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Evaluating Variances Between Departments of Transportation in New England to Create a Strategic Transportation Workforce

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EVALUATING VARIANCES BETWEEN DEPARTMENTS OF TRANSPORTATION IN NEW ENGLAND TO CREATE A STRATEGIC TRANSPORTATION WORK-FORCE

A Thesis Presented

by

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ABSTRACT

EVALUATING VARIANCES BETWEEN DEPARTMENTS OF TRANSPORTATION IN NEW ENGLAND TO CREATE A STRATEGIC TRANSPORTATION WORK-FORCE

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As the baby boomer generation approaches retirement, the transportation workforce is increasingly under strain. Employees are exiting the industry in larger volumes than incoming hires; which is creating a need to reevaluate and revamp work processes. In addition, the industry is transitioning into the 21st century and that is requiring the adaptation of new technologies. The gap between old and new employee skills is growing and seen throughout the industry. There is a growing need and opportunity to develop a new set of job competencies which create job specifications and job postings, which support the organization's strategic plan. In this thesis existing DOT job specifications and job postings for Civil Engineers were gathered and reviewed. Current industry standard competencies from the Bureau of Labor Statistics (BLS) were also gathered and used to summarize existing specifications. Results evaluated how Departments of Transportation in New England compare to their counterparts.

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CHAPTER 1

INTRODUCTION

As the baby boomer generation approaches retirement, the transportation workforce is increasingly under strain. Employees are exiting the industry in larger volumes than incoming hires; which is creating a need to reevaluate and revamp work processes. In addition, the industry is transitioning into the 21st century and that is requiring the adaptation of new technologies. The gap between old and new employee skills is growing and seen throughout the industry. There is a growing need and opportunity to develop a new set of job competencies the create job specifications and job postings, which support the organization's strategic plan. Several steps have been identified to build a dynamic and sustainable transportation workforce.

- There is a need to develop strategic job specifications and job postings as new technologies or new positions in the agency are implemented.
- The identification and development of core competencies within a DOT is key. Once identified, a "learning" culture can be created where employees understand how the development of competencies can impact agency strategic goals and employee career paths.
- It is important to identify similarities and differences in Civil Engineer levels to better understand the levels at each of the DOTs.

By taking these necessary foundational comparative steps, the DOTs in New England can create a more dynamic and sustainable transportation workforce that will excel throughout the 21st century.

CHAPTER 2
LITERATURE REVIEW

The literature reviewed gives an understanding of the published work available in several workforce areas. Provided is a background for understanding how the research assumptions used in this thesis formed. Topics in the literature review are as follows:

- Competency Modeling
- Competency Models in the Transportation Industry
- A Changing Industry: New Technologies and Job Expansion
- Succession Planning and the Need for HRM Strategy

2.1 Competency Modeling

Competencies may be better presented in a competency model. Understanding what a competency is critical for understanding what makes a competency model. Each competency should have two elements. First, is the most general name (e.g. ‘Teamwork’, ‘Leadership’, ‘Design’, ‘Manufacturing’). Second, is its definition, which can be explained in one of two ways:

- A developed statement or
- A bulleted break down of the key concepts

A competency can also take two forms; core competencies and technical competencies. Core competencies are most always established prior to technical competencies. These are broader in the sense that, when developed for a specific job or organization, they are typically agency-wide. When developing core competencies, certain guidelines should be followed with corporate leaders and strategic plans in mind. Often approximately five to ten core competencies that are consistent with all employees in an agency and align with the goals, vision, and both long and short term plans of the company are appropriate

(Sekowski, n.d.). Next technical competencies are developed. Not all competency models have technical competencies; however, if the model is being made for a particular job specification, technical competencies are imperative to the model's effectiveness. When developing technical competencies, it is important to work directly with incumbents and supervisors of the individual job specification being defined who are the most knowledgeable about the job's requirements. Competencies should be developed from the positions major duties and responsibilities and can be broken down into needed levels of mastery for even greater effectiveness (Sekowski, n.d.).

A competency model is a collection of the competencies defined above, which conjointly define successful production in a work setting. The work setting described by the developed model can be very broad or specific to a job specification at an agency. Generally, competency models are developed for work settings such as specific jobs, job groups, organizations, occupations, or industries (CareerOneStop, 2015). Not all competency models are created in the same exact way as they can be targeted to different work settings. Competency modeling in no matter what form is designed to align strategic corporate goals and objectives with the knowledge and skills of employees and future employees. In time, as a company or industry grows and its strategic goals, objectives and job specifications change, so should its competency model.

2.2 Competency Models in the Transportation Industry

The Transportation Curriculum Coordination Council (TC3) has made strides in developing a guide entitled, 'Building Blocks for A Stronger Workforce'. One of TC3's building blocks is a 'Core Curriculum' developed to guide transportation agencies in their training and development of Technicians in their industry. The Core Curriculum Matrix is

divided into six technical categories (Construction, Employee Development, Maintenance, Materials, Pavement Preservation and Traffic and Safety). Within each of these six categories can be found defined subject areas respectively followed by the disciplines. Each matrix encompasses competencies sorted into four skill levels, which TC3 has defined as follows:

Level I - Entry

Is a new employee/trainee with little to no previous experience in the subject area and performs his or her activities under direct supervision

Level II - Intermediate

Understands and demonstrates skills (is competent) in one or more areas of the entry level and performs specific tasks under general supervision.

