollutants related to the transportation sector |
| | 8.2 Reduce noise and vibration impacts on surrounding area (during construction and operation) |
| | 8.3 Reduce energy consumption[22] by the transportation sector |
| | 8.4 Minimize the spatial footprint of the transportation system, particularly on areas of high-environmental sensitivity |
| **9. Pursue JR East Expansion Potential** | 9.1 Maximize profitability for JR East as a private operator |
| | 9.2 Create additional cash flow; increase liquidity of assets[23] |
| | 9.3 Reduce maintenance costs |
| | 9.4 Expand brand (both domestically and perhaps internationally) |
| | 9.5 Build relationships with local communities |
| | 9.6 Develop human capital and create a corporate culture that maximizes human potential |

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[20] There is a correlation between (transportation) agglomeration and productivity (Graham 2007, Westrom 2014).

[21] The intent of this objective and corresponding performance measure is to consider the number of jobs that will be created within the region as a result of transportation investments in the extension. It is not suggest that the goal of transportation system investment should be to maximize job creation at the expense of generating inefficiencies.

[22] This is consumption of fuel both directly by vehicles and for electricity generation for the transportation sector

[23] As part of the Tōhoku Shinkansen extension project, the old conventional rail line was sold to prefectural government and turned over to private regional rail operator. With the new high-speed rail line, JR East now pays rental lease but does not pay property tax or maintenance for the old system.

A keen reader will note that in Goal 4 – "enhance quality of passenger service" – there is no objective regarding the reduction of fares. This is because the Japanese national government mandates a maximum fare for high-speed and conventional rail service; furthermore, JR East has maintained the same fare (excluding inflation) for many years on all of its lines. Therefore, this is not an objective of the Shinkansen system extension. We also do not consider the objective of improving service frequency. This is because the population in Japan in general, and the Tōhoku region in particular, is shrinking; there is little growth in ridership that would demand significant expansion of the frequency beyond what will be gained with improved capacity and efficiency.

With these 35 objectives identified for the Tōhoku Shinkansen development and the 27 stakeholders identified in the previous section, we have gathered all the understanding and inputs necessary to form the stakeholder-objective matrix for the case study.

### 5.2.3 The Stakeholder-Objective Matrix for the Tōhoku Shinkansen Extension

Section 5.2.1 discussed the 27 stakeholders of this case study. These stakeholders included government departments and agencies from the national to the local level, private sector interests, and key user groups. Goals for the development of the transportation system were then identified and further broken down into 35 measurable objectives in Section 5.2.2. From the identification and understanding of the stakeholders and the objectives for system development, we can create a matrix that maps each stakeholder's interests in future system development to the system objectives. Since objectives describe desired future outcomes, relating stakeholders to objectives provides insight into how each stakeholder hopes to improve the system.

As in Table 16, if a stakeholder is concerned about improving a given objective, a blank, ○, ◐, or ● is entered into the corresponding cell indicating whether the stakeholder has no interest or a weak (○), medium (◐), or strong (●) interest. If an actor has no interest in the objective, the corresponding cell is left blank. Figure 35 and Figure 36 show the complete stakeholder-objective matrix for the Tōhoku Shinkansen extension. This complete and symbolic stakeholder-objective matrix will be reduced in dimension, converted into a set of numeric vectors, and then carried through the other two phases of PCBA to identify possible collaborative partnerships that may have been available at the time of early design and construction of the Tōhoku Shinkansen.

Table 16. Key for symbolic stakeholder-objective matrix.

| Interest Level | Symbol |
|---|---|
| No interest | |
| Weak stakeholder interest | ○ |
| Medium stakeholder interest | ◐ |
| Strong stakeholder interest | ● |

**Figure 35.** Complete, symbolic stakeholder-objective matrix for the Tōhoku Shinkansen (part 1 of 2).

**OBJECTIVES**

Objective definitions:

- **1. Improve Transportation System Safety**
  - 1.1 Reduce the number of non-fatal accidents and injuries
  - 1.2 Reduce the transportation system user fatality rate
- **2. Create a Resilient Transportation System**
  - 2.1 Introduce redundancy in the transportation network
  - 2.2 Support efficient evacuation routes
  - 2.3 Withstand environmental pressures and mitigate the effects of natural disasters
- **3. Improve Capacity**
  - 3.1 Increase the physical capacity of the transportation system
  - 3.2 Ensure effective utilization of capacity
- **4. Enhance the Quality of Passenger Service**
  - 4.1 Decrease trip times
  - 4.2 Increase trip time reliability and punctuality
  - 4.3 Reduce congestion on all modes
  - 4.4 Provide a comfortable travel experience
  - 4.5 Encourage productive use of travel time
- **5. Promote Economic Growth**
  - 5.1 Increase accessibility of labor force participants to jobs and of firms to labor force
  - 5.2 Increase the productivity of firms in all sectors of the economy
  - 5.3 Promote short- and long-term job creation
  - 5.4 Stimulate real estate development

**STAKEHOLDERS**

| # | Stakeholder | 1.1 | 1.2 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 5.1 | 5.2 | 5.3 | 5.4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Government** | | | | | | | | | | | | | | | | |
| 1 | National Diet | ● | ○ | ● | ○ | ○ | ○ | | ○ | | | | | | | | |
| 2 | Aomori Prefecture (& Municipalities) | ○ | ○ | ● | ● | ○ | ○ | ○ | ○ | ○ | ● | | ○ | ● | ○ | ● | ○ |
| 3 | Hokkaido Prefecture | | | | | | | | ○ | ○ | | | | | ○ | | |
| 4 | Iwate Prefecture | | | | ○ | | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ |
| 5 | MLIT | ● | ● | ● | ○ | | ● | ● | | | ● | | | | | | |
| 6 | METI | ● | ● | | | | | | | | | ○ | ○ | ○ | ● | ● | ○ |
| 7 | MHLW | ○ | ○ | | | ○ | | | | | ○ | ○ | ○ | ● | | ● | |
| 8 | MEXT | | | | | | | | | | | | | | | | |
| 9 | MIAC | | | | | | | | | | | | | | | | |
| 10 | Ministry of Finance | | | | | | ● | ● | ○ | ○ | ○ | | | ● | ● | ● | ● |
| 11 | Bank of Japan | | | | | | | | ○ | ○ | | | | ○ | ○ | ○ | |
| 12 | JRTT | | | ○ | | | ● | ● | ○ | ○ | ● | | | | | | |
| | **Private Sector** | | | | | | | | | | | | | | | | |
| 13 | JR Hokkaido | ● | ● | | | | ● | ○ | ● | | | | | ○ | | | |
| 14 | JR Freight | ○ | ○ | ○ | | | ● | ● | ○ | | | | | ○ | | | ● |
| 15 | JR East | ● | ● | ● | | | ● | ● | ● | ● | ○ | ● | ○ | ● | ● | ● | ● |
| 16 | Construction Companies & Suppliers | | | | | | | | | | ○ | | ○ | ● | ● | ● | ● |
| 17 | Real Estate Developers | | | | | | | | | | ○ | | ● | ● | ○ | ● | ● |
| 18 | Labor Unions | | | | | | | | | | | | | ● | ○ | ● | ● |
| 19 | Power Companies | | | | | | | | | | | | | | | | |
| 20 | Landowners & Abutters | | | | | | | | | | ○ | ○ | ○ | | | | ○ |
| 21 | Intercity Buses | ○ | ○ | | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | | | | |
| 22 | Airline Industry | ○ | ○ | | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | | | | |
| 23 | Regional Rail Operators | ● | ● | ○ | ○ | ○ | ● | ● | ● | ● | ● | ● | ● | | | | |
| | **Users** | | | | | | | | | | | | | | | | |
| 24 | Intercity Business Travelers | ○ | ○ | | | | | | ● | ● | ● | ○ | ● | ○ | | | |
| 25 | Intercity Leisure Travelers | ○ | ○ | | | | | | ○ | ○ | ● | ● | ○ | | | | |
| 26 | Regional Travelers | ○ | ○ | | | | | | ○ | ● | ● | ● | ● | ○ | ○ | | |
| 27 | Freight Users | ○ | ○ | | | | | | ○ | | ○ | | | ○ | ○ | | |

**Figure 36.** Complete, symbolic stakeholder-objective matrix for the Tōhoku Shinkansen (part 2 of 2).

OBJECTIVES

**6. Revitalize Local Communities**
- 6.1 Maximize benefits from public investment in transportation
- 6.2 Lay the foundation for future connectivity to Hokkaido
- 6.3 Increase the accessibility for rural inhabitants to large metropolitan centers
- 6.4 Improved accessibility and livability within the region
- 6.5 Promote tourism and local businesses

**7. Extend Mobility to All Citizens**
- 7.1 Provide greater mode choice
- 7.2 Facilitate the interconnection between different modes
- 7.3 Expand service for the disabled and elderly
- 7.4 Ensure that the net benefits of the transportation system are evenly distributed spatially and by population segment

**8. Minimize Negative Environmental Impacts**
- 8.1 Reduce noise and vibration impacts
- 8.2 Reduce energy consumption by the transportation sector
- 8.3 Reduce emission of air pollutants related to the transportation sector, particularly on areas of high-environmental sensitivity
- 8.4 Minimize the spatial footprint of the transportation system

**9. Pursue JR East Expansion Potential**
- 9.1 Maximize profitability for JR East as a private operator
- 9.2 Create additional cash flow; increase liquidity of assets
- 9.3 Expand brand (both domestically and perhaps internationally)
- 9.4 Reduce maintenance costs
- 9.5 Build relationships with local communities
- 9.6 Develop human capital and create a corporate culture that maximizes human potential

STAKEHOLDERS

| # | Stakeholder | 6.1 | 6.2 | 6.3 | 6.4 | 6.5 | 7.1 | 7.2 | 7.3 | 7.4 | 8.1 | 8.2 | 8.3 | 8.4 | 9.1 | 9.2 | 9.3 | 9.4 | 9.5 | 9.6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Government** | | | | | | | | | | | | | | | | | | | |
| 1 | National Diet | ○ | | ○ | | | | | | | ○ | ○ | ○ | ○ | | | | | | |
| 2 | Aomori Prefecture (& Municipalities) | ● | ○ | ● | ● | ● | ● | ● | ● | ● | | | ○ | ○ | | | | | ● | |
| 3 | Hokkaido Prefecture | | ● | ● | ○ | ○ | | | | | | | | | | | | | ○ | |
| 4 | Iwate Prefecture | | | ● | ● | ● | | | | | | | | | | | | | ○ | |
| 5 | MLIT | ● | ○ | ● | ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | | | | | | |
| 6 | METI | ○ | | ● | | ○ | | | | ○ | ○ | ○ | ● | ○ | | | | ○ | | |
| 7 | MHLW | | | | | ○ | | | ○ | | ● | ○ | | | | | | | | ○ |
| 8 | MEXT | | | ● | | | | | | | | | | | | | | | | |
| 9 | MIAC | | ○ | ○ | | ○ | | | | ○ | | | | | | ○ | | | ○ | |
| 10 | Ministry of Finance | ○ | | ○ | | | | | | | | | | | | | | | | |
| 11 | Bank of Japan | ○ | | | | | | | | | | | | | | | | | | |
| 12 | JRTT | ● | ● | | | | ○ | ○ | ○ | ● | | | | | | | | | | |
| | **Private Sector** | | | | | | | | | | | | | | | | | | | |
| 13 | JR Hokkaido | | ● | ○ | ● | ○ | ● | ● | ○ | | ○ | ○ | ○ | ○ | | | | | | |
| 14 | JR Freight | ○ | ● | ○ | | | ○ | | | | ○ | ● | ● | ○ | | | | | | |
| 15 | JR East | | ● | ○ | ● | ● | ● | ● | ● | ○ | ● | ● | ● | ○ | ● | ● | ● | ○ | ● | ○ |
| 16 | Construction Companies & Suppliers | | ○ | ○ | | | | | | | | | | ○ | | | | | ○ | |
| 17 | Real Estate Developers | | ○ | ● | | | | | | | | | | ○ | | | | | ○ | |
| 18 | Labor Unions | | ○ | ○ | ○ | | | | | | | | | | | | | | ○ | |
| 19 | Power Companies | | | | | | | | | | ● | | | | | | | | ○ | |
| 20 | Landowners & Abutters | | | ○ | ○ | ○ | | | | | ● | ● | ● | ● | | | | | | |
| 21 | Intercity Buses | | | ○ | | | ○ | ● | | | ○ | ○ | ○ | | | | | | | |
| 22 | Airline Industry | | ● | ○ | | | ○ | ● | | | ○ | ○ | ○ | | | | | | | |
| 23 | Regional Rail Operators | | ○ | ○ | ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | | | | | ○ | ● |
| | **Users** | | | | | | | | | | | | | | | | | | | |
| 24 | Intercity Business Travelers | | | | ● | ○ | ● | ● | ○ | | | | | | | | | | | |
| 25 | Intercity Leisure Travelers | | | ● | ○ | ○ | ● | ● | ○ | ○ | | | | | | | | | | |
| 26 | Regional Travelers | | | ○ | ○ | ● | ● | ● | ○ | ○ | | | | | | | | | | |
| 27 | Freight Users | | | ○ | | | ○ | | | | | | | | | | | | | |

152

While the symbolic or categorical stakeholder-objective matrix for the Tōhoku Shinkansen extension shown in Figure 35 and Figure 36 is useful for clarity and review, it is necessary to convert the "weak," "medium," "strong" classification of interests into an "equivalent" numeric system in order to perform the clustering in the second phase of PCBA. The choice of numeric code is an important tuning parameter that will affect the output of the clustering analysis in the application of PCBA. Best practice from quality function deployment (QFD) literature, suggests that conversion from an ordinal to a cardinal scale utilize a 0-1-3-9, 0-1-3-5, or 0-1-5-9 numeric coding (Franceschini, Galetto & Maisano, 2007; Akao 1998). In addition, sensitivity analysis should be performed to examine the impact of this numeric coding on the overall clustering structure produced.

In the Northeast Corridor case study, we choose to employ the 0-1-3-9 conversion because this provided the greatest (Euclidean) distance and hence differentiation between "medium and "strong" interests, while giving less weight to the difference between no interest and "weak" interest. Given the fractious stakeholder environment of the NEC, this scoring emphasized possible coalitions of stakeholders around their primary (or strongest) interests.

However, for the case study of the Tōhoku Shinkansen extension, the more collaborative institutional environment suggests that stakeholders could form coalitions not just around their strongest or primary interests, but might also work together on objectives where they have medium or weak interest. Therefore, we choose to employ a 0-3-5-9 conversion for the Tōhoku case study. This numeric coding gives equal (Euclidean) distance and hence differentiation between a stakeholder's levels of interest. Compared with the 0-1-3-9 coding used for the NEC case study, the 0-3-5-9 coding deemphasizes the difference between "medium" and "strong" interests and gives greater weight to the difference between no interest and "weak" interest. Therefore, for each cell of a stakeholder-objective matrix for the Tōhoku case study, we assign numeric values according to the conversion key in Table 17.

**Table 17.** Conversion key for the numeric stakeholder-objective matrix for Tōhoku.

| Interest level | Symbol | # |
|---|---|---|
| No interest | | 0 |
| Weak stakeholder interest | ○ | 3 |
| Medium stakeholder interest | ◔ | 5 |
| Strong stakeholder interest | ● | 9 |

Reformatting the stakeholder-objective matrix so that it fits on one page and applying the conversion key in Table 17, we get the complete, numeric stakeholder-objective matrix for the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori given in Figure 37.

**Figure 37.** Complete, numeric stakeholder-objective matrix for the Tōhoku Shinkansen extension.

OBJECTIVES legend:
- 1.1 Reduce the transportation system user fatality rate
- 1.2 Reduce the number of non-fatal accidents and injuries
- 2.1 Withstand environmental pressures and mitigate the effects of natural disasters
- 2.2 Introduce redundancy in the transportation system
- 2.3 Support efficient evacuation routes
- 3.1 Increase the physical capacity of the transportation system
- 3.2 Ensure effective utilization of the transportation system
- 4.1 Increase trip time reliability and punctuality
- 4.2 Decrease trip times
- 4.3 Reduce congestion on all modes
- 4.4 Provide a comfortable travel experience
- 4.5 Encourage productive use of travel time
- 5.1 Increase the productivity of firms in all sectors of the economy / of labor force participants to jobs and of firms to labor force participants
- 5.2 Promote short- and long-term job creation
- 5.3 Maximize benefits from public investment in transportation
- 5.4 Stimulate real estate development
- 6.1 Lay the foundation for future investment in transportation
- 6.2 Increase the accessibility of labor force participants to jobs and connectivity to Hokkaido
- 6.3 Promote tourism and local businesses
- 6.4 Increase the accessibility for rural inhabitants to large metropolitan centers
- 6.5 Improved accessibility and livability within the region
- 7.1 Facilitate the interconnection between different modes / Provide greater mode choice
- 7.2 Expand service for the disabled and elderly
- 7.3 Ensure that the net benefits of the transportation system are evenly distributed spatially and by population segment
- 7.4 Reduce noise and vibration impacts
- 8.1 Reduce emission of air pollutants related to the transportation sector
- 8.2 Reduce energy consumption by the transportation sector
- 8.3 Minimize the spatial footprint of the transportation system, particularly on areas of high environmental sensitivity
- 8.4 Maximize profitability for JR East as a private operator
- 9.1 Create additional cash flow; increase liquidity of assets
- 9.2 Reduce maintenance costs
- 9.3 Expand brand (both domestically and perhaps internationally)
- 9.4 Build relationships with local communities
- 9.5 Develop human capital and create a corporate culture that maximizes human potential
- 9.6 (objective)

| STAKEHOLDERS | 1.1 | 1.2 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 5.1 | 5.2 | 5.3 | 5.4 | 6.1 | 6.2 | 6.3 | 6.4 | 6.5 | 7.1 | 7.2 | 7.3 | 7.4 | 8.1 | 8.2 | 8.3 | 8.4 | 9.1 | 9.2 | 9.3 | 9.4 | 9.5 | 9.6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| National Diet | 5 | 5 | 0 | 3 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aomori Prefecture (& Municipalities) | 3 | 3 | 5 | 5 | 5 | 3 | 3 | 3 | 0 | 5 | 0 | 3 | 5 | 9 | 9 | 5 | 9 | 5 | 9 | 9 | 9 | 0 | 9 | 9 | 5 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hokkaido Prefecture | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 3 | 0 | 3 | 9 | 0 | 0 | 9 | 5 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 |
| Iwate Prefecture | 5 | 5 | 0 | 0 | 0 | 5 | 5 | 0 | 3 | 5 | 0 | 3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| MLIT | 0 | 0 | 5 | 3 | 0 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 9 | 3 | 5 | 5 | 5 | 5 | 0 | 0 | 3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 3 | 0 |
| METI | 3 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 3 | 3 | 3 | 3 | 9 | 5 | 3 | 5 | 0 | 5 | 0 | 3 | 5 | 0 | 0 | 3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| MHLW | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 5 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 5 | 3 | 5 | 0 | 0 | 0 | 0 | 3 | 0 | 3 |
| MEXT | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 5 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| MIAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| Ministry of Finance | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 5 | 5 | 0 | 5 | 5 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bank of Japan | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 3 | 0 | 3 | 3 | 3 | 0 | 9 | 0 | 0 | 0 | 0 | 5 | 3 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| JRTT | 5 | 5 | 0 | 0 | 0 | 9 | 9 | 9 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 9 | 3 | 5 | 3 | 5 | 3 | 3 | 5 | 0 | 0 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| JR Hokkaido | 5 | 5 | 3 | 0 | 0 | 0 | 5 | 9 | 9 | 9 | 9 | 9 | 5 | 0 | 0 | 5 | 0 | 5 | 3 | 5 | 5 | 5 | 5 | 3 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JR Freight | 5 | 5 | 5 | 3 | 3 | 9 | 9 | 5 | 9 | 9 | 9 | 5 | 5 | 0 | 5 | 5 | 5 | 5 | 3 | 5 | 5 | 3 | 5 | 0 | 0 | 3 | 0 | 3 | 3 | 9 | 9 | 9 | 5 | 9 | 5 |
| JR East | 0 | 0 | 5 | 3 | 3 | 9 | 9 | 0 | 9 | 9 | 9 | 9 | 9 | 3 | 5 | 9 | 0 | 3 | 3 | 0 | 0 | 5 | 5 | 5 | 0 | 5 | 5 | 5 | 3 | 9 | 9 | 9 | 5 | 9 | 5 |
| Construction Companies & Suppliers | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 5 | 0 | 0 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 0 |
| Real Estate Developers | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 5 | 3 | 5 | 9 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 0 |
| Labor Unions | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 9 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Power Companies | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| Landowners & Abutters | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 5 | 9 | 9 | 9 | 0 | 0 | 0 | 0 | 0 | 0 |
| Intercity Buses | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 5 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 3 | 5 | 0 | 0 | 3 | 3 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Airline Industry | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 5 | 5 | 9 | 9 | 9 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 0 | 3 | 5 | 0 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Regional Rail Operators | 5 | 5 | 5 | 3 | 3 | 9 | 9 | 5 | 5 | 9 | 5 | 9 | 3 | 0 | 0 | 0 | 0 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 3 | 0 |
| Intercity Business Travelers | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 9 | 5 | 9 | 3 | 0 | 3 | 0 | 5 | 0 | 0 | 5 | 3 | 5 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Intercity Leisure Travelers | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 5 | 9 | 9 | 9 | 0 | 0 | 3 | 0 | 5 | 0 | 5 | 3 | 5 | 5 | 5 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Regional Travelers | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 5 | 3 | 5 | 5 | 0 | 3 | 3 | 3 | 0 | 5 | 0 | 3 | 3 | 5 | 5 | 5 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Freight Users | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 5 | 0 | 0 | 3 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

