OPTIMIZING THE MANAGEMENT AND PERFORMANCE CAPABILITIES OF DOT PRODUCT EVALUATION PROGRAMS

by

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ABSTRACT

DIPIN VEDRAM KASANA. Optimizing the Management and Performance Capabilities of DOT Product Evaluation Programs (Under the direction of DR. JAKE SMITHWICK)

State transportation agencies (STAs) implement countless transportation products that are identified, evaluated, and accepted through a Product Evaluation Program (PEP). Through an effective PEP, STAs can ensure the continuous availability of high performance products to be used on various construction and maintenance projects. STAs are encouraged to constantly monitor and update an Approved or Qualified Product List (APL or QPL, respectively). The purpose of this study was to assess the current state of practice of PEPs throughout transportations departments in the United States. The researcher analyzed flowcharts, product application forms, and standard operating procedures, and also conducted an extensive academic literature related to the subject. A survey was then developed and distributed to all 50 DOTs (56% response rate). Follow-up interviews were conducted with about half of the respondents. Data was collected on PEP staffing levels, satisfaction, size of approved product lists, annual budgets, and more.

The study found that, in general, PEPs lack priority, consistency, and coordination. Statistical analyses revealed that agencies dedicating equal time toward both phases of evaluation (initial product application review and technical product review) have achieved the highest satisfaction levels for PEP communication and performance. An optimal PEP management model is proposed, and includes a modified product application form, past performance survey (where applicable), and revised product evaluation form.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
APEL	AASHTO Product Evaluation List
APL/QPL	Approved Product List/Qualified Product List
ASTM	American Society for Testing Materials
CERF	Civil Engineering Research Foundation
DOT	Department of Transportation
FHWA	Federal Highway Administration
HiCAMS	Highway Construction and Materials System
HITEC	Highway Innovative Technology Evaluation Center
IT	Information Technology
IBM	International Business Machines
MUTCD	Manual on Uniform Traffic Control Devices
NCDOT	North Carolina Department of Transportation
NCHRP	National Cooperative Highway Research Program
NPEP	New Product Evaluation Program
NTPEP	National Transportation Product Evaluation Program
OLR	Ordinal Logistic Regression
PEP	Product Evaluation Program
STA	State Transportation Agency
TWG	Technical Work Group
VMT	Value Management Team

CHAPTER 1: INTRODUCTION

1.1 OVERVIEW

The systematic process of evaluation has long-served as the cornerstone of accomplishment, both in definition and in application. Whether an evaluation process is initiated as a means of measuring productivity, demonstrating efficiency, or determining impacts, it is an inevitable task for any project or program manager. Apart from aiding individuals with making well-informed decisions on behalf of their organization, proper evaluation practices can serve as a protective barrier between success and failure, which is often drawn on a very fine line. Despite the use of evaluation as a basic requirement for most decision-based scenarios, there is evidence that the lack of a consistent evaluation process diminishes the value of entire processes, as well as the subjects of such evaluation.

The current state of practice evidences that evaluation processes, in conjunction with requisite performance measures, are substantially neglected. At the program-level, these critical approaches are sometimes entirely disregarded by high-level management teams. This is especially unfortunate, as there is proven utility and benefit resulting from a formidable evaluation, which fosters innovative thinking and serves to create superior understanding.

1.2 PURPOSE OF STUDY

This research is motivated by the ever-increasing availability of 21st century tools and technologies, many of which offer great utility, and include promises of superior benefit. If used competently, these instruments of innovation can be optimized in a variety of ways, ranging anywhere from general problem resolution, enhanced performance of people and things, ease of application for greater user satisfaction, and ultimately, enable the continued evolution and advancement of society at large. A prime example of such a tool is the Product Evaluation Program (PEP) of the North Carolina Department of Transportation (NCDOT), which offers a framework with the ability to enhance the performance and quality of various construction projects.

Consistent throughout all Departments of Transportation (DOTs) is the existence of a unit or program tasked with the review of proposed products for potential use in the construction, maintenance, and/or operation of the state's transportation projects. The products submitted for evaluation should contribute toward an improved transportation need or benefit, and are typically categorized as either a construction material, equipment, or technology. The proposed product must also satisfy certain federal and state-specific criteria to be considered for the program-level evaluation, which allows the product to be considered for inclusion on the state's approved or qualified product list. Some of the more traditional products that have been subjected to review include concrete admixtures, traffic safety products, various grouts, or roofing materials; however, it is also predictable that these traditional product categories will require at least some expansion, as the availability of advanced technologies continues to grow at a rapid rate, and as DOTs start to standardize their PEPs to include more efficient and expeditious processes.

Before a product can even be considered for an approved or qualified product list, the proposed product must go through various stages of evaluation, tested against different measures, and ultimately categorized according to the receiving agency's pre-established standards and specifications. While much of this process is studied and described throughout this thesis at length, certain procedures are commonplace. For instance, depending on the type of product to be tested, the test may be performed in the field, or in an agency-approved laboratory. Likewise, the products to be considered qualified or approved products are ultimately assigned a product category and placed on the Approved/Qualified Product List (QPL/APL). A few of the commonly used product categories on the APL/QPL are adhesives and sealers, culvert and drainage structures, soil reinforcement and geosynthetics, patching materials, admixtures, construction equipment, traffic control materials, architectural materials, to name a few (ADOT, 2017).