Level III - Advanced

Understands and demonstrates specialized skills in a variety of tasks of the intermediate level and performs specialized tasks in limited areas or broad-based tasks with little to no daily supervision.

Level IV - Project Management (Administrator, Superintendent)

Prepares and reviews plans and schedules for specific activities; oversees or manages day-to-day activities in one or more specific tasks on one or more projects covering a range of complexity and technical functions as well as geographic areas. Individuals

at this level are accountable for resource management and are responsible for making routine and complex decisions. It is recommended that this role of personnel have mastery of skills defined for all of the preceding levels (AASHTO, n.d.).

As stated previously, competency models can be developed in different ways and in the TC3 case, each model is for a single occupation - in this case technicians within the transportation industry, but not for a particular agency. When a transportation agency chooses to use this model as guidance in developing their own competency models they should be sure to incorporate their own strategic goals and objectives, making the competency model specific to that agency.

Others in the industry have applied different competency modeling practices. These models are all particular to the area or agency's employees, skills, knowledge, etc by incorporating their own agency strategic goals, and objectives. Below are other examples in transportation literature where competency modeling has been applied:

Using Competency Models to Guide Rail Transportation System Workforce Development by the Department of Engineering Professional Development College of Engineering, University of Wisconsin (Vieth, et al.)

Identification of a Leadership Competency Model for use in the Development, Recruitment & Retention of Intermodal Transportation Workers by the National Center for Intermodal Transportation, University of Denver (Sherry & Durr, 2010)

2.3 A Changing Industry: New Technologies and Job Expansion

The most modern changes being made to the industry are in relation to new and growing technologies in which are impacting current jobs, creating a need for new ones,

and a need to modify workforce development as a whole. New technologies impact an agency's strategic goals and objectives and consequently changes job specifications and the competencies necessary to be possessed by those already employed by the agency. When new jobs are created, the tasks done originally by another employee may now be a responsibility of new hires. A changing industry results in the need to create new jobs with respective job specifications as well as the modification of existing job specifications.

In 1996, the Denver Regional Transportation District (RTD) introduced some new technologies to their agency. Computer Aided Dispatch (CAD)/Automatic Vehicle Location (AVL) upgraded the communication abilities of the agency in whole improving the bus safety and gain an ability to monitor the adherence to bus schedules (Stearns, 2000).

Aside from the agency's gain in transit efficiency, another favorable outcome is the job expansion as a result of these introduced technologies. CAD/AVL technologies created a need for additional dispatchers and new duties for the existing dispatchers. Much like the Denver Regional Transportation District, other agencies as well as industries have and will experience such job changes with the introduction of new technologies by the industry. An organized and strategic transportation workforce practice would ease the implementation of new technologies as they come along smoothening the transition to job expansion (Stearns, 2000).

Within the industry, others have studied new technologies and their relation to job expansion. Some of the studies are particular to certain technologies and others are very broad to the introduction of technologies in such high volumes during the 21st century. Below are these research studies:

Building Professional Capacity in ITS, An Assessment of ITS Training and Education Needs: The Transit Perspective by the Federal Transit Administration (Volpe National Transportation Systems Center, 1999)

High Efficiency Trucks: New Revenues, New Jobs, and Improved Fuel Economy in the Medium and Heavy Truck Fleet by University of Michigan Transportation Research Institute (Belzowski, McManus, & Woodrooffe, 2010)

2.4 Succession Planning and the Need for HRM Strategy

Transportation workforce issues were explored at the 21st Century Workforce Development Summit. According to research conducted by Ernie Wittwer, Teresa Adams, and Edwin Toledo-Duran, all areas of the transportation industry will have to work as one to create an effective training and development while attracting new students to the career path. Further suggested research pertains to many of the above concepts. Change to leadership is deemed important that builds a strategic decision process inclusive of all the industries stakeholders and effectively communicating the mission, vision, and goals of an agency (Wittwer, Adams, & Toledo-Duran, 2009).

Anthony R. Wheeler's report for the University of Rhode Island Transportation Center, explored state departments of transportation and how they practice human resource management through succession planning. The study was performed through an interview process applied to those agencies who chose to participate.