With the numeric conversion complete, we can prepare the stakeholder-objective matrix for application of PCBA. We want to combine pairs of objectives that are similar to one another and also have high correlation. In this way, we can reduce the number of clustering variables (objectives) without losing information that can differentiate among the interests of the stakeholders. This allows us to reduce the dimensionality of the stakeholder-objective matrix and avoid overrepresentation of a single objective in the clustering. Similar to the preparation of the stakeholder-objective matrix for the NEC case (Section 4.2.3), we can identify similar system objectives by looking at the pairwise Pearson correlation coefficient among the columns (objectives) of the complete, numeric stakeholder-objective matrix for Tōhoku (Figure 37). We can then plot a heat map of the Pearson correlation coefficients among the 35 objectives for the Tōhoku Shinkansen system (see Figure 38).

**Figure 38.** Pearson correlation coefficients among the 35 objectives of the complete stakeholder-objective matrix for Tōhoku.
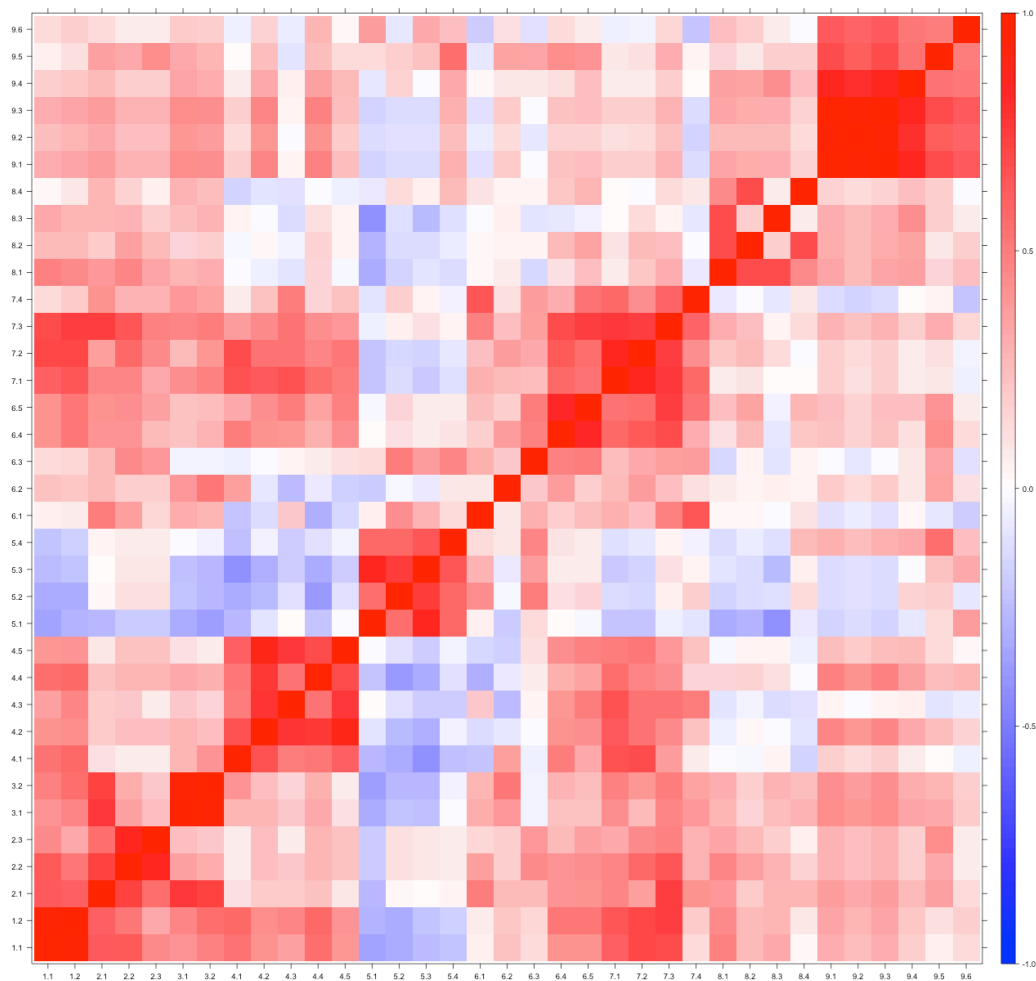


In Figure 38, the more saturated the red in the square, the higher the positive pairwise correlation of the two objectives and the more saturated the blue in the square the higher the negative

155

correlation. We review each pair of highly correlated objectives and decide whether or not the two objectives represent the same stake or interest in the development of the system. If the two objectives represent the same stake, we combine them. For example, we see that objectives 1.1 and 1.2 – "reduce the transportation system user fatality rate" and "reduce the number of non-fatal accidents and injuries" – are almost perfectly correlated and therefore should be combined. Similarly, we see that objectives 9.1, 9.2, 9.3, and 9.4 are all highly correlated and could be combined into one objective variable. This makes sense given that all of these objectives regarding JR East's financial viability and continued business expansion are primarily of interest to only one stakeholder in the Tōhoku system: JR East.

On the other hand, there are some highly correlated objectives that do not represent the same interest. For example, we see that objectives 6.1 and 7.4 – "maximize benefits from public investment in the transportation system" and "ensure that the net benefits of transportation system improvements are evenly distributed spatially and by population segment" – have high positive correlation. While it makes sense that many of the public sector stakeholders would have similar interests in both the magnitude and distribution of public benefits, the author feels that these objectives represent distinct stakes in the system and they are therefore not combined.

Using this pairwise correlation analysis and professional judgment, we also combine objectives 2.2 and 2.3, 3.1 and 3.2, 4.2 and 4.5, 5.1 and 5.3, 6.4 and 6.5, 7.1 and 7.2, and 8.1 and 8.3 as in Table 18. This reduces the number of objectives from 35 to 24.

**Table 18.** Merged pairs of highly correlated objectives in the stakeholder-objective matrix for Tōhoku.

| Objective pair | New combined objective |
|---|---|
| 1.1 and 1.2 | Reduce the transportation system user fatality rate and the number of non-fatal accidents and injuries |
| 2.2 and 2.3 | Introduce redundancy into the transportation network and support efficient evacuation routes. |
| 3.1 and 3.2 | Increase the physical capacity of the transportation system and ensure its effective utilization. |
| 4.2 and 4.5 | Decrease trip times, increase trip time reliability and punctuality, and encourage productive use of travel time. |
| 5.1 and 5.3 | Increase accessibility of labor force participants to jobs and of firms to labor force participants; promote short- and long-term job creation |
| 6.4 and 6.5 | Increase the accessibility for rural inhabitants to large metropolitan centers and improve accessibility and livability within the region |
| 7.1 and 7.2 | Provide greater mode choice and facilitate interconnection between modes. |
| 8.1 and 8.3 | Reduce emission of air pollutants and consumption of energy related to the transportation sector |
| 9.1, 9.2, 9.3, and 9.4 | Maximize profitability for JR East as a private operator, create additional cash flow, reduce maintenance costs, and expand JR East's brand |

When merging a pair of objectives, one must determine each stakeholder's new level of interest in the combined objective. While in many cases, a stakeholder's interest was the same for the two objectives in the pair (hence the high correlation between the objective columns), where a stakeholder had two different levels of interest in the individual objectives, the interest level for the combined objective was taken as the greater interest of the two (as in the NEC case in Section 4.2.3). For example, in the complete stakeholder-objective matrix in Figure 37 the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) has a weak interest in objective 2.2 – "introduce redundancy into the transportation network" – because of its oversight of infrastructure and transportation networks, but has no interest in objective 2.3 – "support efficient evacuation routes" – because a different ministry is responsible for disaster preparedness and relief. For the combined objective of 2.2 and 2.3, we round up and assign MLIT a weak interest.

Figure 39 shows the reduced, numeric Stakeholder-Objective matrix that maps the interests of the 27 stakeholders of the Tōhoku Shinkansen system with the 24 system development objectives resulting from the combination of correlated objectives. Now that we have converted the symbolic stakeholder-objective matrix into a numeric code and reduced the matrix to eliminate significant correlation among the objectives, we have the necessary input for the two phases of Predictive Coalition Building Analysis.

**Figure 39.** Reduced, numeric Stakeholder-Objective matrix for the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori.

Objectives (diagonal column labels, top to bottom):

- Develop human capital and create a corporate culture that maximizes human potential
- Build relationships with local communities
- Maximize profitability for JR East as a private operator, create additional cash flow, reduce maintenance costs, and expand JR East's brand
- Minimize the spatial footprint of the transportation system, particularly on areas of high-environmental sensitivity
- Reduce noise and vibration impacts
- Reduce emission of air pollutants and consumption of energy related to the transportation sector
- Ensure that the net benefits of the transportation system are evenly distributed spatially and by population segment
- Expand service for the disabled and elderly
- Increase the accessibility for rural inhabitants to large metropolitan centers and improve accessibility
- Provide greater mode choice and facilitate interconnection between modes
- Increase the accessibility and livability within the region
- Promote tourism and local businesses
- Lay the foundation for future connectivity to Hokkaido
- Stimulate real estate development
- Maximize benefits from public investment in transportation
- Increase the productivity of firms in all sectors of the economy
- Increase accessibility of labor force participants; promote short- and long-term job creation
- Provide a comfortable travel experience
- Reduce congestion on all modes
- Decrease trip times
- Increase trip time reliability and punctuality and encourage the productive use of travel time
- Increase the physical capacity of the transportation system and ensure its effective utilization
- Introduce redundancy in the transportation network and support efficient evacuation routes
- Withstand environmental pressures and mitigate the effects of natural disasters
- Reduce the transportation system user fatality rate and the number of non-fatal accidents and injuries

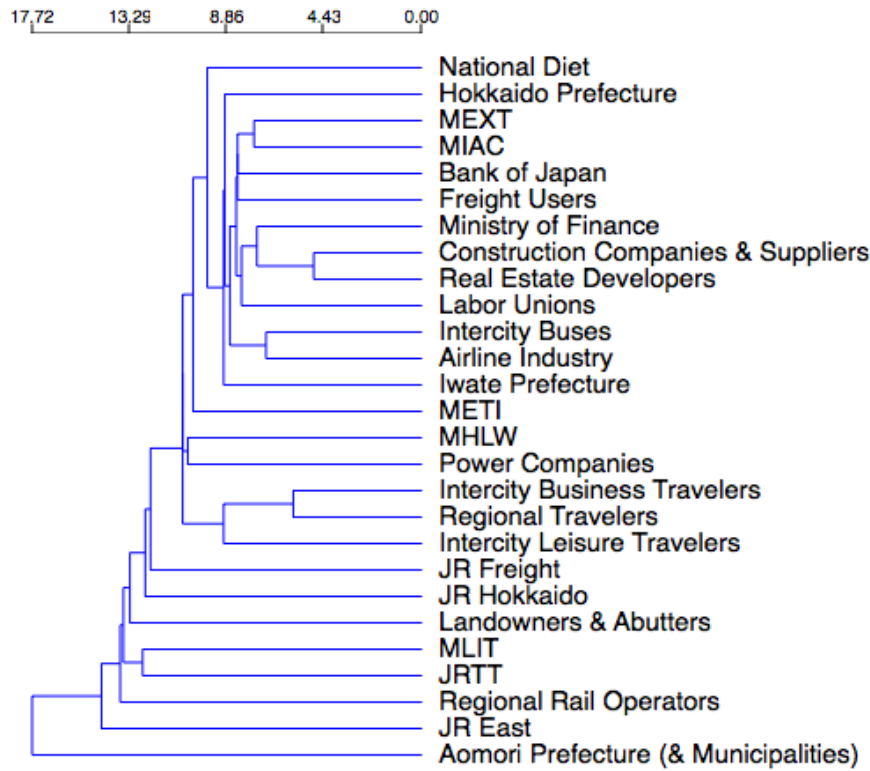| STAKEHOLDERS | 1.1/1.2 | 2.1 | 2.2/2.3 | 3.1/3.2 | 4.1 | 4.2/4.5 | 4.3 | 4.4 | 5.1/5.3 | 5.2 | 5.4 | 6.1 | 6.2 | 6.3 | 6.4/6.5 | 7.1/7.2 | 7.3 | 7.4 | 8.1/8.3 | 8.2 | 8.4 | 9.1-9.4 | 9.5 | 9.6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| National Diet | 5 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 3 | 0 | 3 | 9 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| Aomori Prefecture (& Municipalities) | 3 | 5 | 5 | 3 | 3 | 3 | 5 | 0 | 9 | 9 | 5 | 9 | 5 | 5 | 9 | 9 | 9 | 5 | 3 | 3 | 3 | 0 | 5 | 0 |
| Hokkaido Prefecture | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 9 | 5 | 5 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| Iwate Prefecture | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 3 | 3 | 0 | 0 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| MLIT | 5 | 5 | 3 | 5 | 0 | 0 | 5 | 0 | 5 | 9 | 0 | 9 | 3 | 5 | 5 | 5 | 5 | 3 | 5 | 3 | 3 | 3 | 3 | 0 |
| METI | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 5 | 0 | 3 | 5 | 0 | 0 | 3 | 0 | 0 | 3 | 5 | 5 | 3 | 3 | 0 | 0 |
| MHLW | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 5 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 3 | 0 | 5 | 3 | 0 | 0 | 0 | 3 |
| MEXT | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MIAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 5 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 3 | 0 |
| Ministry of Finance | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 5 | 5 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| Bank of Japan | 0 | 3 | 0 | 0 | 0 | 0 | 5 | 0 | 3 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| JRTT | 0 | 3 | 0 | 9 | 3 | 3 | 5 | 0 | 0 | 0 | 0 | 9 | 5 | 0 | 0 | 5 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| JR Hokkaido | 5 | 0 | 0 | 5 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 3 | 5 | 9 | 3 | 0 | 3 | 3 | 3 | 9 | 0 | 0 |
| JR Freight | 3 | 3 | 3 | 9 | 5 | 9 | 3 | 9 | 0 | 0 | 5 | 0 | 5 | 0 | 0 | 3 | 5 | 0 | 3 | 5 | 3 | 9 | 9 | 5 |
| JR East | 5 | 5 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 5 | 5 | 0 | 3 | 3 | 5 | 5 | 5 | 0 | 5 | 5 | 3 | 3 | 9 | 5 |
| Construction Companies & Suppliers | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 3 | 9 | 0 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 |
| Real Estate Developers | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 3 | 3 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| Labor Unions | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 3 | 3 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 3 | 0 |
| Power Companies | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 3 | 0 |
| Landowners & Abutters | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 5 | 9 | 9 | 0 | 0 | 0 |
| Intercity Buses | 3 | 0 | 3 | 0 | 3 | 3 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 5 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 |
| Airline Industry | 3 | 0 | 3 | 0 | 3 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 5 | 0 | 5 | 5 | 5 | 0 | 3 | 3 | 3 | 0 | 0 | 0 |
| Regional Rail Operators | 5 | 5 | 3 | 9 | 5 | 5 | 5 | 9 | 3 | 0 | 0 | 0 | 3 | 5 | 5 | 5 | 5 | 3 | 3 | 3 | 3 | 9 | 3 | 0 |
| Intercity Business Travelers | 3 | 0 | 0 | 0 | 9 | 9 | 9 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Intercity Leisure Travelers | 3 | 0 | 0 | 0 | 5 | 5 | 5 | 5 | 3 | 0 | 0 | 0 | 0 | 3 | 3 | 9 | 3 | 3 | 0 | 0 | 0 | 0 | 3 | 0 |
| Regional Travelers | 3 | 0 | 0 | 0 | 5 | 9 | 9 | 5 | 3 | 0 | 0 | 0 | 0 | 3 | 5 | 5 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Freight Users | 0 | 0 | 0 | 0 | 3 | 3 | 5 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## 5.3 PCBA PHASE 2: CLUSTERING

As introduced in Section 3.2, the second phase of PCBA employs agglomerative hierarchical clustering on the numerically coded, reduced stakeholder-objective matrix. This phase groups stakeholders based on their interests in the system objectives using Euclidean distance as the dissimilarity measure. While this method is standard across all applications of PCBA, the choice of linkage algorithm – or how the distance from a cluster to a stakeholder or to other clusters is defined – is a tuning parameter chosen to match each specific case.