Identified were a series of impediments to succession planning in government agencies based upon the conducted literature review. The potential impediments to succession planning are as follows:

- Lack of HRM expertise and knowledge about succession planning

- Lack of integration with HRM functions
- A negative view of the HRM function within an organization
- Size of the workforce (larger workforces increase the difficulty of succession planning)
- Lack of resources (manpower, time, funds for training opportunities, poor Information Technology to create knowledgeable libraries and human capital databases)
- Poor management-union relationships
- Political influence from executives, legislatures, and appointed officials (includes transitions of government after elections) (Wheeler, 2012)

Although succession planning has some limiting factors, this does not decrease its importance. Succession planning for these state agencies is strategic effort to secure the success of an agency throughout time by ensuring the quality and quantity of its employees through systematic evaluation. Succession planning has the following qualities:

- Focus on developing knowledge, skills, and abilities of employees and developing human capital of an agency
- Sets broad career paths
- Identifies competency gaps and plans to close those gaps
- Broad succession plans don't address each individual employee (Wheeler, 2012)

The Principal investigator offers a series of recommendations based upon the evidence. One of these recommendations lies in the backbone of succession planning and therefore is one of the utmost importance. The recommendation to update job descriptions through proper job analysis methods has a couple of purposes. For one, and most explicitly,

job descriptions should be updated in time. As the industry changes, as an agency changes, and as jobs change, updates are necessary. The study states that those participating DOTs that did not have functioning succession planning found their job descriptions were not up to date (Wheeler, 2012). Keeping job descriptions up to date would ease the implementation of succession planning.

Others have evaluated or practiced workforce development or succession planning methods in the industry or with a particular agency in the recent years. The expectation of a large employment turnover has prompted many of these studies. Below are some examples in the transportation literature of such studies:

Selection of the Next Generation of Air Traffic Control Specialists: Aptitude Requirements for the Air Traffic Control Tower Cap in 2018 by Dana Broach, Civil Aerospace Medical Institute - Federal Aviation Administration (Broach, 2013)

Development of a Selection Tool for use in the Identification, Recruitment, & Retention of Safe Intermodal Transportation Workers by Michael R. Durr & Patrick Sherry, National Center for Intermodal Transportation (Durr & Sherry, 2012)

Best Practices in Guidance for Workforce Transition and Succession Planning by Teresa Adams and Ernie Wittwer, University of Wisconsin, Madison (Adams & Wittwer, 2011)

Estimating Workforce Development Needs for High-Speed Rail in California by the Mineta Transportation Institute (Haas, Hernandez, & Katherine, 2012)

Serving Future Transportation Needs: Succession Planning for a State Department of Transportation Organization, Its People and Mission by Robert A Perkins, Department of Civil and Environmental Engineering - Institute of Northern Engineering, University of Alaska Fairbanks (Perkins, 2011)

Identification of Barriers to the Recruitment and Retention of Women Intermodal Transportation Workers by the National Center for Intermodal Transportation - University of Denver (Pinarowicz, et al., 2011)

Engaging, Recognizing, and Developing the MTA Workforce by the Metropolitan Transportation Authority, Blue Ribbon Panel on Workforce Development (Ravitch, et al., 2007)

Aviation Workforce Development Practices by the Transportation Research Board (Young, 2010)

CHAPTER 3

METHODOLOGY

Chapter 3, about the methodology, comprises three sections including the problem statement, research objectives, and research tasks. This chapter summarizes why and how the stated research will be performed.

3.1 Problem Statement

Organizational changes to the existing transportation workforce are imperative to the industry's success entering the contemporary age of technologies. Such organizational changes should bring consistency to strategic plans, job specifications and job postings within each DOT.

3.2 Research Objectives

In completing this study, the objective is to ease the implementation of new technologies which yield new and change existing job specifications. Additionally, a competency model will be developed to bring consistency to all the DOTs in New England.

3.3 Research Tasks

3.3.1 Task 1: Literature Review

The literature review will explore a variety of topics:

- Competency modeling
- Competency modeling in the transportation industry
- The industry's technologies effects on job expansion
- Succession planning in the industry

Additionally, each department of transportation's strategic plan in New England will be reviewed to summarize their mission, vision, and goals. These summaries are provided by Appendix A.

3.3.2 Task 2: Compare Job Specifications

Compare all the civil engineer job specifications in New England to see differences and similarities between levels, within DOTs, and between the DOTs

- Define competencies by means of the Bureau of Labor Statistics (BLS) for uniformity by the tasks and skills section of the BLS's page on civil engineers.

- Review the job specifications retrieved from each DOT in New England to develop checklists (by means of the BLS) of the required competencies presented in each job specification using Excel (i.e. MassDOT CE I,II,III, VTrans CE I,II,III,IV,V,VI,VII).

- Populate a matrix for all the civil engineer job specifications that compares the competencies presented in each checklist. The matrix quantifies the number of competencies presented by both, neither, and either (in three columns) of the two competencies being compared at each instance.

3.3.3 Task 3: Group Job Specifications

Distribute the job specifications into brackets reflecting identical checklists and analyze the job specifications and their competencies to establish an understanding of how they all compare.

- The last column of the matrix (indicating either) quantifies the number of competencies presented by one of the specifications but not the either. When this column presents a zero, the specification was grouped with its relatable specifications.
- Following the grouping of the job specifications by quantity, they were analyzed and grouped by identical comparison.

3.3.4 Task 4: Compare DOT Job Specifications

Further analyze the ways each DOT, each job specification, and each competency compares to others.