In order to test which linkage algorithm is most appropriate for the given case, we can run agglomerative hierarchical clustering analysis on the reduced, numeric stakeholder-objective matrix for Tōhoku in Figure 39 for a number of different linkage algorithms. This produces a series of dendrograms (or tree structures) that can help us visualize which actors are most similar in their interest for the Tōhoku Shinkansen extension. Figure 40 through Figure 43 show the dendrograms produced from using single linkage, complete linkage, average linkage, and Ward's method, respectively (see Section 3.2.4). We can compare these tree structures to our knowledge of existing stakeholder relationships to choose the linkage algorithm most appropriate for the Tōhoku Shinkansen extension.

For the NEC case study, we chose to employ the complete linkage or furthest neighbor algorithm because we did not expect stakeholders to form equally sized clusters, nor did we suspect one large cluster of NEC stakeholders to form. Employing this linkage algorithm, a stakeholder in one cluster considering a coalition with another cluster evaluates his/her interests against the stakeholder in the other coalition least alike to them. We asserted that this best mirrored the history of fragmentation among stakeholders of the NEC.

For this second case study on the Tōhoku Shinkansen extension we have decided to use the versatile single linkage method (as in Figure 40) rather than the complete linkage algorithm. This is because, unlike the stakeholders on the NEC that have a history of fractious interests, the stakeholders surrounding Japanese high-speed rail development have a long history of collaboration with well-defined and complementary roles set out in the Nationwide Shinkansen Railway Development Act of 1970, updated in 2002. This is reflected in the use of a minimum distance or nearest neighbor algorithm such as single linkage. Employing this linkage algorithm, a stakeholder in one cluster considering a coalition with another cluster evaluates his/her interests against the stakeholder in the other cluster most alike to them. Therefore, we might expect stakeholders of the Tōhoku Shinkansen system to form one large cluster, with the possibility of a few outliers.

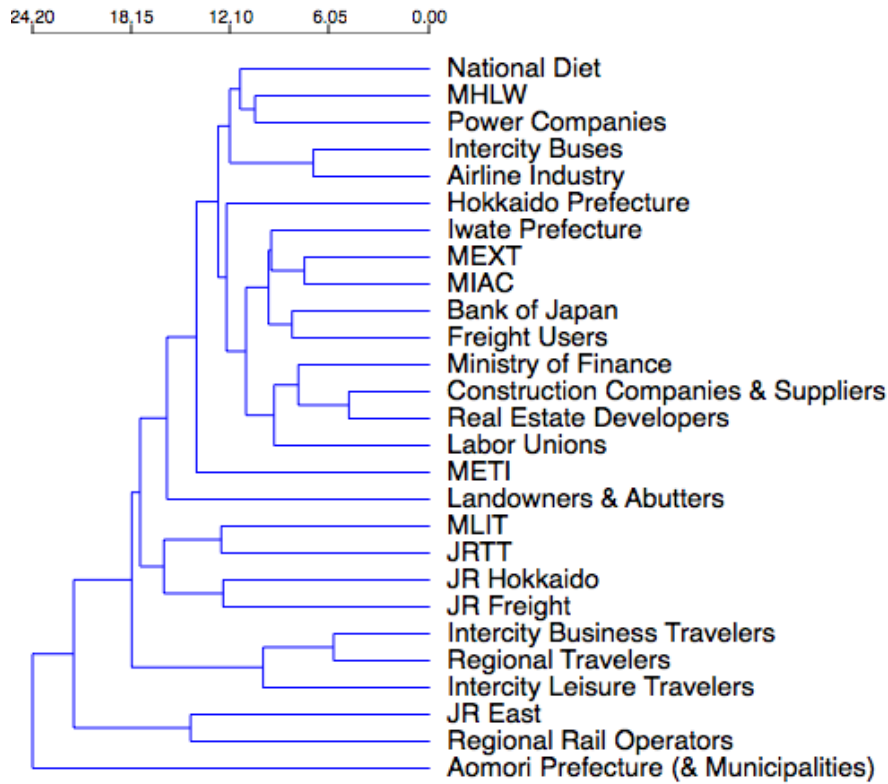**Figure 40.** Hierarchical clustering using single linkage (nearest neighbor) algorithm for Tōhoku.



| 17,72 | 13,29 | 8,86 | 4,43 | 0,00 |

National Diet
Hokkaido Prefecture
MEXT
MIAC
Bank of Japan
Freight Users
Ministry of Finance
Construction Companies & Suppliers
Real Estate Developers
Labor Unions
Intercity Buses
Airline Industry
Iwate Prefecture
METI
MHLW
Power Companies
Intercity Business Travelers
Regional Travelers
Intercity Leisure Travelers
JR Freight
JR Hokkaido
Landowners & Abutters
MLIT
JRTT
Regional Rail Operators
JR East
Aomori Prefecture (& Municipalities)

**Figure 41.** Hierarchical clustering using complete linkage (furthest neighbor) algorithm for Tōhoku.



| 28,48 | 21,36 | 14,24 | 7,12 | 0,00 |

National Diet
MHLW
Power Companies
Intercity Buses
Airline Industry
Iwate Prefecture
MEXT
MIAC
Bank of Japan
Freight Users
Hokkaido Prefecture
Ministry of Finance
Construction Companies & Suppliers
Real Estate Developers
Labor Unions
METI
Landowners & Abutters
MLIT
JRTT
JR Hokkaido
JR Freight
Intercity Business Travelers
Regional Travelers
Intercity Leisure Travelers
Aomori Prefecture (& Municipalities)
JR East
Regional Rail Operators

160

**Figure 42.** Hierarchical clustering using average linkage algorithm for Tōhoku.



**Figure 43.** Hierarchical clustering using Ward's method for Tōhoku.
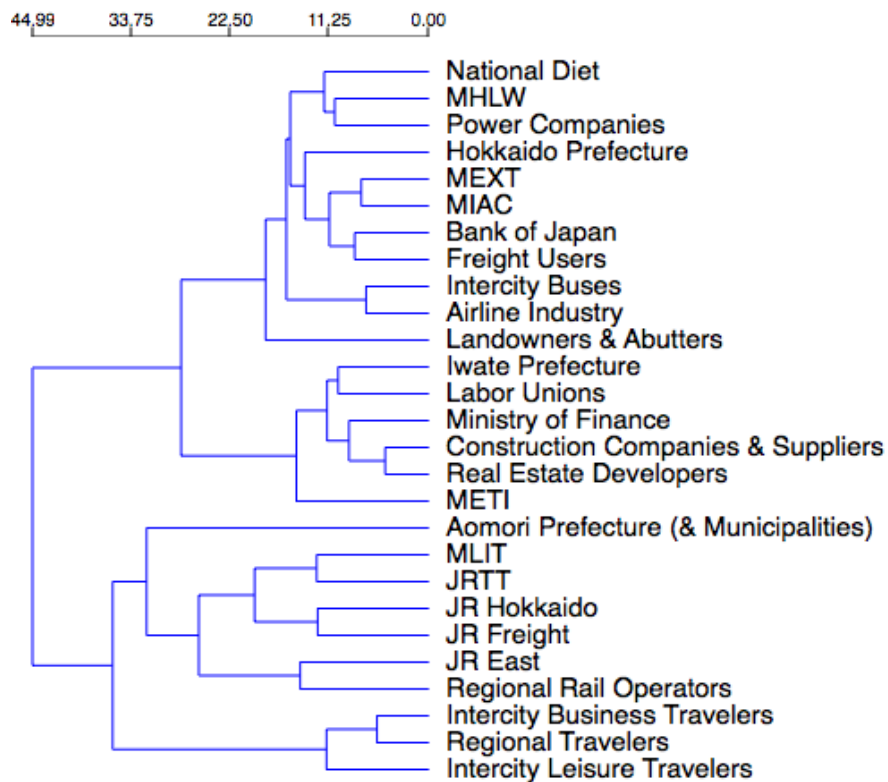
Therefore for the second phase of PCBA on the Tōhoku Shinkansen extension, we run an agglomerative hierarchical clustering analysis on the reduced, numeric stakeholder-objective matrix in Figure 39 using Euclidean distance as our dissimilarity measure and single linkage as our algorithm (as in Figure 40). We perform the analysis using the open source data-mining program, Orange. This analysis produces a dendrogram, reproduced and annotated as Figure 44 below, that can help us visualize which stakeholders are most similar in their interest in the Tōhoku Shinkansen system development objectives.

**Figure 44.** Agglomerative hierarchical clustering analysis results for Tōhoku Shinkansen extension (using Euclidean distance and Single Linkage algorithm).
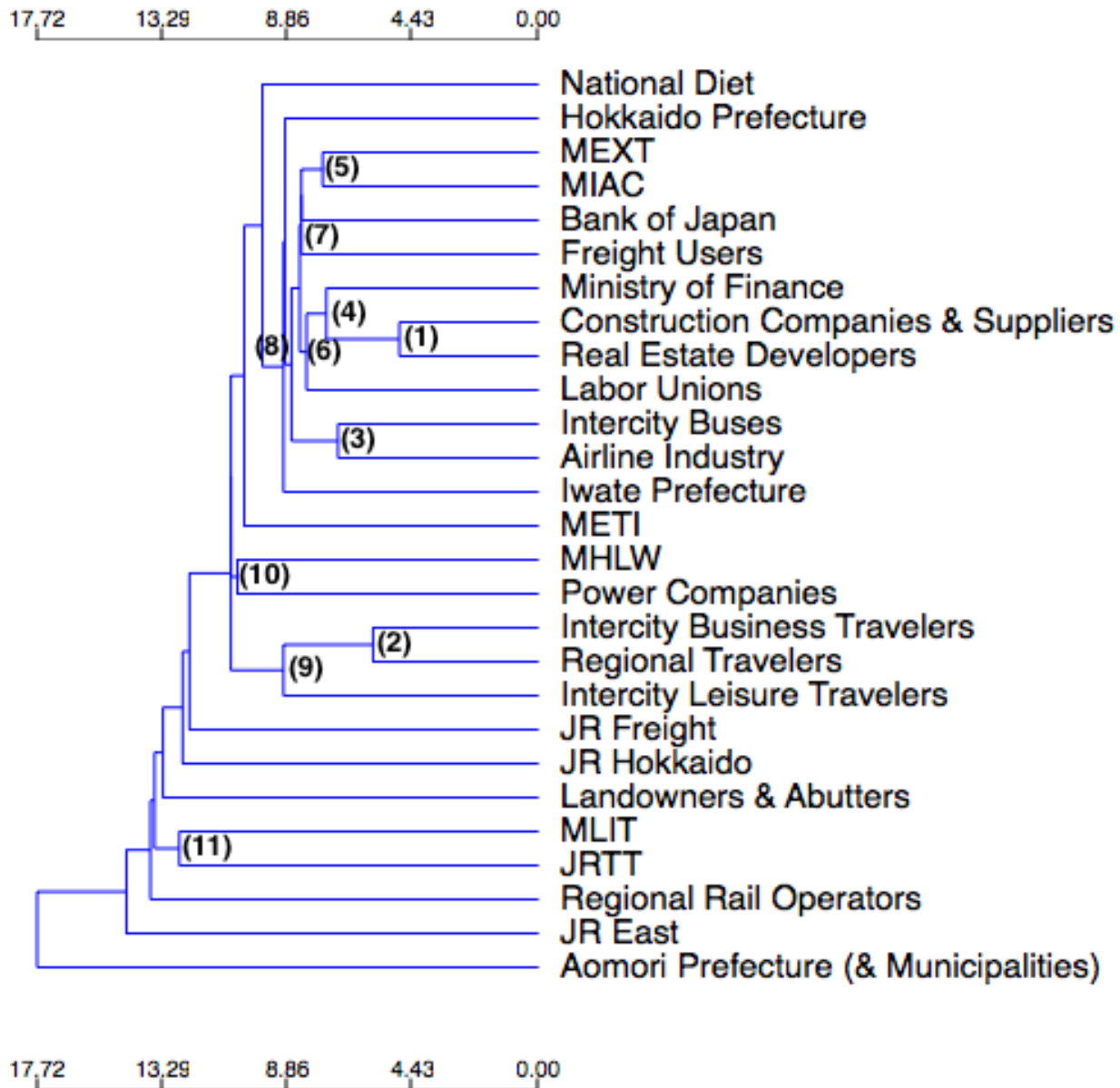


At the far right of Figure 44 at position 0.00, each stakeholder is placed into their own singleton cluster based on their unique interests in the Shinkansen system objectives. Increasing distance

162

from the right to the left indicates greater dissimilarity of interests. When two branches come together at a node, this indicates that the two stakeholders or stakeholder groups have been clustered together based on their interests in the 24 system objectives. The further to the left this node is located on the diagram, the less similar the interests of the actors in the cluster are and therefore the less likely the cluster will form according to belief homophily.

For our analysis, greater dissimilarity among stakeholders in a cluster indicates the need for more compromise on interest or more energy expended in order to work together and form a coalition. For example, we can compare the node number (1) bringing together Construction Companies & Suppliers with Real Estate Developers and the node number (3) bringing together Intercity Buses and the Airline Industry. We see that Construction Companies & Suppliers cluster with Real Estate Developers further to the right (with more similarity in interest) than Intercity Buses and the Airline Industry. The dendrogram also allows us to trace along the branches from one node to the next to see how two like-minded stakeholders, such as Construction Companies & Suppliers and Real Estate Developers could form an even stronger coalitions if they reached out to other stakeholders just a branch away. For example, the cluster at node (1) has jointly similar interests to the Ministry of Finance and could form an additional partnership at node (4).

From the dendrogram in Figure 44, we see that at a reasonable level of similarity among interests many of the stakeholders of the Tōhoku Shinkansen extension form one large cluster. However, within this collective structure we identify 11 possible clusters or coalitions among the stakeholders to discuss in further detail. Numbered according to which clusters are most to least similar, the second phase of PCBA identifies the following possible groupings:

(1) Construction Companies & Suppliers and Real Estate Developers
(2) Intercity Business Travelers and Regional Travelers & Commuters
(3) Intercity Buses and the Airline Industry
(4) Construction Companies & Suppliers and Real Estate Developers (1) and the Ministry of Finance
(5) The Ministry of Education, Culture, Sports, Science, and Technology (MEXT) and the Ministry of Internal Affairs and Communication (MIAC)
(6) Construction Companies & Suppliers, Real Estate Developers, and the Ministry of Finance (4) and Labor Unions
(7) Bank of Japan and Freight Users
(8) Hokkaidō Prefecture, Iwate Prefecture, and (3), (5), (6), and (7)
(9) Intercity Business Travelers and Regional Travelers & Commuters (2) and Intercity Leisure Travelers
(10) The Ministry of Health, Labour, and Welfare (MHLW) and Power Companies
(11) The Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) and the Japan Railway Construction, Transport, and Technology Agency (JRTT)

Each of these clusters will be examined in more detail and discussed in terms of their incentives for and barriers to working together during the third phase of PCBA. Below we simply discuss the overall shape of the dendrogram in Figure 44 and its implications for stakeholder cooperation on the Tōhoku Shinkansen extension.

One general lesson that we might draw from the dendrogram is that the users in cluster (9) are fairly isolated from the interests of many of the other actors. However, their nearest neighbors are the local governments and private operators – JR Freight, JR Hokkaidō, JR East, and Regional Rail Operators – that are supposed to cater to needs. Compared to the dendrogram of the NEC, which had a great distance between the interests of users and operators, this may indicate that the Japanese rail providers better understand and work with the needs and interests of its users.

Another, more promising feature of the dendrogram for the Tōhoku Shinkansen case is that the government entities (both at the national and prefectural levels) are well dispersed among the private sector (and user) stakeholders. This might suggest that the legislative and regulatory bodies in the Japanese government are responsive to the interests and needs of the public (both individuals and firms in different sectors) and therefore public-private partnerships toward infrastructure investment and expansion may be more likely. This is in stark contrast to the dendrogram produced for the NEC, where the tree isolated the legislative and administrative government stakeholders (Congress, State Governments, and Local/Municipal Governments) and the USDOT from all other stakeholders (both private sector entities and users) (see Figure 18 in Section 4.3).

The dendrogram helps us identify not just possible coalitions of stakeholders with similar beliefs, but also outlier stakeholders that have interests far removed from or unique compared with those of any other stakeholder. We note that Aomori Prefecture and the Municipalities of Hachinohe and Shin-Aomori, the JR (East, Hokkaidō, and Freight) and Regional Rail Operators, MLIT and JRTT (11), and Landowners & Abutters are far-removed from the main cluster of stakeholders and have no very close neighbor. We can also identify stakeholders within the main cluster that are marginalized by the other stakeholders. These stakeholders – like the National Diet and METI – are part of the main cluster of stakeholders, but have no nearest neighbor other than a large coalition of many other stakeholders. In addition to the possible pairs and groupings with significant "belief homophily," these outlier and marginalized stakeholders will also be discussed in more detail in the following section. Because coalition building requires compromise and effort on the part of the parties, stakeholders must believe that by acting collectively they will be made better off; otherwise, they will have no incentive to form partnerships (Ostrom, 1990). Thus, the third phase of PCBA considers the hierarchical clustering structure of this second phase and discusses the incentive structure for and possible barriers to coalition building among those stakeholders.
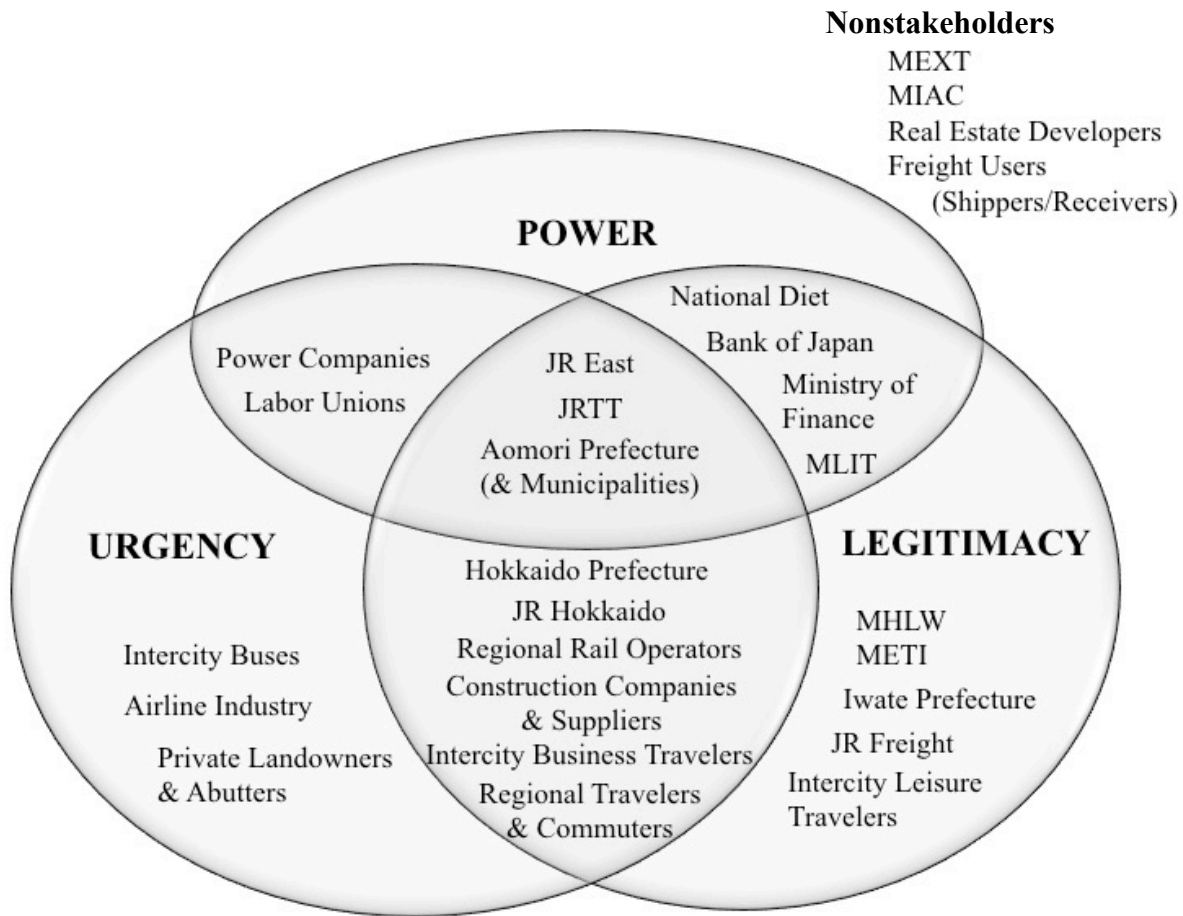
## 5.4 PCBA PHASE 3: INCENTIVES

The third phase of PCBA considers the output of the hierarchical clustering in the second phase and applies ideas from the Institutional Analysis and Development (IAD) Framework and Michell, Agel, and Wood's stakeholder typology to discuss incentives and barriers to coalition building among the clusters of stakeholders. First, we assign each of the stakeholders of the Tōhoku Shinkansen extension any of three stakeholder attributes – power, legitimacy, and urgency (as discussed in Sections 2.3 and 3.3). In accordance with the original theory, assignment of the three attributes is binary so a stakeholder either has an attribute or it doesn't (there are no levels). For the Tōhoku Shinkansen system, Table 22 in Appendix C provides a brief description of why or why not each attribute is assigned to each of the government stakeholders, private sector stakeholders, and users. Based on the combination of the attributes that each stakeholder possesses, they are classified into one of 8 stakeholder types (also included in the final column of Table 22).

Based on these assignments, Figure 45 shows the stakeholders of the Tōhoku Shinkansen system within a stakeholder typology Venn diagram. We find that some stakeholders do not possess any of the three attributes. While termed *nonstakeholder* in the Mitchell, Agel, and Wood framework, these actors are still included in the analysis because, through partnership, they could gain an attribute and enter the diagram.

From this analysis, we can identify the three most salient, or *definitive*, stakeholders for the Tōhoku Shinkansen extension: JRTT, JR East, and Aomori Prefecture (and the municipalities of Hachinohe and Shin-Aomori). These stakeholders individually possess all three stakeholder attributes and therefore have the greatest influence on the direction of Shinkansen development.

**Figure 45.** Stakeholders of the Tōhoku Shinkansen extension arranged by stakeholder typology.

**Nonstakeholders**
MEXT
MIAC
Real Estate Developers
Freight Users
(Shippers/Receivers)

**POWER**

Power Companies
Labor Unions

JR East
JRTT
Aomori Prefecture
(& Municipalities)

National Diet
Bank of Japan
Ministry of Finance
MLIT

**URGENCY**

Intercity Buses
Airline Industry
Private Landowners
& Abutters

Hokkaido Prefecture
JR Hokkaido
Regional Rail Operators
Construction Companies
& Suppliers
Intercity Business Travelers
Regional Travelers
& Commuters

**LEGITIMACY**

MHLW
METI
Iwate Prefecture
JR Freight
Intercity Leisure
Travelers

As discussed in Section 3.3 and applied to the NEC in Section 4.4, the stakeholder typology allows prediction about the circumstances under which a stakeholder might attempt to acquire a missing attribute. This is often achieved through partnership with other stakeholders. Thus the stakeholder can enhance its salience and ability to influence the Shinkansen development by working with another stakeholder. Therefore, gaining an additional stakeholder attribute, and hence salience, is a significant incentive for collective action and coalition building. However, from public policy literature, we know that stakeholders will not partner with just anyone; instead, they will work with whoever they see as having the most similar interests or beliefs. Therefore, we incorporate the Mitchell, Agel, and Wood typology into the cluster hierarchy to help explain which groups of stakeholders with similar interests identified in the second phase of PCBA might or might not work together (see Figure 46).

166

**Figure 46.** PCBA phase 3 clustering hierarchy incorporating stakeholder typologies for Tōhoku.
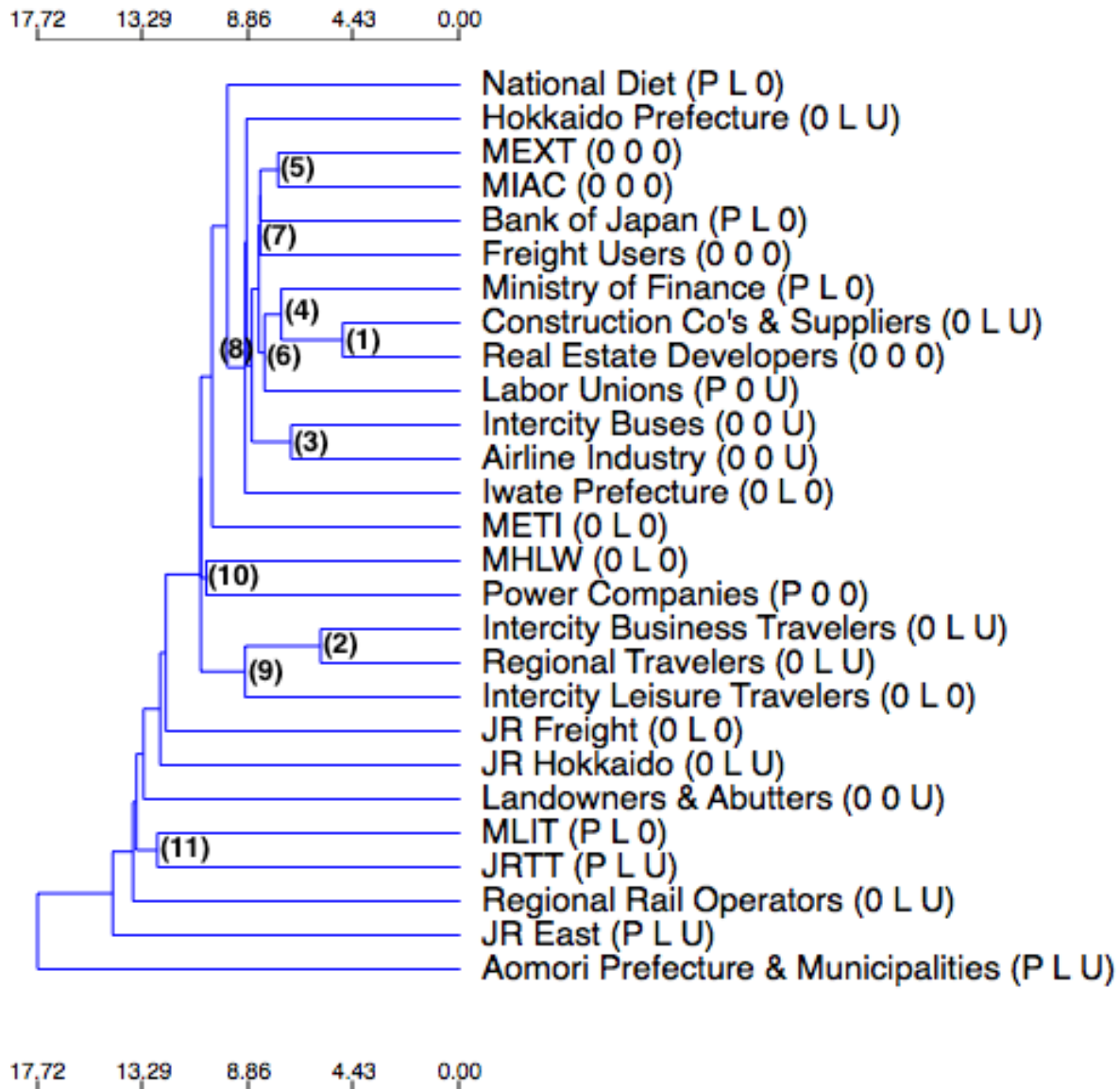


In the following discussion, we consider the incentives that exist among the stakeholders in each of the 11 clusters identified in the clustering phase of PCBA (and again labeled in Figure 46). For each cluster, we note the primary interests around which the coalition might form and draw conclusions about the likelihood of these coalitions forming by considering existing relationships, possible barriers, and the whether the incentive for partnership is nonexistent, one-sided, or bi-directional. The results are summarized in Table 19.

**Table 19.** Summary of PCBA results: likelihood of partnerships among stakeholders of the Tōhoku Shinkansen extension.

| (#) | Actor Pairing or Grouping | Cluster Typology | Likelihood of Partnership |
|---|---|---|---|
| (1) | Construction Companies & Suppliers and Real Estate Developers | (0 L U) | Highly likely |
| (2) | Intercity Business Travelers and Regional Travelers & Commuters | (P L 0) | Unlikely |
| (3) | Intercity Buses and the Airline Industry | (0 0 U) | Somewhat unlikely |
| (4) | Construction Companies & Suppliers and Real Estate Developers (1) and the Ministry of Finance | (P L U) | Likely |
| (5) | The Ministry of Education, Culture, Sports, Science, and Technology (MEXT) and the Ministry of Internal Affairs and Communication (MIAC) | (0 0 0) | Somewhat likely |
| (6) | Construction Companies & Suppliers, Real Estate Developers, and the Ministry of Finance (4) and Labor Unions | (P L U) | Unlikely |
| (7) | Bank of Japan and Freight Users | (P L 0) | Highly unlikely |
| (8) | Hokkaidō Prefecture, Iwate Prefecture, and (3), (5), (6), and (7) | (P L U) | Highly unlikely |
| (9) | Intercity Business Travelers and Regional Travelers & Commuters (2) and Intercity Leisure Travelers | (0 L U) | Highly unlikely |
| (10) | The Ministry of Health, Labour, and Welfare (MHLW) and Power Companies | (P L 0) | Somewhat likely |
| (11) | The Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) and the Japan Railway Construction, Transport, and Technology Agency (JRTT) | (P L U) | Highly likely |

Each of these possible coalitions in Table 19 is discussed below, with the sections labeled 5.4(#), where (#) identifies the node identifier from the PCBA dendrogram as in Figure 46.

5.4(1) CONSTRUCTION COMPANIES & SUPPLIERS AND REAL ESTATE DEVELOPERS

The cluster with the most similar interests on the institutional hierarchy surrounding the Tōhoku Shinkansen extension is represented by node (1), which brings together Construction Companies & Suppliers with Real Estate Developers (see Figure 46). These two stakeholders are paired on their similar interests in objectives in the economic impacts of the transportation system, including creating jobs, increasing productivity, and stimulating real estate development. They also share medium interests in promoting tourism and future connectivity to network expansion (and therefore future development). However, it is important to note the difference in timeframe for these objectives/interests. While there is often some speculative real estate development prior to the start of HSR revenue service the majority of this development and land use change in general will come after much of the project is complete. Therefore, it is likely that Construction Companies & Suppliers will have much greater urgency and involvement from the onset of the project when compared with Real Estate Developers.

168

This is reflected in the stakeholder typologies assigned in Table 22 in Appendix C. Construction Companies & Suppliers are found to be *dependent* stakeholders (0 L U) while Real Estate Developers are *nonstakeholders* (0 0 0) during the initial planning phase. Therefore, we see that the incentive for partnership is one-sided, since Real Estate Developers can gain both legitimacy and urgency from working with Construction Companies & Suppliers with bids and contracts on the Shinkansen development. Despite this one-sided nature of the salience incentive, it is likely that Construction Companies & Suppliers will also be interested in this partnership because business relationships and partnerships formed with real estate developers might bring more work in the future. Therefore, because of the similarity of interests and the mutual benefit that can be gained from working together, we find that node (1) represents a highly likely coalition.

If we follow the branch of the dendrogram towards the left from node (1), we find that the nearest neighbor of Construction Companies & Suppliers and Real Estate Developers is the Ministry of Finance – at node (4). The Ministry of Finance shares many of the same interests in the economic development and impacts of Shinkansen development, but has additional objectives in maximizing benefits from public investment in transportation and ensuring equitable distribution of these benefits that is not shared by the private interest in cluster (1). When considering the salience incentive of the cluster, we note that Construction Companies & Suppliers and Real Estate Developers as a cluster are a *dependent* stakeholder (0 L U) while the Ministry of Finance is a *dominant* stakeholder (P L 0). By partnering together, both stakeholders at the node can gain full salience – Construction Companies & Suppliers and Real Estate Developers can gain power by working with the government ministry that mobilizes national funding, while the Ministry of Finance can gain urgency by working with the local business interest. Therefore, together, this possible coalition would become a *definitive* stakeholder (P L U) that could strongly influence the direction of Shinkansen development. Because of the similarity and interests and the dual-sided incentive for partnership, node (4) is determined to be a likely coalition.

Following this branch even further, we find that the cluster at node (4) pairs with Labor Unions at node (6) (see Figure 46). This clustering is formed again around similar interest in economic impacts and growth that might develop with the Shinkansen; however, Labor Unions are particularly focused on objectives related to job growth and improved accessibility of labor force participants to jobs. We found that the coalition at node (4) among Construction Companies & Suppliers, Real Estate Developers, and the Ministry of Finance gained full salience to become a *definitive* stakeholder (P L U). Therefore, they have little incentive to partner further with Labor Unions. However, Labor Unions as a *dangerous* stakeholder (P 0 U) could gain legitimacy by partnering with the government ministry or a private company bidding or contracted on the project. Because of this one-sided incentive structure and the number of different stakeholders in this rather large cluster, we find that the additional partnership at node (6) is unlikely.

Node (2) in Figure 46 clusters Intercity Business Travelers with Regional Travelers & Commuters. Recall that Intercity Business Travelers focus on those using the Tōhoku Shinkansen to travel outside of Aomori Prefecture, particularly all the way to the Tokyo Metropolitan Area; whereas, Regional Travelers & Commuters represent those who use conventional (and possible high-speed rail) service within Aomori Prefecture between Shin-Aomori and Hachinohe and for shorter distance trips within the Tōhoku region. This pairing may seem intuitive as both user stakeholders have similar interests in terms of punctuality and reliability of rail service and reduction of congestion in the region. Similarly, since business travelers and commuters are primarily focused on work trips, they are more likely to share the same value of time and demand elasticities than users of the system with different trip purposes. In the Northeast Corridor case, we found that both of these user stakeholders would likely be impacted in much the same way by any improvements to HSR system, but this is likely to be the case only with shared corridor development. If instead, HSR were to be developed on dedicated track (like the Tōhoku Shinkansen extension, as implemented), this separation of infrastructure and operations from conventional regional rail might separate these two groups rather than bring them together.

From the stakeholder typologies applied in the third phase of PCBA, we see that Intercity Business Travelers and Regional Travelers & Commuters are both demanding stakeholders (0 L U). Since they each lack the power to be fully salient voices in HSR development, neither can gain an additional attribute by working together. Despite similarity of interest, the lack of incentive to work together and the extremely dispersed, large, and heterogeneous nature of the individuals that make up these stakeholders, we find that it is unlikely that they will be able to mobilize an effective coalition.

Following the dendrogram branch from node (2) in Figure 46, we find that Intercity Leisure Travelers are paired with the cluster of Intercity Business Traveler and Regional Travelers & Commuters at node (9). While again this cluster is formed around interests in service quality and reliability, leisure travelers also have interest in the development of the tourism industry accessible by the Tōhoku Shinkansen service. Furthermore, their distinct recreational trip purpose is often associated with a different value of time and demand elasticity as compared with work trips. This difference is also reflected in the assignment of stakeholder attributes and typologies (see Table 22). We find that compared to other passenger travelers, intercity leisure travelers have less urgency when it comes to Shinkansen development. This is because they have more discretion in when and where they travel. We found above that Intercity Business Travelers and Regional Travelers & Commuters had little to gain from partnership and were unlikely to form a coalition. Adding another disperse, heterogeneous, and less urgent stakeholder into the cluster makes it only more unlikely that a coalition would form at node (9).

## 5.4(3) INTERCITY BUSES AND THE AIRLINE INDUSTRY

The third cluster with similar interests among the stakeholders of the Tōhoku Shinkansen development brings together Intercity Buses and the Airline Industry (3). As two direct competitors to high-speed rail, intercity buses and passenger airlines compete with rail for the same market of passengers. While often these modes cater to different segments of the population, each is concerned with transportation system fatality rates and mitigating disasters. Furthermore, while intercity buses and the airline industry do not share the same infrastructure, they both have similar interests in the overall expansion and maintenance of transportation infrastructure and capacity and its effective utilization. When considering the stakeholder typologies of these two private sector stakeholders, we find that concern for lost market share lends them urgency, but they lack the power or legitimacy in the Japanese market to strongly influence Shinkansen development. Therefore, they are both *demanding* stakeholders (0 0 U) as in Table 22. Despite the fact that they share similar competitive concerns about Shinkansen development, Intercity Buses and the Airline Industry share the same stakeholder typology and therefore have no incentive to work together. Therefore we find this coalition to be somewhat unlikely, but still an important partnership to watch throughout the planning and design phases of the project due to its oppositional nature.

## 5.4(5) MEXT AND MIAC

The next cluster in the hierarchy in terms of similarity of interests is node (5), bringing together the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) and the Ministry of Internal Affairs and Communication (MIAC). These stakeholders are clustered around their similar interest in promoting tourism and local businesses. As national ministries with administrative duties far removed from the direct governance of Shinkansen development, both MEXT and MIAC were characterized as *nonstakeholders* (0 0 0) in Table 22. Despite the fact that both stakeholders have no salience or attributes to contribute to a partnership, because they are both ministries in the same government administration, they share the same policy directions. Because of this existing relationship, this partnership is determined to be somewhat likely; however, even if it were to form, the coalition still remains a *nonstakeholder* with limited interest in the overall system objectives.

## 5.4(7) BANK OF JAPAN AND FREIGHT USERS

The Bank of Japan and Freight Users are clustered around their mutual interests in objective 5.3/5.4 – "increase accessibility of labor force participants to jobs and of firms to labor force participants; promote short- and long-term job creation" – and objective 5.2 – "increase the productivity of firms in all sectors of the economy." Both the Bank of Japan and Freight Users would benefit from general economic growth in the region spurred by HSR development. The Bank of Japan is interested in promoting any economic growth in order to drive Japan out of decades of stagnant GDP. Freight Users would benefit from increased economic activity as it

might expand their shipping market and customer base. So while they have similar objectives, the Bank of Japan and Freight Users derive different benefits from their objective outcome.