- Using the fraction of competencies presented by each job specification, establish ranges for the competency presentation at each DOT.
- Quantify each competency by a fraction of the number of job specifications it is presented in.
- Present tables that represent each competency (or competencies found identical in their job specification presentation) that show exactly which job specifications held that particular competency and which did not.
- Compare the competencies based on frequency scores (how frequent it is presented by the various job specs) and based on weighted scores (how often each competency is presented by upper or lower level civil engineer job specifications).

CHAPTER 4

RESULTS

The analysis produced a 26 by 26 matrix comparing all of the civil engineering job specifications at each DOT in New England across its comparative DOT's job specifications as well as amongst its own levels. Noted below, columns B, N, and E signifying 'both', 'neither', and 'either' represent the number of job specifications out of 17 that were presented by both, neither, or either of the two job specifications the cell corresponds to. The fraction out of 17 in the gray cell signifies the number of competencies out of 17, which will further be called the frequency score, that were presented by an individual job specification. The matrix is broken up by state DOT below for simplification of presentation in **Tables 1 through 6**.

*B = # of competencies presented by **both** job specifications*

*N = # of competencies presented by **neither** job specification*

*E = # of competencies presented by **either** one job specification but not the other*

X/17: # of competencies presented in job specifications out of the 17 from the BLS (defined on sheet "Defined Competencies")

Table 1: Connecticut Department of Transportation Matrix

Connecticut Matrix		CE I			CE II		
		13/17			16/17		
		B	*N*	*E*	*B*	*N*	*E*
CE I	13/17				12	1	3
CE II	16/17	13	1	3			

Table 2: Maine Department of Transportation Matrix

Maine Matrix		CE I			CE II		
		13/17			14/17		
		B	*N*	*E*	*B*	*N*	*E*
CE I	13/17				11	2	4
CE II	14/17	11	2	4			

Table 3: New Hampshire Department of Transportation Matrix

New Hampshire Matrix		CE I			CE II			CE III			CE IV			CE V			CE VI			CE VII		
		15/17			15/17			15/17			13/17			13/17			14/17			13/17		
		B	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*
CE I	15/17				**15**	**2**	**0**	**15**	**2**	**0**	13	2	2	13	2	2	13	1	3	13	2	2
CE II	15/17	**15**	**2**	**0**				**15**	**2**	**0**	13	2	2	13	2	2	13	1	3	13	2	2
CE III	15/17	**15**	**2**	**0**	**15**	**2**	**0**				13	2	2	13	2	2	13	1	3	13	2	2
CE IV	13/17	13	2	2	13	2	2	13	2	2				**13**	**4**	**0**	13	3	1	**13**	**4**	**0**
CE V	13/17	13	2	2	13	2	2	13	2	2	**13**	**4**	**0**				13	3	1	**13**	**4**	**0**
CE VI	14/17	13	1	3	13	1	3	13	1	3	13	3	1	13	3	1				13	3	1
CE VII	13/17	13	2	2	13	2	2	13	2	2	**13**	**4**	**0**	**13**	**4**	**0**	13	3	1			

Table 4: Massachusetts Department of Transportation Matrix

Massachusetts Matrix		CE I			CE II			CE III			CE IV			CE V			CE VI		
		11/17			13/17			13/17			13/17			14/17			14/17		
		B	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*
CE I	11/17				11	4	2	11	4	2	11	4	2	11	3	3	11	3	3
CE II	13/17	11	4	2				**13**	**4**	**0**	**13**	**4**	**0**	13	3	1	13	3	1
CE III	13/17	11	4	2	**13**	**4**	**0**				**13**	**4**	**0**	13	3	1	13	3	1
CE IV	13/17	11	4	2	**13**	**4**	**0**	**13**	**4**	**0**				13	3	1	13	3	1
CE V	14/17	11	3	3	13	3	1	13	3	1	13	3	1				**14**	**3**	**0**
CE VI	14/17	11	3	3	13	3	1	13	3	1	13	3	1	**14**	**3**	**0**			

Table 5: Rhode Island Department of Transportation Matrix

Rhode Island Matrix		CE Associate			CE		
		15/17			15/17		
		B	*N*	*E*	*B*	*N*	*E*
CE Associate	15/17				15	2	0
CE	15/17	15	2	0			