Next we consider the incentive structure of the partnership. In Table 22, the Bank of Japan is found to be a *dominant* stakeholder (P L 0), with power and legitimacy as a government entity charged with controlling the value of the yen and domestic interest rates. Freight Users were found to be a *nonstakeholder* (0 0 0), without power, legitimacy, nor urgency to influence the outcome of the Tōhoku Shinkansen development. This means that the incentive structure is extremely one-sided; Freight Users could gain power and legitimacy by partnering with the Bank of Japan, but the Bank of Japan would gain no additional salience by partnering with Freight Users. In addition to the lack of incentive, we note two other barriers to the formation of this coalition. First, there are no existing or historical relationships or avenues by which Freight Users could contact and work with the Bank of Japan. In fact, it would be unlawful for the Bank of Japan to show preferential treatment towards one industry or interest group, such as Labor Unions. Second, Freight Users are a disperse and heterogeneous group that without urgency is unlikely to come together to strongly advocate for their interests. Therefore we conclude that this coalition, despite its common interests in the economic objectives of HSR development, is highly unlikely.

5.4(8) Hokkaidō Prefecture, Iwate Prefecture, and (3), (5), (6), and (7)

The next node on the dendrogram brings together the interests of the two Prefectural governments neighboring Aomori – Hokkaidō and Iwate – with earlier clusters of Intercity Buses and the Airline Industry (3), MEXT and MIAC (5), Construction Companies & Suppliers, Real Estate Developers, the Ministry of Finance, and Labor Unions (6), and the Bank of Japan and Freight Users (7). This cluster involves such a large number of different stakeholders and stakeholder groups, that is would be extremely difficult to build consensus among the many interests (despite their similarity among the system objectives). Furthermore, some of the clusters within this larger cluster – namely nodes (3), (6), and (7) – were previously found to be unlikely. Therefore, we find that the larger cluster at node (8) is highly unlikely.

Within this cluster we should discuss the possible partnership of Iwate (0 L 0) or Hokkaidō (0 L U) Prefectures. Already served by the Tōhoku Shinkansen, Iwate Prefecture has a legitimate stake on development alternatives for the extension that might disrupt their existing service; however, they lack significant urgency or power. Therefore, Iwate will likely be an inert stakeholder content to maintain their limited, individual interests by themselves and unlikely to disturb the structure of the dendrogram. Hokkaidō, on the other hand, relies on the development of the Tōhoku Shinkansen extension to Aomori for future development of Shinkansen service on the northernmost island. Therefore, they have legitimate and urgent claims and may seek to partner with another stakeholder that can lend them power. The only stakeholders within this large cluster that have the attribute of power to contribute to a partnership are the Ministry of Finance, the Bank of Japan, and Labor Unions. In particular, Hokkaidō Prefecture may try to put

pressure on the Ministry of Finance to apportion funding for the Tōhoku extension as early as possible, laying the foundation for future connectivity to the northern island. Therefore, while the collective cluster at node (8) is determined to be unlikely, planners of the project may want to carefully consider Hokkaidō prefecture as a possible disruptive stakeholders that might reach out to unlikely partners to gain additional salience in the Shinkansen development. A similar argument could be made when considering JR Hokkaidō, although its interests are even further removed from the collective cluster of the majority of stakeholders.

5.4(10) MHLW AND POWER COMPANIES

At node (10) in the dendrogram, we find that the Ministry of Health, Labour, and Welfare (MHLW) and Power Companies are clustered together around their common interest in the emissions of air pollutants and the consumption of energy related to the transportation sector. However, we note that despite the similarity of the magnitude of their interests in this objective, the direction may likely be different. As a national ministry charged with serving the public welfare, MHLW would be interested in minimizing emissions and energy consumption to protect the health of its people and the climate. On the other hand, Power Companies would likely be interested in selling more energy (within regulated guidelines and standards). There is already an existing, tenuous relationship between these two stakeholders as Power Companies lobby MHLW for environmental and energy regulation that still supports its business model. This coalition is one that might be better understood by incorporating the direction (oppositional vs. supportive) as well as the magnitude of interests in PCBA analysis. This possible extension of the methodology is discussed further in Chapter 6.

In addition to considering the similarity of their interests, we also consider their stakeholder typologies. We find that as a government ministry with concern over environmental impacts, labor, and health concerns surrounding Shinkansen development, MHLW is a *discretionary* stakeholder (0 L 0) with legitimacy, but no power nor urgency. On the other hand, Power Companies are found to be *dominant* stakeholders (P 0 0), with the stakeholder attribute of power but not legitimacy nor urgency. Therefore, the incentive for partnership is bi-directional: MHLW could gain financial and resource power by partnering with Power Companies, while Power Companies could gain legitimacy by working with the government ministry. Therefore, despite the uncertainty of oppositional vs. supportive interest, we find that both stakeholders could gain salience through this cluster. This incentive, in addition to the existing connection between the stakeholders, makes a partnership somewhat likely.

For many, this may be an unobvious pairing and as such is likely to be overlooked by project managers and planners considering the institutional context of Shinkansen development. This helps to demonstrate the added value of a standardized structure such as PCBA for considering stakeholder relationships and possible coalitions.

## 5.4(11) MLIT AND JRTT

The final cluster at node (11) pairs the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) with the Japan Railway Construction, Transport, and Technology Agency (JRTT). These two stakeholders cluster based on their similar interest in expanding and effectively using transportation capacity, concerns over transportation safety and resiliency, as well their attention to the appropriate use of public funds in transportation investment. This pairing is intuitive and matches with the roles specified by the Nationwide Shinkansen Railway Development Act of 1970 (updated in 2002). One additional and interesting structural implication of note is the fact that the interests of these two stakeholders are far away from the other stakeholder. This is likely because MLIT and JRTT are the main two stakeholders involved in the planning and design stages of the project, whereas many others have interest in the construction and resulting operations phases.

Considering the partnership incentives, we find that MLIT is a *dominant* stakeholder (P L 0), while JRTT is already a *definitive* stakeholder (P L U). Therefore, there is a one-sided incentive for MLIT to partner with JRTT to gain urgency and full salience. Despite the one-sided incentive, the existing (and legally contractual) relationship between MLIT as the government oversight and JRTT as the Shinkansen construction and infrastructure manager make this coalition highly likely.

We previously noted that the dendrogram helps us identify not just possible coalitions of stakeholders with similar beliefs, but also outlier stakeholders that have interests far removed from or unique compared with those of most other stakeholders. In the case of the Tōhoku Shinkansen extension, individual outlier stakeholders include Aomori Prefecture and the Municipalities of Hachinohe and Shin-Aomori, JR and Regional Rail Operators, and Private Landowners & Abutters. We briefly discuss each of these outliers in turn.

Aomori Prefecture and JR East are unique among this group of singleton, outlier stakeholders because they are already *definitive* stakeholders. By themselves, they each command full salience to influence system development. While this does not preclude the possibility of partnership, it does imply that the onus would be on other stakeholders to compromise interests and reach out to form the partnership. Since there are few stakeholders nearby in term of interests, it is likely that both Aomori Prefecture (which includes the Municipal Governments of Hachinohe and Shin-Aomori) and JR East will act on their own. Particular attention should be paid to both of these stakeholders given their full salience in determining Shinkansen development.

We next consider Regional Rail Operators. In the context of the Tōhoku Shinkansen extension, the Regional Rail Operator was JR East, which was responsible for the infrastructure and operation of conventional rail between Hachinohe and Shin-Aomori prior to construction of the Shinkansen line. However, as soon as Shinkansen revenue service commenced, the regional rail infrastructure and maintenance was transferred to Aomori Prefecture and operations were spun off as a new third-party public-private partnership, "Aoimori Railway." Therefore, this

stakeholder changes significantly throughout the development of the project, but JR East and Aomori Prefectures together likely capture its interests.

Next we consider the interests of JR Freight company. We find that JR Freight is a *discretionary* stakeholder (0 L 0), with a legitimate claim on Shinkansen development as it is likely to disrupt their existing service and affect their access to rail capacity. Because JR Freight lacks urgency, it is unlikely that it will compromise its interests significantly to reach out and form a partnership with other stakeholders. Therefore, it is likely to be inert.

Private Landowners & Abutters (0 0 U) are isolated in terms of interest and have urgency, but little other saliency to influence the development of the Tōhoku Shinkansen extension. Given their position in the dendrogram, they would have to compromise their interests significantly to partner with any other stakeholder to gain their missing attributes. In addition to this necessary and significant level of compromise, Private Landowners & Abutters also suffer from their internal heterogeneity and dispersed nature. As a collection of individuals without existing relationships or an overarching organization, it would be unlikely that they would be able to mobilize consensus and reach out to form coalitions with any stakeholder within the institutional context of the Tōhoku Shinkansen extension.

This concludes the discussion of the main clusters and outliers among the stakeholders surrounding the Tōhoku Shinkansen extension as identified by PCBA. This discussion highlighted the intuitive partnerships identified among the stakeholders, validating the hierarchical structure of the tool with comparison to domain knowledge and professional expectations. In addition, the discussion highlights unintuitive partnerships that reflect the additional insight or value of using a standardized tool such as PCBA rather than an ad-hoc judgment of stakeholder relationships. The final section of this chapter serves as further validation of the PCBA methodology; we take advantage of the Tōhoku Shinkansen as a historical case study to compare the results of PCBA outlined above to what actually transpired.


## 5.5 COMPARISON OF PCBA RESULTS WITH HISTORICAL DATA

For the Tōhoku Shinkansen extension, we applied PCBA to a historical case study as if we were considering the project at the time it was being planned. This allows us to systematically compare the predicted results obtained from PCBA with what actually transpired through the implementation of this project. This comparison can not only serve to validate the key findings of PCBA (by showing where the tool properly captured existing and future stakeholder relationships), but also to highlight additional insights and added value that project managers may have gained by using this tool to better understand institutional uncertainties. In this section, we discuss each of the identified coalitions and outlier stakeholders. We compare their likelihood of partnership from PCBA (summarized in Table 19) with news articles and interview accounts of what actually happened throughout the planning, construction, and start of revenue service of the Tōhoku Shinkansen extension. The majority of this material is supplied by an email

questionnaire sent by the author to a Mr. Iori Mori and Mr. Satoshi Kuji at East Japan Railway Company (full transcript included as Appendix D), but the author is responsible for the interpretations presented here.

While Mr. Kuji was prompted with the list of 27 stakeholders identified for the Tōhoku Shinkansen extension in this application of PCBA, he did not discuss the motivations or relationships of some of the stakeholders on the list (such as the Airline Industry or Intercity Buses) and he aggregated others (such as the many national government ministries). Therefore, there are some PCBA pairings that we do not have sufficient information to compare to actual results. Table 20 summarizes the comparison of all PCBA partnerships with actual outcomes (where available) and a brief description of each comparison follows. Since the focus of this case study is on the Tōhoku extension from Hachinohe to Shin-Aomori, we discuss the actual outcomes from the re-initialization of this project (nominally in 1994) through the completion of construction and the start of revenue service (2012) (see the timeline of the project included as Table 24 in Appendix D).

**Table 20.** Comparison of PCBA coalition prediction with what actually happened during the Tōhoku Shinkansen extension project from 1994-2012.

| (#) | PCBA Actor Pairing or Grouping | PCBA Likelihood of Partnership | Actual Outcome |
|---|---|---|---|
| (1) | Construction Companies & Suppliers and Real Estate Developers | Highly likely | Considered to be one stakeholder; materialized |
| (2) | Intercity Business Travelers and Regional Travelers & Commuters | Unlikely | Did not materialize |
| (3) | Intercity Buses and the Airline Industry | Somewhat unlikely | [not discussed] |
| (4) | Construction Companies & Suppliers and Real Estate Developers (1) and the Ministry of Finance | Likely | Materialized |
| (5) | The Ministry of Education, Culture, Sports, Science, and Technology (MEXT) and the Ministry of Internal Affairs and Communication (MIAC) | Somewhat likely | Considered to be one stakeholder |
| (6) | Construction Companies & Suppliers, Real Estate Developers, and the Ministry of Finance (4) and Labor Unions | Unlikely | [not discussed] |
| (7) | Bank of Japan and Freight Users | Highly unlikely | [not discussed] |
| (8) | Hokkaidō Prefecture, Iwate Prefecture, and (3), (5), (6), and (7) | Highly unlikely | [not discussed] |
| (9) | Intercity Business Travelers and Regional Travelers & Commuters (2) and Intercity Leisure Travelers | Highly unlikely | Did not materialize |
| (10) | The Ministry of Health, Labour, and Welfare (MHLW) and Power Companies | Somewhat likely | [not discussed] |
| (11) | Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) and Japan Railway Construction, Transport, and Technology Agency (JRTT) | Highly likely | Materialized |

It is additionally important to note that the news and questionnaire review regarding actual relationships among stakeholders throughout the extension project were performed after completing the hierarchical clustering and assignment of stakeholder typologies. This ordering was intentional so that the author when discussing PCBA results was not informed or biased by what actually transpired when making predictions.

5.5(1) CONSTRUCTION COMPANIES & SUPPLIERS AND REAL ESTATE DEVELOPERS

We start with the first coalition identified by PCBA: the pairing of Construction Companies & Suppliers with real Estate Developers at node (1). PCBA found that this pairing was highly likely due to the strong similarity of interests and a mutual benefit from working together on business endeavors. In his response to our questionnaire, Mr. Kuji of JR East often discussed this coalition as if it were one stakeholder, in many ways assuming that the land development and contractor interests would be aligned, primarily during the construction (and operation) phase of the project (see Table 23 in Appendix D). This implies that these two stakeholders behaved as one entity when it came to the development of the Tōhoku Shinkansen extension. Therefore, we can say that this likely coalition materialized and behaved much as PCBA predicted.

5.5(2) INTERCITY BUSINESS TRAVELERS AND REGIONAL TRAVELERS & COMMUTERS

PCBA found that a coalition between Intercity Business Travelers and Regional Travelers & Commuters was unlikely given the dispersed nature of these stakeholders and their lack of incentive to gain salience through partnership. In reality, the separation of the infrastructure for regional/conventional and high-speed rail service helped to separate these two user groups. In fact, it was not just a separation of infrastructure, but also a separation of operations/service. Upon the opening of the Shinkansen track, JR East abandoned its regional operation on the conventional lines running parallel to the new track. Regional operations were transferred to a newly created public-private third-party operator, Aoimori Railway, whose network continued to link 11 towns and cities within Aomori Prefecture (Nagafuchi, 2011). While we were unable to find an explicit mention of any traveler group advocacy, it is clear that the approximately 670,000 regional travelers and commuters (48% of the prefectural population of 1.37 million living near the line) would have had different allies from those of the intercity business travelers looking to use the new high-speed rail service. Therefore, again we can say that the prediction of "unlikely" for the coalition matched with the reality of the Tōhoku Shinkansen extension development.

PCBA goes on to cluster Intercity Business Travelers and Regional Travelers & Commuters (2) with Intercity Leisure Travelers at node (9). Because the previous cluster was determined to be "unlikely" and because the addition of a third user stakeholder would only contribute additional complications and complexities without additional salience, this cluster was determined to be "highly unlikely." While the traveler perspective is often not explicitly discussed, there was clearly some tension between the interests and needs of commuters vs. those of tourists. These

manifested themselves in conflicts over the location and name of stations along the Shinkansen alignment (see Appendix D) that would likely have involved different traveler groups on different sides of the argument. To the extent of the author's knowledge, there is no evidence of any user advocacy groups working to harmonize and promote both the interests of intercity business and leisure travelers, let alone the inclusion of regional travelers as well. Therefore, we can say that this coalition did not develop, as suggested by PCBA.

5.5(4) THE MINISTRY OF FINANCE AND (1)

Next we consider the pairing of the Ministry of Finance with the cluster at node (1) – Construction Companies & Suppliers and Real Estate Developers. PCBA determines that this is a likely coalition of stakeholders during the planning of the Tōhoku Shinkansen extension. When the project was originally postponed in 1982 (see project timeline, Table 24 in Appendix D), the Ministry of Finance and local business interests were in conflict. However, once the government determined that they had the finances to move forward and the project was reinitiated, the relationship become more collaborative. Local business interests were able to lobby the national government to mobilize the finances and speed up the construction process by two years (Railway Gazette, 2005). Furthermore, local business interests worked with the national government (including the Ministry of Finance) to have the extension plans changed from a shared track, "mini-Shinkansen" to a more expensive dedicated track development. Since we perform PCBA as if we were considering the project around the year 1995, the prediction that the coalition is likely to occur matches with what actually transpired once the project was reinitiated.

5.5(5) MEXT AND MIAC

The Ministry of Education, Culture, Sports, Science, and Technology (MEXT) and the Ministry of Internal Affairs and Communication (MIAC) was determined to be a somewhat likely coalition by PCBA because of its shared policy umbrella under the same coalition government. This aggregation of national ministries into a single, like-minded stakeholder is echoed in both the news and Mr. Kuji's response to the questionnaire. While we were unable to find a distinct mention of these two particular ministries working together, we assert that the PCBA prediction is corroborated simply by the pervasive implicit assumption that these two stakeholders are one with the general government.

5.5(11) MLIT AND JRTT

PCBA determined that the cluster at node (11) – pairing the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) and the Japan Railway Construction, Transport, and Technology Agency (JRTT) – was highly likely given the similarity of interests, one-sided incentive, and existing relationships between the two stakeholders. This coalition did in fact manifest as directed by law and predicted by PCBA. MLIT worked with JRTT to advance the construction

178

schedule and to change the construction plans from a "mini-Shinkansen" to dedicated high-speed rail Shinkansen system.

In addition to the clusters discussed above, there were five other possible clusters identified through PCBA that were not discussed in any of the news review or the response to the questionnaire. Therefore, we are unable to say anything definitive about the actuality of these relationships. Because these stakeholders were not discussed together in any of the sources reviewed, one might assume that it is because no relationship existed between them and they did not act together. This would match with the fact that four of these five clusters – Intercity Buses and the Airline Industry, the Bank of Japan and Freight Users, Construction Companies & Suppliers, Real Estate Developers, and the Ministry of Finance (4) and Labor Unions, and Hokkaidō Prefecture, Iwate Prefecture, and (3), (5), (6), and (7) – were determined by PCBA to be somewhat to highly unlikely (see Table 20). However, more information would be needed to make any strong inferences regarding PCBA's predictive validity in these cases.

In terms of outlier stakeholders, many were not mentioned in the news articles reviewed by the author nor the answers to the questionnaire provided by Mr. Kuji of JR East; however, Aomori Prefecture and the municipal governments of Hachinohe and Shin-Aomori are the exception. PCBA analysis showed that Aomori Prefecture and its municipalities had interests the furthest removed from any other stakeholder surrounding the Tōhoku Shinkansen extension. Because the extension was contained wholly within Aomori Prefecture, Aomori bore a significant amount of the construction and environmental costs and risk, but also stood to benefit the most from improved service and accessibility and economic growth. No other stakeholder was as invested in all stages of the extension project, from initial planning through construction and into operation. PCBA also noted that Aomori Prefecture was a fully salient, *definitive* stakeholder and therefore did not need partnership to influence the Shinkansen development. Therefore, it was able to act on its own towards its goals. When prompted to discuss any unexpected stakeholder behavior that manifested itself during the Tōhoku Shinkansen development, Mr. Kuji noted the opinions and actions of the municipal governments that had to be mediated by Aomori Prefecture. Because this stakeholder singly had full salience, it could act however it wanted (sometimes somewhat unpredictably).