Table 6: Vermont Department of Transportation Matrix

Vermont Matrix		CE I			CE II			CE III			CE IV			CE V			CE VI			CE VII			CEE		
		10/17			11/17			12/17			15/17			16/17			16/17			16/17			16/17		
		B	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*	*B*	*N*	*E*
CE I	10/17				10	6	1	10	5	2	10	2	5	10	1	6	10	1	6	10	1	6	10	1	6
CE II	11/17	10	6	1				11	5	1	11	2	4	11	1	5	11	1	5	11	1	5	11	1	5
CE III	12/17	10	5	2	11	5	1				12	2	3	12	1	4	12	1	4	12	1	4	12	1	4
CE IV	15/17	10	2	5	11	2	4	12	2	3				15	1	1	15	1	1	15	1	1	15	1	1
CE V	16/17	10	1	6	11	1	5	12	1	4	15	1	1				**16**	**1**	**0**	**16**	**1**	**0**	**16**	**1**	**0**
CE VI	16/17	10	1	6	11	1	5	12	1	4	15	1	1	**16**	**1**	**0**				**16**	**1**	**0**	**16**	**1**	**0**
CE VII	16/17	10	1	6	11	1	5	12	1	4	15	1	1	**16**	**1**	**0**	**16**	**1**	**0**				**16**	**1**	**0**
CE VIII	16/17	10	1	6	11	1	5	12	1	4	15	1	1	**16**	**1**	**0**	**16**	**1**	**0**	**16**	**1**	**0**			

Reviewing the matrix, the job specifications were identified with bold font in which were identical in the number of competencies they both did have or both did not have. These identical job specifications were grouped together into various brackets. Some job specifications are in their own brackets and do not identically match any other job specifications while others are in brackets with 2-6 others. Many are identically alike to other level Civil Engineers from its own DOT while very few land in the same bracket as other DOT's. In developing the 14 distinct brackets for civil engineer job specifications at the DOTs in New England, variances between levels and between DOTs were made note of. Next, each DOT was analyzed to establish a range of their job specification's competency presentation based on the frequency scores shown in the matrices, presented in **Table 8**.

Table 7: Range of the fraction of 17 competencies presented at each state DOT

State	% of Specifications Range on All Levels
Connecticut	77 - 94%
Massachusetts	65 - 94%
Maine	77%
New Hampshire	77 - 88%
Rhode Island	88%
Vermont	59 - 94%

Table 7 represents the percent range of all the job specifications at that agency presenting the job specification with the least number of competencies to the job specification with the most number of competencies. After acquiring a general sense of the % of represented competencies at each DOT, the competencies themselves were analyzed.

Table 8 below, indicates the percentage of job specifications that presented each of the 17 competencies. Here, 100% would indicate that every single job specification presented that competency and 0% would indicate that none of the job specifications presented that competency.

Table 8: Percentages of job specifications presenting each of the 17 competencies

100%	Decision making	Math	Organizational
	Speaking	Writing	Analysis
	Problem-solving	Surveying	
89%	Leadership	Regulation knowledge	
81%	Cost estimation	Management	
63%	Design Software	Public presentation	
56%	Soil testing	Material testing	
4%	Permit application		

After establishing an understanding of the range and frequency of these competencies in each job specification there grew a need to understand each competency's presentation in the individual job specifications. Each of the tables below represents a competency or a few competencies, if they were presented identically throughout the job specifications, for various civil engineer job specifications at each DOT. All job specifications were listed and the blacked-out job specifications indicate that job specification did not present that particular competency. There are eight tables below (**Tables 9 through 16**) accounting for all 17 competencies.

Table 9: Job specification presentation for decision making, math, organizational, speaking, writing, analysis, problem-solving, and surveying

Connecticut	CE I	CE II						
Maine	CE II	CE III						
Massachusetts	CE I	CE II	CE III	CE IV	CE V	CE VI		
New Hampshire	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	
Rhode Island	CE	CE Associate						
Vermont	CE I	CEII	CE III	CE IV	CE V	CE VI	CE VII	CE VIII

Table 9 representing many of the competencies is unique in that all of the job specifications presented these competencies including decision making, math, organizational, speaking, writing, analysis, problem-solving and surveying. This shows that each of the job specifications presented a minimum of 8 competencies as represented by the table.

Table 10: Job specification presentation for regulation knowledge, and leadership

Connecticut	CE I	CE II						
Maine	CE II	CE III						
Massachusetts	CE I	CE II	CE III	CE IV	CE V	CE VI		
New Hampshire	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	
Rhode Island	CE	CE Associate						
Vermont	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	CE VIII

In Table 10**,** regulation knowledge and leadership are both presented in 89% of the job specifications. Vermont is shown to be the only state that doesn't present regulation knowledge as a required competency by some of its lower level Civil Engineers. Civil Engineers I-III at Vermont do not present regulation knowledge in their job specifications while Civil Engineers IV-VII do. All of the other state's job specifications present these competencies.

Table 11: Job specification presentation for cost estimation

Connecticut	CE I	CE II						
Maine	CE II	CE III						
Massachusetts	CE I	CE II	CE III	CE IV	CE V	CE VI		
New Hampshire	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	
Rhode Island	CE	CE Associate						
Vermont	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	C VIII

In **Table 11,** cost estimation, like regulation knowledge is not presented be the specifications of Civil Engineers I-III in Vermont. Additionally, Civil Engineer I in Massachusetts

and Civil Engineer II in Maine both do not present cost estimation as a competency. Massachusetts still has 5 job specifications where it is presented unlike Maine which only had one.

Table 12: Job specification presentation for management

Connecticut	CE I	CE II						
Maine	CE II	CE III						
Massachusetts	CE I	CE II	CE III	CE IV	CE V	CE VI		
New Hampshire	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	
Rhode Island	CE	CE Associate						
Vermont	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	CE

In Table 12**,** management was not presented in Connecticut's Civil Engineer I position or Vermont's I-IV. However, Connecticut II and Vermont V-VIII did present management in their job specifications.

Table 13: Job specification presentation for design software

Connecticut	CE I	CE II						
Maine	CE II	CE III						
Massachusetts	CE I	CE II	CE III	CE IV	CE V	CE VI		
New Hampshire	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	
Rhode Island	CE	CE Associate						
Vermont	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	CE VIII

Table 13 shows Maine and New Hampshire do not at all present design software in their job specifications and Civil Engineer I at Vermont does not either. Civil Engineer II-VIII do however present design software as a competency.

Table 14: Job specification for public presentation

Connecticut	CE I	CE II						
Maine	CE II	CE III						
Massachusetts	CE I	CE II	CE III	CE IV	CE V	CE VI		
New Hampshire	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	
Rhode Island	CE	CE Associate						
Vermont	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	CE VIII

In Table 14, public presentation was not presented in about 37% of the job specifications reviewed including Civil Engineers I-III in Vermont, all of Rhode Island's job specifications (Civil Engineer and Civil Engineer Associate), I-IV in Massachusetts, and Civil Engineer II in Maine. Accounting for the 63% or job specifications where public presentation was presented are IV-VIII in Vermont, all of New Hampshire and Connecticut, Civil Engineer III in Maine, and Civil Engineer V and VI in Massachusetts.

Table 15: Job specification presentation for soil and materials testing

Connecticut	CE I	CE II						
Maine	CE II	CE III						
Massachusetts	CE I	CE II	CE III	CE IV	CE V	CE VI		
New Hampshire	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	
Rhode Island	CE	CE Associate						
Vermont	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	CE VIII

In Table 15, soil testing and materials testing had identical competency presentation in the job specifications. Approximately half of the job specifications did not present soil and materials testing skills as approximately half did present it. Civil Engineers IV-VII in New Hampshire, all of Massachusetts job specifications (Civil Engineer I-VI), Civil Engineer III in Maine, and Civil Engineer I in Connecticut did not present soil or materials testing in their job specifications. However, all of Vermont and Rhode Island presented it as well as Civil Engineer I-III in New Hampshire and Civil Engineer II in Maine as well as Connecticut.

Table 16: Job specification presentation for permit application

Connecticut	CE I	CE II						
Maine	CE II	CE III						
Massachusetts	CE I	CE II	CE III	CE IV	CE V	CE VI		
New Hampshire	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	
Rhode Island	CE	CE Associate						
Vermont	CE I	CE II	CE III	CE IV	CE V	CE VI	CE VII	CE VIII

In Table 16, permit application was presented the least of all competencies by the job specifications at 4%. 96% of the job specifications did not present permit application. The only job specification that presented permit application was Civil engineer VI in New Hampshire. All other states including Vermont, Rhode Island, Massachusetts, Maine, Connecticut as well as Civil engineers I-V and VII in New Hampshire did not present this competency.

Finally, the need to present these competencies by their degree of seniority prompted designating each competency to a weighted score. This scale of junior to senior competencies means that as a competency is presented by junior level job specifications and less so by senior level job specifications the competency is deemed to have low seniority. Likewise, as a competency is presented by senior level job specifications and less so by junior level job specifications the competency is deemed to have high seniority. The development of the scale started by giving each competency a fraction based on how many levels of civil engineers are at that DOT and where that particular specification lies within those levels. For example, Vermont has eight levels of civil engineers. CE I would receive a 1/8; CE II, a 2/8; CE III, a 3/8; CE IV, a 4/8; CE V, a 5/8, CE VI, a 6/8; CE VII, a 7/8; and CE VIII, an 8/8. Under the same methods but with denominators designated to that DOT's specific number of levels of civil engineers, the respective fractions were designated per job specification. The fractions of the job specifications that presented a particular competency were summed and divided by the number of job specs that presented that competency to produce a weighted score per competency ranging from 0-1. The higher the weighted score is, the more seniority that competency has. The weighted score and the frequency score are presented in **Figure 1** below for like comparison.