In conclusion, the Tōhoku Shinkansen case study serves as another example of how to apply PCBA and highlights the additional insight and value gained by using it as a tool for understanding stakeholder relationships and how they might develop in the future. Furthermore, as a historical case study, we can compare the results achieved from PCBA to what actually happened in the institutional context surrounding the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori. We find that all of the "highly likely" and "likely" stakeholder coalitions identified by PCBA actually materialized, while those coalitions that were considered "unlikely" or "highly unlikely" did not materialize (or were not mentioned).

While further validation remains for the PCBA methodology, this case study suggests that the tool not only provides a useful, transparent, and standardized framework for considering stakeholder relationships, but that it has predictive validity for understanding how these relationships might evolve cooperatively. The final chapter discusses some of the remaining work and possible extensions of PCBA, discusses how the tool might easily fit into existing planning and management practice, and summarizes the conclusions and contributions of this case study along with those of the NEC.

# CHAPTER 6.

# CONCLUSIONS

Stakeholder analyses are now arguably more important than ever because of the increasingly interconnected nature of the world. Choose any public problem or infrastructure system – and it is clear that 'the problem' encompasses or affects numerous people, groups, and organizations (Bryson, 2004). Therefore, most large infrastructure projects in general, and transportation systems in particular, are "sociotechnical" in nature. Literature and practical experience concur that stakeholder support and cooperation is necessary to create and sustain winning coalitions (Riker, 1962; Riker, 1969; Baumgartner & Jones, 1993) and to ensure the long-term viability of organizations (Eden & Ackermann, 1998; Abramson & Kamensky, 2001), policies, plans, programs, and projects (Bryson & Crosby, 1992; Baumgartner & Jones, 1993, Roberts & King, 1996). However, despite the growing importance of stakeholder analysis, few user-friendly tools exist for planners and project decision makers to explore changes in institutional structure over time, particularly the formation of cooperative partnerships among stakeholders. To help to fill this gap, PCBA was developed as a transparent and visual tool that can be used by stakeholders with varied interests and backgrounds to better understand the likelihood of cooperative relationships among stakeholders of a complex, sociotechnical system or large-scale infrastructure project.

Chapter 2 of this thesis presents a review of relevant stakeholder analysis theories, techniques, and conclusions from the public policy and strategic management domains. Synthesizing and operationalizing ideas from the Advocacy Coalition Framework (Sabatier, 1988; Weible, Sabatier, & McQueen, 2009), the Institutional Analysis and Development Framework (Ostrom, 1991), and Mitchell, Agel, and Wood's stakeholder typology and discussion of salience (1997), we present a three-phase methodology for identifying and understanding the likelihood of coalitions among the stakeholders of a sociotechnical system in Chapter 3:

1. We first gather the necessary data to identify and characterize stakeholders, develop objectives for the system development, and map the stakeholders' interests to these objectives.
2. Next, we operationalize the idea of "belief homophily" around ACF's policy core beliefs by hierarchically clustering the stakeholders based on the similarity of their interest in the system objectives. In this way, the second phase of the method draws upon public policy literature's understanding of how multiple actors related to each other and many different

policy or performance objectives to answers the question: *who might be willing to work with whom?*

3. However, our analysis also recognizes that similarity of interest is a necessary, but not sufficient condition for coalition building. Incorporating theories of collective action and the discussion of stakeholder salience in business and management literature, the third phase of the methodology discusses the incentives and barriers to possible coalition formation. In this way, we take conclusions from retrospective public policy analyses and apply them dynamically to current and future situations. In this third phase, we answer the question: *who might be motivated to work with whom*?

This three-phase methodology is a predictive tool for stakeholder analysis for complex sociotechnical systems. The predictive nature of PCBA can be useful in exploring future scenarios to understand uncertainties in political support and opposition among stakeholders of a project. This understanding can allow project managers to identify possible sources of institutional risk and create mitigation strategies for how to compromise with or proactively plan for the interests of salient, oppositional coalitions. It can also be used to identify possible supportive coalitions that project managers may want to bring together to form the larger consensus necessary for implementation of large-scale, complex sociotechnical systems.

In addition to providing the intellectual basis, motivation, and methodological contribution for the development of PCBA, this thesis applies the tool to two case studies of high-speed rail systems: possible development along the Northeast Corridor of the United States and the completed Shinkansen extension from Hachinohe to Shin-Aomori, Japan. These case studies contribute to the domain knowledge about these two systems; furthermore, the case studies demonstrate what insights PCBA provides project planners beyond ad-hoc professional judgment.

In the NEC case, we test PCBA for its sensitivity and robustness to perturbations, demonstrating that the tool responds to small changes in the institutional context in meaningful ways. This highlights the usefulness of PCBA as a tool for exploring different future scenarios and understanding the uncertainty of stakeholder relationships and coalitions surrounding the system or project of study. Furthermore, we compare the results of PCBA to those of Multi-Stakeholder Trade Space Exploration (MSTSE) for the NEC. While these two methods have different objectives – PCBA focused on the likelihood of coalition building among stakeholders and MSTSE focused on finding a design alternative in a negotiation setting that satisfies a majority of stakeholders – we can use this comparison to discuss the relative merits of PCBA compared with other stakeholder analysis tools for complex, large-scale, interconnected, open sociotechnical systems. These merits include:

182

- An inclusive definition of stakeholders that allow project managers to understand and explore relationships among all groups and individuals affected by the project, not just those that might support it.
- Relatively few assumptions that are transparently carried through to the final discussion and findings of the analysis. This allows stakeholders and planners with diverse backgrounds to participate collectively on a level playing field.

In the case of the Tōhoku Shinkansen extension, we are able to directly discuss the predictive validity of the tool by comparing the coalition likelihood results obtained from PCBA with what *actually happened* through the planning, construction, and start of revenue service (1994-2012). From this comparison, we find that all of the highly likely and likely coalitions identified by PCBA actually materialized throughout the project lifecycle. Furthermore, the coalitions that were considered unlikely or highly unlikely did not materialize or were not mentioned in the news or other accounts of the project. Therefore, we can conclude that, in this case, PCBA gave an accurate picture of what might happen among the stakeholders surrounding the development of the Tōhoku Shinkansen extension.

Through its application to case studies of high-speed rail development, we have demonstrated that PCBA not only accurately reflects the current state of inter-actor relationships within the institutional context of a complex system, but that it also provides useful information about how stakeholders may come together to form coalitions in the future. While it remains to be seen how this predictive information will be used in practice, the author hopes that decision-makers and project proponents may be able to identify possible coalitions and bring these like-minded and incentivized stakeholders together to form the political and institutional consensus necessary for project development and implementation.

## 6.1 LIMITATIONS AND FUTURE WORK

Throughout the text, we have discussed the assumptions underlying PCBA and touched upon some of the limitations of the methodology. While some of these limitations are inherent in the methodology itself – such as its vulnerability to large-scale pattern breaks – many others are areas of future work that can be addressed with extensions to the existing PCBA framework. This section focuses in more detail on some possible areas of further research and discusses how the methodology might be improved to lend additional insight.

### 6.1.1 Pattern Breaks

Like any stakeholder analysis tool, PCBA provides snapshots of what may be a rapidly changing context, where positions and influence are subject to change from internal events, external events and possibly the stakeholder analysis process itself. The environment, the context of the analysis,

stakeholder interests, positions, alliances and influence change over time. The political context of policy-making and project management is often highly dynamic, and can be subject to sudden, unexpected transformations. Therefore, if the timeframe of a prospective analysis is too long or study results are not applied in a relatively short period of time, especially in complex and unstable settings, the relevance of the analysis for informing stakeholders on how to manage the future decreases rapidly (Varvasovszky & Brugha, 2000). This is particularly important for a tool, such as PCBA, that seeks to be predictive about possible coalition formation.

Because of this, PCBA is not designed to predict a point-solution, but rather to explore how coalitions might form, around which interests, and why or why not. In the case of the NEC, we have demonstrated that the tool is robust to small perturbations, such as a new entrant to a market or the changing of one stakeholder's interests (see Section 4.5). Of course, more research is needed to explore the magnitude of change that PCBA is able to capture without having to redo the initial data collection phase. However, the fact that PCBA can adapt to even small changes with relatively simple insertions or changes to the stakeholder-objective matrix gives it an advantage over many other methods which must start from scratch after any significant change in the type or interests of the stakeholders of the system. Because of this ability to explore small perturbations, PCBA is particularly useful in providing insight for different possible future institutional scenarios without the need for re-estimation of complex inputs or models.

### 6.1.2 Evaluating Cooperation around Specific Design Alternatives

One of the limitations of the existing framework is that the stakeholder relationships are evaluated around general transportation system objectives rather than specific design alternatives. This limitation was noted in the comparison of PCBA results for NEC with those obtained from application of MSTSE – a tool developed around a tradespace of many design alternatives (Section 4.6). As the methodology stands now, additional manual post-processing would be needed to match the interests of certain coalitions in the system objectives to those design alternatives that would meet the specific objectives. However, with additional research some of this mapping could be automated so that PCBA discusses the interests *and* design alternatives of likely (and unlikely) stakeholder coalitions. Research in Total Quality Management might lend insight into how to incorporate stakeholders interests and types from PCBA and connect them with project alternatives (Yu, Chen, Chen, & Chang, 2012).

### 6.1.3 Weighting Objectives

By performing clustering analysis on the stakeholder-objective matrix, the analyst weighs each of the objectives equally as a variable for determining similarity of interest. However, one could easily imagine that certain objectives (such as safety) may be more important for most or all stakeholders than others (such as community building and placemaking) and should therefore be weighted more heavily. This is, in part, captured by the ranking of stakeholder interests in terms

184

of their strength and the nonlinear numeric assignment of value to the strongest interests. In this way, there are certain objectives within the matrix that have many stakeholders with a strong interest and therefore influence the final clustering hierarchy more than other objectives that are not of strong or even medium interest to many stakeholders.

If one still wishes to weight certain objectives more heavily than others, there is no methodological barrier to including weights for the variables in a clustering analysis. However, determining these weights would be an additional area of calibration and research more difficult to fit into existing practice. One way to estimate the weights would be through a discrete choice model. One could administer a stated preference survey of key stakeholders (or perhaps historical data on existing and past relationships) to calibrate the discrete choice model and then apply those weights to future predictive exploration. Including weights would likely require a significantly longer implementation time frame since additional data collection and model estimation would have to be run before the clustering and salience discussion can commence. The author notes that this may detract from the approachability and transparency of PCBA as it has been presented here.

## 6.1.4 Accounting for Supportive and Oppositional Interests

Throughout the text we have stressed the importance of having an inclusive definition of stakeholders, especially when considering large infrastructure projects within the public domain. This means that our case studies include stakeholders from both the public and private sector, stakeholders that represent collections of individuals or organizations, and stakeholders who are likely to be supportive of or opposed to the system development. By considering both those who would benefit and those who might lose from the project, managers can help identify possible coalitions for consensus-building, but also possible coalitions that might form to slow down or stop the project. By identifying these oppositional clusters and the system objectives that they care about, project managers might be able to identify important areas for compromise or mitigation.

However, the stakeholder-objective matrix, clustering analysis, and stakeholder typology used in PCBA as it stands, do not differentiate supportive and oppositional interests in the system objectives. While this is an important item of discussion throughout the third phase of the analysis, when discussing the interests, incentives, and barriers of possible coalitions, one could extend the methodology to include the direction of the interest directly. In the stakeholder-objective matrix one might characterize stakeholder's interests in each of the system objective s not just by their magnitude (none, weak, medium, or strong), but also by their direction (positive or negative). One could then perform the same clustering analysis and application of the Mitchell, Agel, & Wood typology. It remains to be seen whether this characterization of support vs. opposition at the objectives-level would add significant additional insight, but it would be a relatively simple extension of the existing framework.

## 6.2 CLOSING REMARKS

The previous chapters of this thesis presented the intellectual underpinnings and the motivation for PCBA (Chapter 2), the three-phase methodological framework (Chapter 3), and application to two case studies of complex, multi-stakeholder HSR systems (Chapters 4 and 5). Throughout this discussion we have tested the robustness and validity of PCBA and highlighted the additional insight provided by the application of a transparent, standardized, and predictive tool for understanding stakeholder relationships. This final chapter discussed in more detail some of the main limitations and areas of future work remaining in the development and application of the methodology. In addition, we restated the purpose and synthesized the main contributions of PCBA as a tool for planners and project managers to better understand future uncertainties in institutional structures and cooperative relationships surrounding large, complex, multi-stakeholder infrastructure and transportation projects. While the case studies in this thesis explore high-speed rail development, the author asserts that this tool could be useful for exploring other sociotechnical systems within and beyond the transportation domain, even more so as the tool continues to develop.

Despite its limitations, we assert that PCBA is a useful and practical tool for the planners and managers of complex sociotechnical system. Designed with this audience in mind, PCBA is transparent and visual, making it accessible by people of many different backgrounds. In practice, stakeholder analysis is generally done with focus groups or by bringing relevant stakeholders together to map interests and identify resources. The stakeholder-objective matrix provides a standard structure for this type of collaborative meeting and in the spirit of "full, open, and truthful exchange" could be developed collectively by stakeholders to better understand similarities of interests in system development (Raiffa, Richardson, & Metcalfe, 2002; Fitzgerald, 2016). While the author was unable to test the tool with actual decision-makers in experimental workshops, the author asserts that this technique is easily incorporated into existing project planning and stakeholder analysis processes. Furthermore, by considering objectives for the entire system rather than the goals or resources of individual stakeholders (such as maximizing utility), PCBA might help to reduce "positional bargaining" – an intractable and inefficient negotiation strategy that involves a stakeholder holding on to a fixed idea or position of what it wants and arguing for it regardless of other alternatives or interests (Spangler, 2003; Fitzgerald, 2016).

In conclusion, this thesis lays the foundation for future research into and application of PCBA. As a tool developed for professional application, the strength of this tool lies in its usability, transparency, and communicability. We have demonstrated that PCBA can provide real, predictive insight at a macro scale to help explore uncertainties in stakeholder relationships, making it valuable for policy-makers who want to easily understand and visualize the broad institutional context of the system.

We thank the reader for their interest and hope that the tools and findings from this thesis will prove useful for researchers and practitioners to identify and foster supportive coalitions towards the implementation of large-scale, complex, and sociotechnical infrastructure and transportation projects.

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196

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# APPENDIX A. STAKEHOLDER TYPOLOGY ASSIGNMENTS FOR THE NEC

**Table 21.** Assignment of stakeholder attributes and typologies for the NEC HSR system.

| Stakeholder | Power | Legitimacy | Urgency | Type (P L U) |
|---|---|---|---|---|
| Congress | √ Controls all federal legislation and funding (including budget for DOT and allocations for Amtrak). | √ Authority given by the U.S. Constitution and the mandate of the electorate. | X Glacially slow to act and the issue of HSR/transportation is only one of many being considered. | Dominant (P L 0) |
| State Governments | √ Controls all legislation and funding on the state level; however, any projects with matched federal funding must conform to all federal regulations. | √ Authority given by the mandate of the electorate. | X Not focused solely on the issue of HSR, but have a slightly more immediate stake than Congress. Would be most focused on the interests of state commuter rail and highway agencies. | Dominant (P L 0) |
| Local/Municipal Governments | X Oversee local legislations, regulation and taxation, but have few resources compared to the federal or state levels; have no authority over a project as large as intercity/interstate HSR. | √ Voting public elects officials to address local needs; has the authority to administer some programs funded by the state or federal government as well as regulate public utilities (including transport access). | √ Local and urban transportation issues are of vital and immediate importance, especially concerning whether a region or city is served by the proposed HSR alignment and connectivity to urban public transportation organizations. | Dependent (0 L U) |
| USEPA | X Implement/administer environmental laws and impose some punishment for noncompliance, but reliant on funding and law enactment from Congress. | √ Regulatory Agency given authority by Congress and the Justice Department. | √ Maintain a pointed interest in the impact of transportation infrastructure projects on air, water, and land quality, etc. | Dependent (0 L U) |
| Department of Commerce | X Has little financial or regulatory power over HSR development as long as existing domestic rules regarding technology and business are followed. | √ Cabinet-level department in the US government with secretary appointed by the President; has wide range of responsibilities in areas of trade, technology, economic and business development, etc. | X Would not have a stake until the first international-quality HSR is established; then they might be involved in negotiating technological exchange abroad. | Discretionary (0 L 0) |

| Stakeholder | Power | Legitimacy | Urgency | Type (P L U) |
|---|---|---|---|---|
| Department of Energy | X — Does not have jurisdiction over transportation projects; would only be involved tangentially with energy generation and transmission, etc. | √ — Cabinet-level department in the US government with secretary appointed by the President to address energy, environmental, and nuclear challenges | X — Not concerned with HSR development as long as existing energy regulations are followed. | Discretionary (0 L 0) |
| USDOT | √ — Have power in many areas of transportation in the U.S. including: regulation, legislation, research and statistics, policy initiatives, and allocation of grant resources. | √ — Cabinet-level department in the US government with secretary appointed by the President. | √ — USDOT has identified improvements to the NEC (and HSR development) as a strategic goal for a new transportation system to promote continued, national economic growth. | Definitive (P L U) |
| Amtrak | √ — As primary owner of NEC track, Amtrak controls intercity passenger operation and infrastructure upgrades to existing lines; however, Amtrak is also dependent on large government subsidies for non-NEC passenger service and is inherently weak politically | √ — Created in 1970 by the Rail Passenger Service Act to provide all national passenger rail service; incorporated in DC and subsidized by the federal government. | √ — As both the infrastructure manager and sole intercity operator on the NEC, HSR development is of vital importance. | Definitive (P L U) |
| NEC Commission | X — Determine and allocate costs, revenues, and compensation among Northeast Corridor (NEC) owners and operators, but have no significant finance or policy leverage. | √ — Created by Congress to address system improvement planning for the NEC; have many other stakeholders as members. | √ — Small-scope institution focused on NEC rail infrastructure; not only is HSR a top priority, but the Commission also faces time pressures from PRIIA deadlines and other regulations. | Dependent (0 L U) |
| I-95 Corridor Coalition | X — While the I-95 Corridor Coalition makes policy suggestions, its agreements do not hold any regulatory clout. | √ — Provides a forum to consider multiple operator interests with formal membership of many key stakeholders along the corridor | X — Relatively small-scope institution focused on improving traffic flow and safety on the existing NEC highway system. Rail is only tangentially related to their mission. | Discretionary (0 L 0) |
| Port Authorities | √ — Most port authorities are financially self-supporting and control financing and operation of key infrastructure along the NEC spine, including bridges, shipping and railroad terminals, and airports. | √ — Port authorities are usually governed by boards or commissions appointed by governmental chief executives with explicit powers codified in law. | X — Port authorities have many pressing concerns regarding existing infrastructure (particularly bridges and airports) along the corridor and therefore early-stage plans for HSR take a backseat. | Dominant (P L 0) |

| Stakeholder | Power | Legitimacy | Urgency | Type (P L U) |
|---|---|---|---|---|
| Commuter Rail Agencies | √ Own some NEC track; provide service necessary for HSR connectivity and success; and have history of using litigation to stall or cancel passenger infrastructure improvements that do not meet their interests. | √ Many share corridor contracts with Amtrak on NEC so they have legal claim to the right-of-way. | √ Have important and immediate claim on alignment and connection of HSR to existing commuter routes and to any disruption of current or future service. | Definitive (P L U) |
| Urban Public Transportation Organizations | X Operate on such a small geographic scale, that they have no jurisdiction over intercity HSR. | √ May be necessary to provide shuttle service to and from HSR hub stations; are seen as an important public service and are subsidized by city government | √ Many Urban PT Org's are facing a critical time for capital improvement; HSR development could have significant implications on future network load (particularly in congested urban centers). | Dependent (0 L U) |
| Terminals | X Have little financial or governmental recourse to influence HSR development. | √ Terminals will be an important focus of infrastructure planning/construction for HSR; they affect total travel time along the route (dwell time). | √ Terminals along the proposed HSR alignment will likely need timely and large-scale remodeling to meet increased demand for passenger service capacity. | Dependent (0 L U) |
| Freight Railroad Companies | X Have capital, but are interested in investing in their own infrastructure in other areas of the country; do not have any administrative rights over much of the NEC. | √ Have shared corridor contracts with Amtrak, who owns track along NEC. | √ Freight railroads will be financially impacted by any increased passenger service on shared track. They will likely face increased competition for limited capacity and increased safety/railcar regulation due to mixed traffic. | Dependent (0 L U) |
| Intercity Bus Operators | X Do not have financial or governmental recourse to influence development of HSR. | X Intercity bus operators are often small, relatively unregulated companies with nonunionized labor; some are not recognized as reputable businesses. | √ Development of HSR would increase competition for intercity passengers, possibly reducing bus market share. | Demanding (0 0 U) |
| Trucking Industry | X Do not have jurisdiction over rail development projects. | √ The trucking industry is recognized as an important and powerful trade group, which promotes American jobs and economic growth. | X Improving transportation flow along the highly congested NEC corridor highways is of interest, but trucks rely on roads rather than rail and are not in direct competition with intercity passenger services (HSR). | Discretionary (0 L 0) |

| Stakeholder | Power | Legitimacy | Urgency | Type (P L U) |
|---|---|---|---|---|
| Airline Industry | X<br>Do not have financial or governmental recourse to influence development of HSR. | √<br>The government subsidizes airline operation since it is seen as an important public service. | √<br>Intercity HSR development would affect demand and cost of severely congested domestic air shuttle service on the NEC. | Dependent (0 L U) |
| Suppliers | X<br>Provide materials and experience to the project, but reliant on award of contracts by private sector or government. | √<br>Would be involved in HSR construction/implementation through contracts. | √<br>HSR development would provide a great business opportunity/new market for infrastructure construction, materials, and labor force. | Dependent (0 L U) |
| Private Consortiums | X<br>Potentially important source of capital investment or expertise in construction/management, but reliant on award of contracts | √<br>Would be involved in HSR implementation through contracts. | √<br>Would have vital stake given that they have directly invested money/labor and expect a return, once they invest. | Dependent (0 L U) |
| Labor Unions | √<br>Have some coercive power since they can organize strikes and make wage and contractual demands of employers. | X<br>Although they are legally recognized representatives of industry workers, they do not have a binding vote in the development of new infrastructure. | √<br>Development of HSR on the NEC would directly affect jobs in transport, construction, materials manufacturing, etc. | Dangerous (P 0 U) |
| Banking Industry | √<br>Control loans, interest and discount rates, credit ratings, etc. for financing. | √<br>Necessarily involved in any high-cost infrastructure/capital project (although the level of involvement might scale with the usage of private funding). | X<br>The banking industry can make money in any economic sector and therefore has no particular interest in long-term, rather low-yield transportation infrastructure projects. | Dominant (P L 0) |
| Insurance Industry | √<br>Must be involved in all legal, personnel, and property assurances for any investment in transportation infrastructure. | √<br>Seen as necessary for risk-mitigation and necessarily involved in any high-cost infrastructure/capital project. | X<br>Within the insurance industry's diverse portfolio, higher-risk, longer-term, lower-yield transportation infrastructure projects do not tend to take priority. | Dominant (P L 0) |
| Private Landowners | X<br>Control land possibly needed for right-of-way for new track alignment, but the average individual has little power (even in litigation that causes delays) compared to larger entities. | √<br>Legally and contractually own land that would be needed for HSR development; would need to be relocated. | √<br>HSR development would have immediate importance for any landowner in the direct track path or in radius of a station. | Dependent (0 L U) |

| Stakeholder | Power | Legitimacy | Urgency | Type (P L U) |
|---|---|---|---|---|
| Abutters | X Although project managers may ask for public opinion on plans, abutters have no real recourse (coercive, utilitarian, or otherwise) for influencing HSR development. They can slow implementation through litigation. | X Abutters are such a small group of the general public that often benefits for the many will outweigh the stake of a few in large infrastructure development. | √ Daily lives are affected by noise (and light) pollution from HSR development. | Demanding (0 0 U) |
| Political Activists / Lobbyists | X Large donors can influence a political campaign, but most groups alone cannot outright influence policy. | X These 'fringe' groups are often considered too extreme to garner large public opinion support; even large, well-established groups are often stigmatized as not representing the interests of the public. | √ These groups are often focused on only a few issues, so those that have a stake in HSR implementation will consider it vital. | Demanding (0 0 U) |
| Media | √ Has coercive power over public opinion and policy through choosing what information is presented and how it is portrayed. | X There is public skepticism over the political bias of many news agencies/forms of media. | X HSR development on the NEC has both support and opposition in the media, but neither group is particularly vocal (since there are many other issues covered). | Dormant (P 0 0) |
| Intercity Travelers | X Source or most immediate HSR demand; yet the average individual public user has little power compared to government or corporate entities. | √ Intercity travelers are the economic market for HSR passenger service and are therefore recognized as stakeholders. | √ Intercity travelers would be directly affected by HSR development, particularly because it would provide greater mode choice along the NEC, reduce travel time, and present competition to reduce fares. (disruption of service during construction) | Dependent (0 L U) |
| Commuters | X The average individual commuter has little power compared to government or corporate entities. | √ HSR can function as a form of transit between urban centers; in this way, commuters may begin to use new HSR networks as well as existing commuter lines (but only after construction). | X Intercity HSR is not an immediate concern unless planning/construction disrupts existing networks; HSR could reduce congestion on highways and existing rail, reducing trip times once operational. | Discretionary (0 L 0) |
| Freight Customers (Shippers/ Receivers) | X The average individual public user has little power compared to government or corporate entities. | √ Hold legal contracts with freight railroads and trucking companies that use existing NEC rail and highway systems. | X The development of high-speed passenger rail only has an oblique effect on freight (rail or truck). | Discretionary (0 L 0) |

# APPENDIX B. OUTLINE OF JR EAST GROUP MANAGEMENT VISION V

The following outline contains the finer details of how JR East plans to achieve these six courses of action using the headings and subheadings of the English language publication of the JR East Group Management Vision V – Ever Onward (2012). While many of the priorities in this document, such as enhanced service quality and collaborating with local communities, were likely to have been goals during the mid-1990s when the Tōhoku extension was being considered, others such as international expansion may not have been a focus. Therefore, where possible, the R/HSR group has denoted with ** those objectives in the outline that were likely **not** the focus of JR East Management when they were considering the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori (around 1994).

1. **Excel:** Pursuing extreme safety levels
   a. Responding to major earthquakes
      i. Seismic reinforcement and other counter measures
      ii. Rescuing customers and saving lives in the event of a disaster
         1. Response in the event of an earthquake
         2. Guiding tsunami evacuations
   b. Response to natural disasters and extreme weather events
   c. **Automatic platform gates[24]
   d. Promoting measures to prevent train collision and derailment accidents
   e. Upgrading systems and structures to ensure safety
2. **Improve:** Service quality reforms
   a. Improve transportation quality
      i. Prevent disruptions to service
      ii. Quickly resume operations and stop the impact of service disruptions from spreading further
      iii. Providing passengers with more information
   b. Pursuing customer-friendly railway services
      i. Enhancing service management by each line-side area
      ii. Building a reliable and comfortable railway
      iii. **Enhancing convenience when purchasing products using ICT
   c. Improving the quality of the Tokyo metropolitan area railway network
      i. Improving transportation services on each line
      ii. Establishing new stations from a strategic perspective

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[24] The Tokyo Metro began installing barriers in 1991 with the opening of the Namboku Line. In August 2012 the Japanese government announced plans to install barriers at stations used by 100,000 or more people per day. At that time only 34 of 235 stations with over 100,000 users per day had implemented platform gates. Nationally, MLIT stated that as of 2012 539 of approximately 9,500 train stations across Japan have barriers.

    d. Expanding the intercity transportation network – growing Shinkansen, expanding tourism, and discovering new travel routes
        i. **Launch of Hokuriku Shinkansen and Hokkaidō Shinkansen operations
        ii. **Operating Tōhoku Shinkansen at faster speeds
    e. Enhancing the convenience of Suica[25] as social infrastructure
        i. Enhancing Suica's convenience as an IC railway ticket
        ii. **Driving further growth in the electronic money business
        iii. **New business initiatives
    f. Enhancing services for seniors
        i. **Expanding *Otona no Kyujitsu* [Adult Vacation] Club[26]
        ii. Developing a diverse array of services

3. **Together:** Strengthening collaboration with local communities
    a. **Restoration of segments along the Pacific coast damaged by the tsunami caused by the Great East Japan Earthquake
        i. **Addressing closed segments including the restricted area around the nuclear power station
        ii. **Restoration of Kesunnuma, Ofunato, and Yamada conventional lines
    b. Promoting Japan as a tourism-oriented nation
        i. Collaboration with local communities
        ii. **Support for the recovery of the *Tōhoku* region through tourism
        iii. **Introduction of high-grade trains
        iv. Promoting an inbound tourism strategy
    c. Driving further growth in the lifestyle business
        i. **Large-scale development of terminal railway stations
        ii. Developing a line-side area brand that is chosen by customers
        iii. Revitalize core regional cities
    d. Measures to fulfill our role as provider of regional transportation
        i. Developing trains that people seek to board for the "ride" itself
        ii. Increasing operating efficiency on regional routes
    e. Revitalizing local industries
    f. **Contributing to communities and society as a whole through medical services*[27]*

4. **Pioneer:** Technological innovation
    a. Establishing energy and environmental strategies
        i. Promoting energy creation
        ii. Promoting energy conservation
        iii. **Introducing smart grid technology to train power systems
        iv. **Meet environmental targets for FY2021

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[25] Suica was introduced on November 11, 2001.
[26] The *Otona no Kyujitsu* Club was launched in June 2006.
[27] JR Tokyo General Hospital and JR Sendai Hospital are operated by JR East.

1. **Reduce energy usage by railway operations by 8%
2. **Improve the $CO_2$ emissions coefficient of JR East's own power plants by 30% compared to FY1991
   b. Utilizing ICT
      i. Improving customer service quality
      ii. Transforming transportation systems
      iii. Innovation in frontline operations
   c. Operating Shinkansen at faster speeds
   d. Promoting an intellectual property strategy
5. **Grow:** Tackling new business areas
   a. **Participating in overseas railway projects
      i. **Develop an overseas railway consulting business around Japan International Consultants (JIC)
      ii. **Participate in overseas projects in the operations & maintenance fields
      iii. **Developing overseas sites
   b. **Expand railcar manufacturing operations
      i. **Enhancement measures aimed at establishing a fourth business pillar
      ii. **Promoting overseas business expansion
   c. **Fully leveraging external technologies and services
      i. **Actively introducing overseas technology
      ii. **Expanding procurement from overseas
   d. New business initiatives
      i. New business initiatives in the lifestyle business
      ii. Promotion of mergers and acquisitions (M&As)
6. **Empower:** Developing employees and creating a corporate culture that maximizes human potential
   a. Expanding opportunities for employees to succeed and tackle challenges
      i. Expanding opportunities to fulfill employees' aspirations
      ii. Promote diversity
      iii. Passing on skills and technology-related capabilities of veteran employees, while nurturing leaders of technological innovation
      iv. **Nurturing global human resources
   b. Corporate culture reforms – reforming work style and raising the efficiency of organizational management
      i. Promoting cohesive group management
      ii. Speedy corporate management
      iii. Innovation in work styles at the Head Office, etc.
   c. Establishing a lean, muscular, and agile management structure
      i. Cash flow policies that help to improve corporate value
      ii. Strategic downsizing

It is important to note that this Management Vision was presented to the JR East Group board on October 30, 2012. Therefore, this document was completed *after* the completion of the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori. While many of the priorities in this document, such as enhanced service quality and collaborating with local communities, were likely to have been goals during the mid-1990ss when the Tōhoku extension was being considered, others such as international expansion may not have been a focus. In particular, this document was completed after the Tōhoku earthquake and tsunami that decimated the region in March 2011. Therefore, a greater urgency and focus on resiliency to earthquakes and natural disaster mitigation may be reflected in this document than was as much of a concern of the management group at the time of the Tōhoku Shinkansen extension.

# APPENDIX C. STAKEHOLDER TYPOLOGY ASSIGNMENTS FOR TŌHOKU

**Table 22.** Assignment of stakeholder attributes and typologies for the Tōhoku Shinkansen extension.

| Stakeholder | Power | Legitimacy | Urgency | Type (P L U) |
|---|---|---|---|---|
| National Diet | √<br>The National Diet has authority over all lawmaking and the budget for all national programs | √<br>Elected by the people, with powers and responsibilities outlined in the national constitution. | X<br>HSR is only one of many concerns and not necessarily the most pressing. | Dominant<br>(P L 0) |
| Aomori Prefecture (and Municipalities) | √<br>The Tōhoku extension from Hachinohe to Shin-Aomori lies exclusively within the jurisdiction of the Aomori Prefectural government, who is also responsible for some of the construction funds. | √<br>The Nationwide Shinkansen Railway Development Act calls for this extension of the system and outlines the involvement of the Aomori prefectural and municipal governments. | √<br>The Tōhoku extension would substantially change the accessibility profile of the prefecture by connecting its two largest cities and freeing up capacity on non-JR East conventional line for regional travel. | Definitive<br>(P L U) |
| Iwate Prefecture | X<br>The Tōhoku extension does not lie within the jurisdiction of the Iwate Prefectural government, therefore the Prefecture has little political or financial power over the project. | √<br>Existing service on the Tōhoku extension runs through Iwate Prefecture and therefore the government has a legitimate stake in how an extension might affect service down the line in their region. | X<br>Since Shinkansen service has a reputation of reliability and safety, Iwate Prefecture is not likely concerned about service disruption caused by construction further down the line. | Discretionary<br>(0 L 0) |
| Hokkaidō Prefecture | X<br>The Tōhoku extension does not lie within the jurisdiction of the Hokkaidō Prefectural government. | √<br>The Tōhoku extension to Shin-Aomori sets the stage for further HSR connectivity to Hokkaidō as in the Nationwide Shinkansen Railway Development Act. | √<br>Extension will connect them to the entire mainland with faster, more reliable service and provide additional mode choice to air; the sooner Hokkaidō receives this connectivity the sooner they get the accompanying economic growth and improved quality of life. | Dependent<br>(0 L U) |

| Stakeholder | Power | Legitimacy | Urgency | Type (P L U) |
|---|---|---|---|---|
| Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) | √ MLIT oversees and authorizes JRTT construction of the Shinkansen lines as outlined in National Shinkansen Railway Development Act. | √ MLIT is a national ministry given authority to supervise domestic HSR development through legislation. | X The Tōhoku extension is only one of many transportation, land-use, and other infrastructure concerns within the ministry. | Dominant (P L 0) |
| Ministry of Economy, Trade, and Industry (METI) | X While METI influence the energy use and technological specifications of the HSR development, it does not have decision-making power. | √ METI is a national ministry given authority over industrial standards and energy generation/transmission. | X Tōhoku is very small part of GDP; economic impacts of region are small.[28] | Discretionary (0 L 0) |
| Ministry of Health, Labour, and Welfare (MHLW) | X Only tangential power over some of the cost of the project through labour and employment regulation, but less involved in the decision of whether or not to pursue construction. | √ MHLW is a national ministry given authority over labor and employment in the transportation and construction sectors. | X While HSR development will involve labor negotiations for transportation and construction workers, job growth will likely be seen as positive. Therefore Tōhoku extension is likely not a contentious or large issue compared to others being handled by the ministry. | Discretionary (0 L 0) |
| Ministry of Education, Culture, Sports, Science, and Technology (MEXT) | X Other than R&D, MEXT has little authority over any aspect of HSR implementation. | X While MEXT provides funding and encourages research into natural disaster mitigation and other sustainability technologies that are related to rail, JR East has its own R&D Center that is more directly involved in these issues for HSR. | X HSR is well-proven technology and the Tōhoku extension does not present an important educational or research opportunity. Natural disaster mitigation, particularly resiliency to earthquakes, is an area of MEXT interest that could overlap with HSR development. | Nonstakeholder (0 0 0) |

[28] More recently (not at the time when the Tōhoku Shinkansen extension from Hachinohe to Shin-Aomori was being considered), METI is more interested in exporting and expanding Japanese HSR technology internationally, rather than on domestic extensions.