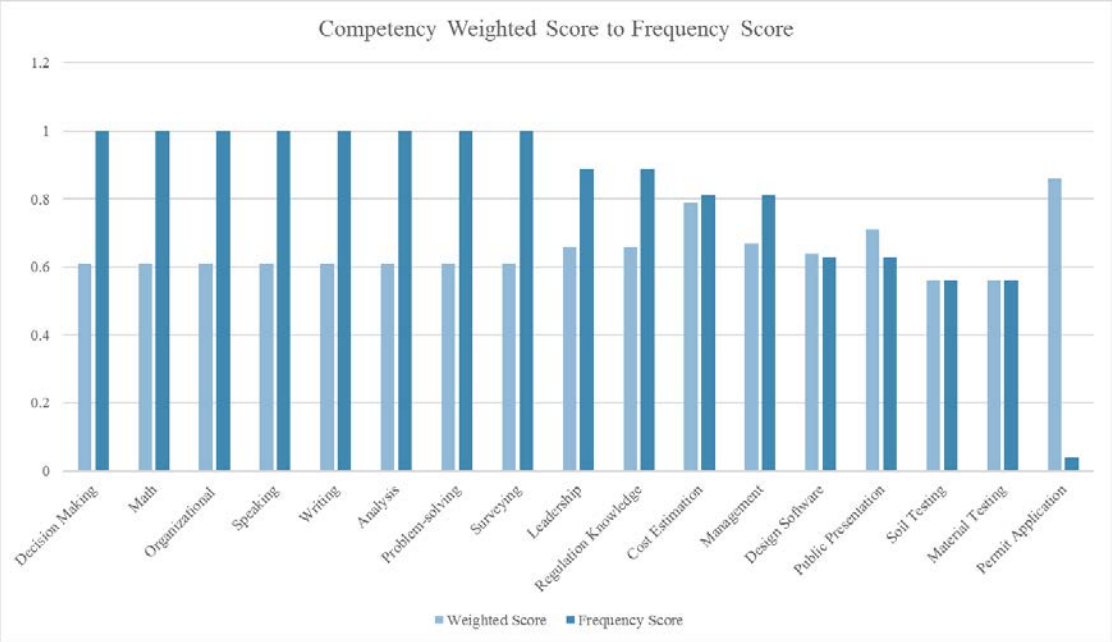

Figure 1: Weighted and frequency scores for the 17 competencies

Soil testing and materials testing appear to have the lowest weighted scores indicating them to be competencies with the least seniority. Permit application however, has the highest weighted score and simultaneously the lowest frequency score. This indicates that few job specifications presented permit application, but when it was presented it was by upper level civil engineers indicating it having high seniority.

CHAPTER 5

DISCUSSION & CONCLUSIONS

5.1 Discussion

The analysis effectively finds many variances between how the DOT's in New England present their job specifications for all their existing civil engineer levels. Based on the competency analysis, every single competency is not represented at every single DOT by one of their level civil engineer specifications. Maine, Massachusetts and Rhode Island each have 2 occurrences of not presenting a particular competency by any of its civil engineer levels. New Hampshire, Vermont and Connecticut each have an occurrence of not presenting a particular competency by any of its civil engineer levels.

The weighted scores categorize the competencies by their degree of seniority and it is found that soil and materials testing each have the lowest seniority while permit application and cost estimation have the highest.

5.2 Conclusions

The many variances between the DOTs in New England pose a discussion for why these differences exist. It could be that each DOT has reason for not presenting all of the competencies at their agency or having eight CE levels as appose to two. By educating the respective DOTs on why they are established the way they are could bring light to better practices, with some uniformity but some differences that are appropriate - as each agency is different from the next.

CHAPTER 6

FURTHER RESEARCH

An understanding of where the DOTs of New England lie comparatively to each other in terms of job specifications and how their competencies are presented lays ground work for next steps of this project. Future researchers could analyze a number of different of topics branching off of what has been done including:

1. Are professional certifications part of job specifications at (all or some) DOTs? – Why or why not?
2. How do working knowledge of competencies vs. expert level compare in job specifications (e.g. soil and materials testing)? Are senior level staff not expected to have working knowledge of soil and materials testing? If not, is it still on their job specification (as expert level understanding)
3. How do specialists in the agencies impact existing job specifications? If there is a CAD specialist, for example, does this presence override the design software competency at this agency?
4. Why are agencies set up as they are? And are their differences from other DOTs beneficial or harmful? (e.g. Why does one agency only have 2 CE levels and another has 8?)
5. How does agency size and the number of job levels compare?
6. Similar analysis for civil engineer technicians – Are civil engineer technician competency presentation similarly inconsistent as civil engineers at each of the New England DOTs?
7. How do salaries compare by level and per DOT?

8. Furthering the analysis by looking at required vs. preferred competencies by the agencies
9. Expanding this analysis to the other states in the US

APPENDIX

STRATEGIC PLAN SURVEY

MaineDOT - 2016

A core part of MaineDOT's mission is to provide a safe transportation system for all users. Safety is continually being evaluated, strategies developed and improvement actions initiated. This is being accomplished through:

- Focusing on leading crash and injury trends – statewide and at individual locations.
- Establishing transportation system crash improvement strategies.
- Cooperating with other state agencies and safety advocates to address the state's road safety improvement priorities.
- Addressing work zone safety issues through programs that reach MaineDOT employees, the general public, and others working in work zones.
- Improving crash data and other transportation-related systems to enable enhanced data quality and accessibility.
- Partnering with other stakeholders to create an integrated safety strategy (MaineDOT Trasportation Safety, n.d.)

VTrans - October 1, 2015

Mission

Provide for the safe and efficient movement of people and goods.

Vision

A safe, reliable and multimodal transportation system that promotes Vermont's quality of life and economic wellbeing.

Strategic Goals and Agency-wide Objectives

Goal 1: Provide a safe and resilient transportation system that supports the Vermont economy

- Reduce the number of major crashes
- No unplanned road closures or restrictions due to conditions within VTrans' control
- Increase the resilience of the transportation network to floods and other extreme weather and events.

Goal 2: Preserve, maintain and operate the transportation system in a cost effective and environmentally responsible manner.

- Maintain pavement, structures and other transportation system assets in a state of good repair
- Implement an Asset Management System and integrate it with Planning and Programming (budget decisions).
- Minimize the environmental impacts of the transportation system.

Goal 3: Provide Vermonters energy efficient, travel options.

- Minimize traveler delay
- Increase use of walking, biking, transit, rail, and Travel Demand Management options
- Increase use of state and municipal Park & Ride system

Goal 4: Cultivate and continually pursue innovation, excellence and quality customer service.

- Information given to customers is accurate and comprehensive
- Staff are competent, fair, polite and sympathetic to customers' needs
- Staff deliver the outcome as promised and manage any problem

Goal 5: Develop a workforce to meet the strategic needs of the Agency.

- Recruit excellent, qualified and diverse employees.
- Retain and develop excellent and diverse employees
- Implement succession planning

MassDOT - July 23, 2010

Mission

Deliver excellent customer service to people who travel in the Commonwealth, and to provide our nation's safest and most reliable transportation system in a way that strengthens our economy and quality of life. We are one transportation organization focused on customer service and safety.

Vision

Leading the Nation in Transportation Excellence.

Goals

1. Safety:

Actively manage the nation's safest transportation system to minimize injuries whenever, wherever, and to whomever possible.

2. Build and Preserve:

Build a quality transportation system and maintain it in a state of good repair.

3. Stewardship:

Operate the transportation system in a manner that embraces our stewardship of the Commonwealth's natural, cultural, and historic resources.

4. Customer Service:

Deliver superb service that both anticipates and responds to customer needs.

5. Efficiency:

Invest public funds and other resources wisely while fostering economic development (MassDOT, 2010).

ConnDOT - August 25, 2011

Mission

The mission of the Connecticut Department of Transportation is to provide a safe and efficient intermodal transportation network that improves the quality of life and promotes economic vitality for the State and the region.

Vision

The vision of the Department of Transportation is to lead, inspire and motivate a progressive, responsive team, striving to exceed customer expectations.

Values

Measurable Results: We will endeavor to utilize the latest technology and preserve the integrity of our current assets to provide a safe, efficient, integrated, multimodal, transportation system that offers options for mobility.

Customer Service: We are committed to consulting with our internal and external stakeholders in an open and transparent decision-making process; and to being responsive by providing timely information on services and programs.

Quality of Life: We will strive to maintain and enhance the quality of life in the State and the region by maintaining the character of our communities, supporting responsible growth, and by enhancing and being sensitive to the environment.

Accountability & Integrity: We will prudently manage and invest the human and financial resources entrusted to the Department using sound criteria and efficient, cost-effective methods that put safety and preservation first.

Excellence: We will demand excellence in all we do to fulfill our mission by being solution-oriented and focused on project delivery. We will continuously re-evaluate our mission, values, performance and priorities to ensure that the Department and its employees are innovative and responsive to changing needs (Redeker, 2011).

NHDOT - 2015

Mission

Transportation excellence enhancing the quality of life in New Hampshire.

Purpose

Transportation excellence in New Hampshire is fundamental to the state's sustainable economic development and land use, enhancing the environment, and preserving the unique character and quality of life. The Department provides safe and secure mobility and travel options for all of the state's residents, visitors, and goods movement, through a transportation system and services that are well maintained, efficient, reliable, and provide seamless interstate and intrastate connectivity.

Vision

Transportation in New Hampshire is provided by an accessible, multimodal system connecting rural and urban communities. Expanded transit and rail services, a well-maintained highway network and airport system provide mobility that promotes smart growth and sustainable economic development, while reducing transportation impacts on New Hampshire's environmental, cultural, and social resources. Safe bikeways, sidewalks, and trails link neighborhoods, parks, schools, and downtowns. Creative and stable revenue streams fund an organization that uses its diverse human and financial resources efficiently and effectively (NHDOT, n.d.).

Strategic Goals

Customer Satisfaction: The Department's work must be transparent and responsive to our customers - those residents and visitors to our state who depend of transportation. NHDOT will strive to provide a transportation system and services that support quality of life.

Performance: The Department must continue to improve: the conditions of all elements of the transportation system; the performance (mobility, safety, and security) of the transportation system; the efficiency of the Department; and the effectiveness of its partnerships.

Effective Resource Management: The Department must: make effective use of financial resources; use its workforce strategically; and protect and enhance the environment.

Employee Development: The Department workforce must be prepared for new challenges due to changes in technology and expected vacancies due to retirement; focus will continue on improving employee health and safety, and aligning employees with the Department's Mission and Purpose through improved communication (NHDOT, n.d.).

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