| Stakeholder | Power | Legitimacy | Urgency | Type (P L U) |
|---|---|---|---|---|
| Ministry of Finance | √ The Ministry of Finance authorizes any funds used for national programs, including any subsidies that pass through MLIT to JRTT; it is often considered the most powerful government ministry in Japan. | √ The Ministry of Finance has its authority over issues of government spending from legislation. | X While the Ministry of Finance will be concerned with money how public funds are spent, the Tōhoku Shinkansen has been planned 1970 and this extension is minor compared to some other government expenditures. | Dominant (P L 0) |
| Ministry of Internal Affairs & Communication (MIAC) | X There was little need for MIAC's functionalities, such as government-to-public outreach or coalition building with local governments (given generally favorable view in Aomori Pref.) | X Although a cabinet-level national ministry, high-speed rail development is not directly related to any of its legislated functions. | X Unless there is significant local government opposition to high-speed rail development, HSR is unlikely to require significant attention from MIAC | Nonstakeholder (0 0 0) |
| Bank of Japan | √ The Bank of Japan controls interest rates and the printing of domestic currency. Therefore, they have tangential power over construction costs during the project timeline. | √ The Bank of Japan is established and given its powers by national law. | X Consideration of the Tōhoku extension is not of primary interest among the Bank's functions. | Dominant (P L 0) |
| JRTT | √ JRTT will own the infrastructure and controls the funds and administration needed for construction. | √ JRTT is an independent administrative institution created by a legislative act of the National Diet and given responsibility over railway construction. | √ Railroad construction is one of the main interests/functions of JRTT according to their mandate. | Definitive (P L U) |
| JR Freight | X JR Freight does not own track infrastructure in the Tōhoku Shinkansen area and has little power compared with passenger railroads in the country. | √ Have shared corridor contracts with JR East, who owns track along the Tōhoku Main Line. | X Construction of a parallel Shinkansen line would have little impact on freight service; however, were "mini-Shinkansen" being considered, having shared traffic may constrain capacity. | Discretionary (0 L 0) |

| Stakeholder | Power | Legitimacy | Urgency | Type (P L U) |
|---|---|---|---|---|
| JR Hokkaidō | X<br><br>The Tōhoku extension is outside of the geographic scope of JR Hokkaidō's operations and power. | √<br><br>Extension of Tōhoku Shinkansen seen as step towards connection to Hokkaidō, which is given legitimacy through its place in the National Shinkansen Railway Development Act. | √<br><br>The sooner the Tōhoku Shinkansen extension to Shin-Aomori is completed, the sooner planning and construction can commence to connect Honshu to the northern island and JR Hokkaidō service area. | Dependent<br>(0 L U) |
| JR East | √<br><br>As one of the primary decision-makers in the Tōhoku extension, JR East has significant power to decide whether or not the project is completed as it is the designated Operator for the line. | √<br><br>With privatization of JNR, JR East was given the rights of railroad operation for the greater Tokyo Metropolitan Area and the north of the main island. Therefore, they inherited the Tōhoku plans within the National Shinkansen Railway Development Act. | √<br><br>As the sole intercity operator along the Tōhoku Shinkansen line, HSR development and continued extension is of vital importance. | Definitive<br>(P L U) |
| Regional Rail Operators | X<br><br>Regional rail operators are small compared with JR East and therefore have little decision-making power for construction of a new, dedicated HSR line. | √<br><br>Regional rail is seen as an important public accessibility concern and therefore has a legitimate stake in how HSR development might impact service. | √<br><br>Have important and immediate claim on alignment and connection of HSR to existing commuter routes. | Dependent<br>(0 L U) |
| Airline Industry | X<br><br>Do not have financial or governmental recourse to influence development of HSR. | X<br><br>The airline industry has a history of government subsidy since it can be seen as a public service; however, domestic travel by rail is recognized in Japan as more sustainable. | √<br><br>Intercity HSR development would affect demand and cost of domestic air services in the Tōhoku region, which already has low mode share. This will likely affect both airlines and airports. | Demanding<br>(0 0 U) |
| Intercity Buses | X<br><br>Do not have financial or governmental recourse to influence development of HSR. | X<br><br>Intercity bus operators (other than JR Bus) are often small companies that do not have the public recognition enjoyed by the rail sector. | √<br><br>Development of HSR would increase competition for intercity passengers, possibly reducing bus market share. But HSR could also reduce highway congestion and make bus more appealing for its distinct (young, lower-income, leisure) customer base. | Demanding<br>(0 0 U) |

| Stakeholder | Power | Legitimacy | Urgency | Type (P L U) |
|---|---|---|---|---|
| Labor Unions | √ Have some coercive power over the cost of implementation through strikes and bargaining, but union membership has declined since JNR privatization | X Although they are legally recognized representatives of industry workers, they do not have a binding vote in the development of new infrastructure. | √ Development of HSR would directly affect jobs in transport, construction, materials manufacturing, etc. | Dangerous (P 0 U) |
| Construction Companies & Suppliers | X Provide materials and experience to the project, but reliant on award of contracts by private sector or government. | √ These stakeholders provide a key service that would be involved in HSR construction and implementation through contracts. | √ HSR development would provide a great business opportunity/new market for infrastructure construction, materials, and labor force. | Dependent (0 L U) |
| Power Companies | √ Power companies control the infrastructure necessary for generation and transmission of energy. Therefore they have power over the supply and cost of electricity necessary to run Tōhoku Shinkansen service. | X Power companies will have additional demand on their energy generation and transmission infrastructure. However, as private entities, demand should influence supply through market-forces. | X Because the Tōhoku region is not heavily industrialized and is not, on a whole, densely populated, meeting additional power requirements for Tōhoku Shinkansen extension is not a major concern. | Dominant (P 0 0) |
| Real Estate Developers | X Real estate developers (other than JR East) have little power compared to local governments in influencing where HSR stations may be located; they will influence how the land is developed once service begins. | X Real estate developers have little claim to existing public right-of-way used for the Tōhoku extension. | X While real estate developers may be interested in the increased value of land in areas with new HSR access, these interests are not particularly immediate since many of these economic/development gains will be far in the future. | Nonstakeholder (0 0 0) |
| Private Landowners & Abutters | X Control land possibly needed for right-of-way for new track alignment, but the average individual has little power (even in litigation that causes delays) compared to larger entities. | X Landowners and abutters are such a small group of the general public that often benefits for the many will outweigh the stake of a few in large infrastructure development. | √ HSR development would have immediate importance for any landowner in the direct track path or in radius of a station; daily lives of abutters are affected by noise (and light) pollution from HSR development. | Demanding (0 0 U) |

| Stakeholder | Power | Legitimacy | Urgency | Type (P L U) |
|---|---|---|---|---|
| Intercity Business Travelers | X<br>Key source of HSR demand; yet the average individual public user has little power compared to government or corporate entities. | √<br>Intercity travelers are the economic market for HSR passenger service and are therefore recognized as stakeholders. | √<br>HSR development would expand service and reduce travel time and expand mode choice for regular business intercity travelers. | Dependent<br>(0 L U) |
| Intercity Leisure Travelers | X<br>Another key source of HSR demand; yet the average individual public user has little power compared to government or corporate entities. | √<br>Intercity travelers are the economic market for HSR passenger service and are therefore recognized as stakeholders. | X<br>HSR development would expand service and reduce travel time for leisure intercity travelers, but leisure trips have a different value-of-time and are often not an imperative. | Discretionary<br>(0 L 0) |
| Regional Travelers | X<br>The average individual commuter has little power compared to government or corporate entities. | √<br>HSR can function as a form of transit between urban centers that are reasonably close together; in this way, commuters may begin to use new HSR networks as well as existing commuter lines (which should not be disrupted). | √<br>Intercity HSR is an immediate concern because planning and construction might disrupts existing regional or conventional rail networks and because once operational parallel HSR tracks could reduce congestion on existing rail, reducing regional trip times. | Dependent<br>(0 L U) |
| Freight Users (Shipper/ Receiver) | X<br>The average individual freight user has little power compared to government or corporate entities. | X<br>Freight users hold legal contracts with JR Freight that use existing Tōhoku Main Line rail, but have no legitimate stake in passenger rail development. | X<br>The development of high-speed passenger rail only has an oblique effect on freight. | Nonstakeholder<br>(0 0 0) |

# APPENDIX D. Q&A ON TŌHOKU SHINKANSEN EXTENSION

The following section includes the transcript of an email exchange with Mr. Satoshi Kuji of East Japan Railway Company completed on April 27, 2016. The author prepared a series of questions regarding institutional and stakeholder relationships surrounding the Tōhoku Shinkansen extension project from Hachinohe to Shin-Aomori and received answers back, which have been edited for improve readability. The author expresses her sincerest gratitude to Mr. Kuji for his thoughtful and detailed response.

Along with the author's review of relevant Japanese and English language news articles throughout the planning, construction, and initial operation of project, this interview material provides the historical account of what actually transpired in terms of stakeholder coalitions. We compare this account to the results of PCBA for the case study in Section 5.5 to validate the predictive nature of the methodology.

**Q1. Were the stakeholder relationships generally cooperative or combative when it came to specific design and implementation alternatives for the project? We might expect that these relationships between stakeholders changed from the design phase through construction and into operation. Could you briefly explain any such changes, particularly any relationships that might have switched from being cooperative to combative, or vice versa.**

It is difficult for me to define the relationships among the stakeholders for each phase of the project, so I have summarized the main point of view for each stakeholder through planning, construction, and operation in Table 23. In the table below, a "+" indicates a positive or supportive interest, "-" indicates an oppositional interest, and a blank indicates no relationship. For those interests that were particularly, strong a double symbol is used; for example, "++" indicates a strong positive interest.

**Table 23.** Point of view of each major stakeholder through the planning, construction, and operation phases of the Tōhoku Shinkansen extension project.

| Stakeholder | Phase of the Tōhoku Shinkansen Extension Project | | |
| --- | --- | --- | --- |
| | **Planning** | **Construction** | **Operation** |
| National Government | ++ Planning | + Approval<br>- Financial burden | + Regulatory agencies |
| JRTT | + Investigation | ++ Orders construction | + Infrastructure holders<br>+ Lease revenue from JR |
| Local and Municipal Government | + Inclusion in HSR route<br>- Environment issues | + Expansion of production in the construction<br>+ Community revitalization<br>- Noise and Vibration<br>- Financial burden | + Increase population or offices<br>+ Expand tax revenue<br>+ Tourists increase<br>- - Management the convention line |

215

| Operator (JR East) | | - Inspection and Field Test of new line | ++ Operator<br>+ Increase ridership<br>+ Lease fee is limited within the range of beneficiaries |
|---|---|---|---|
| Land Development | | ++ Contractor | |
| Power Companies | | | + Increase volume of electricity sales |
| Labor Union | | | - Relocation of employees<br>+ Transferred to local public enterprise |
| Intercity Passengers | | | + Expanding commuting area |
| Regional Travelers | | | + Expanding the tourist area |
| Freight Users | | - Suspended service due to construction | - Increase of the line usage fee |

**Q2. Were there any specific challenges or disagreements regarding design alternatives, implementation schemes, or system objectives? Which stakeholders worked well together toward common goals? And between which stakeholders was there general friction?**

There were two route alternatives from Morioka to Shin-Aomori: the East corridor via Hachinohe city and the Western corridor via Hirosaki city. When the route was determined and the extension was planned through Hachinohe, it sparked a fierce battle between the two local/municipal governments. Therefore, Aomori Prefecture had to mediate the controversy among the local governments.

In addition, the original proposal by the Ministry of Land, Infrastructure, Transport, and Tourism called for a "mini-Shinkansen" system (shared operation between Shinkansen and convention line, the same as Akita or Yamagata Shinkansen) for the Tōhoku Shinkansen between Hachinohe and Shin Aomori in order to reduce the construction cost. However, there was fierce opposition to the shared operation proposal and in 1994, the "mini-Shinkansen" proposal was withdrawn and a new proposal for dedicated right-of-way HSR was developed by the "ruling coalition and affiliated minister."

**Q3. Were there any stakeholders that took on an unexpected role or exerted influence in an unexpected way?**

The basic plan for the Tōhoku Shinkansen extension was decided in 1973, but was postponed by the government for a while in 1982 due to financial difficulties of JNR, the deterioration of public finances, the Oil Shock, and other unexpected events. The former Shinkansen and rail network that was built by JNR was burdened by a constrained national budget.

But Shinkansen projects, including the Tōhoku line, were revitalized for public construction after 1996 when the Nationwide Shinkansen Railway Development Act was revised. For new Shinkansen projects, the construction costs are to be paid by the national and prefectural government (2/3 national and 1/3 local). The JR company must then pay the rental fee to the

216

government (through JRTT); so the organization structure is vertically separated only on new Shinkansen track built after 1996.

Two municipal governments, Shichinohe town and Towada city, that are adjacent to a new HSR station along the alignment wanted to have a say in the name of the nearby station for purposes of attracting tourist. They exerted their influence on JR East to adopt their unique station name, which they did.

The conventional rail lines that run parallel with the Tōhoku Shinkansen between Hachinohe and Shin-Aomori were separated from JR East at the time of Shinkansen opening. Ownership of the parallel convention line infrastructure was transferred to Aomori Prefecture, who are also responsible for managing train operation on the new "Aoimori Railway." However, with shrinking rural populations in the area, local train ridership is low and their business conditions are difficult (perhaps one reason to have the local conventional rail run as a public service rather than by a private operating company).

**Q4. Did Aomori Prefecture comment on the construction proceedings? Was there any commentary at the municipal level?**

There was no opposition about the environmental assessment from Aomori Prefecture. In fact, on behalf of the interests of its citizens, Aomori Prefecture asked the Ministry of Land, Infrastructure, Transportation, and Tourism (MLIT) to advance the project as soon as possible to construction and implementation.

In early planning and development, there was a conflict of opinion between Japan National Railways (JNR) and municipal officials regarding the position of the station in Shin-Aomori city. Aomori Prefecture had to mediate and coordinate the opinions.

**a. Was there friction between the prefectural and local/municipal governments when it came to the funding of the project?**

As set out by the Nationwide Shinkansen Railway Development Act, funding for new HSR infrastructure is "2/3: national government, 1/3: prefecture." Aomori Prefecture did not ask the local or municipal governments to contribute to the project so there was no friction there.

**b. Was there prefectural or municipal disfavor with the project expressed at any point during the construction proceedings?**

Both Aomori Prefecture and municipal governments expressed disfavor after a series of construction accident on the line. The Sambongihara Tunnel excavation, part of the extension project of the Tōhoku Shinkansen Line between Hachinohe and Shin-Aomori, was started in August 2001, but two significant collapses occurred in March and September of 2002. These

accidents caused grave concern and outcry over safety conditions and caused project delays.[29]

**Q5. Were there any major construction delays? If so, how were these viewed by different stakeholders on the project?**

The basic plan for the Tōhoku Shinkansen extension was decided in 1973, but was postponed by the government for a while in 1982 due to financial difficulties of JNR, the deterioration of public finances, the Oil Shock, and other unexpected events. This delay was preferred by the funding sector, such as the Ministry of Finance and local government, but was undesirable for local residents and businesses who would benefit from improved mobility and better connectivity to the Tokyo metropolitan area with the opening of the Shinkansen.

**Q6. Did business owners in Aomori voice any concerns or expectations associated with the opening of the line? Was there any business development that took place in Aomori or Hachinohe in advance of the start of service on the extension (for example, development stimulated by the expectation of HSR service)?**

The original schedule for the project was advanced 2 years due to the strong demands of the local community, making the opening date of the line 2012. In terms of real estate development, Aomori Prefecture constructed the station plaza, roads, and other amenities near the station. Some private sector companies also built commercial facilities or businesses offices near the station.

**Q7. Was there anything unique when it came to stakeholder relationships surrounding this extension project compared to other Shinkansen projects on the JR East system?**

On the Tōhoku Line, there are two types of organization structure for the Shinkansen. South from Morioka (to Tokyo) is vertically integrated, with JR East owning the infrastructure and operating service; however, North of Morioka (including from Hachinohe to Shin-Aomori), the system is vertically separated. JRTT constructed and owns the infrastructure and JR East must pay a lease fee to operate its service. The upper limit of the lease fee is determined by considering the benefits (and expected operating revenue) of the Shinkansen upon the start of revenue service.

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[29] For more information on the tunneling technique used and the accidents, I refer the reader to:

Iida, H., Isogai, A., Chishiro, K., Ono, T., Koyama, Y., & Koizumi, A. (2006). Work and design of a new tunneling method 'SENS' to unconsolidated ground. Retrieved from www.issmge.org/images/joomd/tc204/2005_028.pdf

## Q8. What was the timeline of some of these relationships and major project milestones?

**Table 24.** Timeline of major events in the history of the Tōhoku Shinkansen.

| Date | Event |
|---|---|
| May 18, 1970 | Promulgation "Nationwide Shinkansen Railway Development Law" |
| Jan. 18, 1971 | Basic plan of Tōhoku Shinkansen Omiya to Morioka has been determined |
| Nov. 28, 1971 | Construction of Tōhoku Shinkansen Omiya to Morioka has been started |
| June 29, 1972 | Basic plan of Tōhoku Shinkansen Morioka to Shin-Aomori has been determined |
| Nov. 13, 1973 | Project plan of Tōhoku Shinkansen Morioka to Shin-Aomori has been determined |
| May, 1974 | Japan National Railways presented 3 proposals for Shin-Aomori Station position |
| Jan. 31, 1980 | Shin-Aomori Station position has been determined by JNR, Aomori mayor, Aomori Prefecture Governor |
| June 12, 1981 | Nationwide Shinkansen Railway Development Law is amended (It has become possible to determine the burden to local governments) |
| March 30, 1982 | Tōhoku Shinkansen route between Morioka and Aomori is determined |
| June 23, 1982 | Tōhoku Shinkansen between Omiya and Morioka was opened |
| Sept. 24, 1982 | It was determined by the Cabinet that the "Shinkansen plan is postponed for a while." |
| Jan. 30, 1987 | Cabinet decide to cancel the construction freeze (September 1987) |
| April 1, 1987 | Japan National Railway division privatization |
| Aug 31, 1988 | Government determines the start of construction priorities of the new Shinkansen lines in the following order:<br>1. Hokuriku Shinkansen (Takasaki to Nagano, Kanazawa to Takaoka),<br>2. Tōhoku Shinkansen (Morioka to Shin-**Aomori**),<br>3. Kyusyu Shinkansen (Yatsushiro to Nishi-Kagoshima),<br>4. Hokuriku Shinkansen (Uozu to Itoigawa),<br>* Priority is reviewed in 5 years in consideration of changes in economic and social conditions |
| Jan 17, 1989 | The government decides a burden ratio of Shinkansen construction<br>JR 50%, National Government 35%, and Local Government (Prefecture) 15% |
| | It was decided to start difficult construction<br>1. Hokuriku (Kagoshi-Tunnel),<br>2. Tōhoku (Iwate-Tunnel),<br>3. Kyusyu (Daisan Shioyama-Tunnel) |
| Dec. 24, 1990 | The government has decided to start construction work in 1991 (provisional development plan: Piecewise International Quality HSR) |
| | (Ministry of Finance is unofficial announcement the budget 4.5 billion yen for Tōhoku Shinkansen between Morioka and **Aomori**) |
| Sept. 4, 1991 | Construction of Tōhoku Shinkansen Morioka to **Aomori** has been started |
| Dec. 19, 1994 | Agreement with Ruling coalition and Ministers (Cancel the Piecewise International Quality HSR plan (mini-Shinkansen system), The construction of Hachonohe-St. and Hakkoda-Tunnel started) |
| April 21, 1995 | Withdraw the construction instruction by the mini Shinkansen system **between Hachinohe and Aomori** |
| Dec. 25, 1996 | Government and the ruling party had decided to build Tōhoku Shinkansen **between Hachinohe and Shin Aomori** in international Quality HSR spec. |
| Jan. 21, 1998 | The government and the ruling party Shinkansen Review Committee decided to build Tōhoku Shinkansen **between Hachinohe-Shin-Aomori** in top priority |

| | |
|---|---|
| March 27, 1998 | Begin construction of Tōhoku Shinkansen **between Hachinohe and Shin Aomori** |
| Dec. 18, 2000 | The government and the ruling party Shinkansen Review Committee decided to opened Tōhoku Shinkansen **between Hachinohe-Shin-Aomori** by 2014 |
| Dec. 1, 2002 | Tōhoku Shinkansen between Morioka and Hachinohe was opened |
| Dec. 16, 2004 | Government and the ruling party decided to open the Tōhoku Shinkansen extension between **Hachinohe-Shin Aomori** by the end of 2010 (2 years ahead of schedule) |
| Nov. 10, 2008 | JR East has announced the opening date of the Tōhoku Shinkansen between **Hachinohe-Shin-Aomori** will be December 2012. |
| Dec. 4, 2012 | Tōhoku Shinkansen between **Hachinohe and Shin Aomori** was opened |