As shown in Figure 1, the product evaluation program can be broken down into four major stages of investigation. In the first stage, the product manufacturer or the vendor submits the product evaluation application form and other associated documents to provide the necessary product information as required by the receiving agency. Once received by the state agency, the product application and supporting documentation are reviewed by the designated PEP manager, who must determine whether the product conforms to applicable standards and specifications, helps to fill an internal need, is readily available, and can be installed at a reasonable cost, among other things, before the product can be approved for the second phase of evaluation.

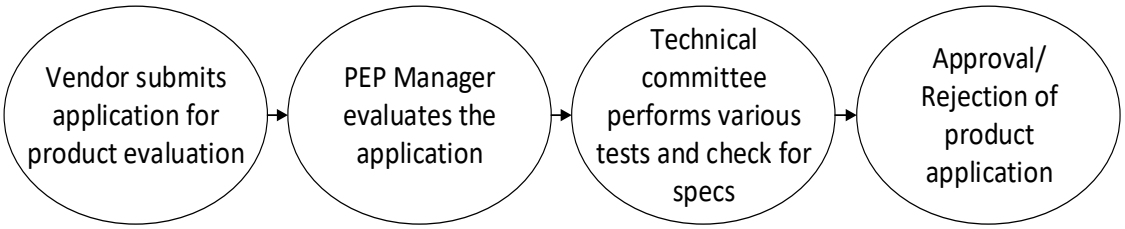

Figure 1: Product evaluation process framework

If a product satisfies the initial review, it is eligible for consideration by the technical review committee. The designated technical team is tasked with subjecting the product to a variety of conditions, either in the field or in a laboratory, and examine the product's ability to perform according to stated standards. The results of the technical investigation are compared against the pre-requisite qualification criteria as recognized by the agency for that type of product. The technical committee makes the final decision of the evaluation and assigns a status. The products are generally assigned the status of approval, conditional approval, field trial, additional information required, or rejection at the end of the technical evaluation. The evaluation is closed-out once the PEP manager notifies the vendor and other employees of the committee's decision. It is also expected that the PEP manager will update the status of the product on the APL or QPL in accordance with the basis of the final decision.

In addition to enhancing the general body of knowledge, conducting an effective and thoughtful evaluation can help to improve a given process or program, determine feasibility of efforts with cost-saving and value-enhancing results, answer questions of influential bodies such as stakeholders, address accountability and promote compliance, with countless other benefits. The evaluation completed for this study, for instance, will help to improve product evaluation efforts and offer a manageable process, with the ability

to facilitate broad impacts with the alignment of product-tracking efforts throughout the industry.

While there is no specific formula for implementing an effective evaluation, this thesis offers a general blueprint that can assist users, such as value managers, product evaluation teams, and technology transfer groups to improve their understanding of a given product evaluation program (PEP), as well as aid to deliver satisfactory results through an enhanced, collaborative, and uniform approach to the evaluation process. Furthermore, the proposed guidelines will have the ability to serve as a standard approach intended for widespread applicability and ease of implementation, with the potential to create sweeping improvements of product-tracking processes throughout Departments of Transportation nationwide.

1.4 RESEARCH SCOPE & OBJECTIVES

The aim of the program is to propose a standard and structured approach to enhance the quality of qualified products, and to eventually assist with better management and utility of an Approved / Qualified Product List (APL). The APL/QPL will consist of high-performance products confirmed by proven testing and evaluation procedures that will help to ensure each product conforms to required specifications and performance capabilities. The final research product will be founded on best practices, as defined through lessons learned both within and outside of industry, as well as through expertise gained from other state agencies.

This thesis presents a some of the work required to develop an effective evaluation process that can be used by any DOT operating a formal product evaluation program. The research objectives focus on the identification, development, and implementation of the

best practices available to determine the most effective structure for a standard evaluation program, and specifically include the following action items:

- Evaluate national industry practices in DOT's product evaluation program to capture best practices of current methods.
- Develop an evaluation model with modified practices to enhance the performance of the evaluation process based on the analyses of state agencies with improved PEP.
- Create a product-alignment matrix to compare the evaluation practices of NCDOT's PEP and the recommended practices in the evaluation model developed by the Researcher.
- Create a simplified PEP flowchart to create better communication channels, ensure easier understanding of the PEP procedure, and promote program recognition.
- Illustrate optimal tools & techniques for tracking the performance of approved products in the field, and monitoring capabilities to enhance long term performance, increased safety, and better cost benefit values.
- Address the communication gap among different groups of people involved in, or responsible for, the execution of product evaluation activities.
- Create a simplified, straightforward approach to enhance ease of implementation, a process that is currently inhibited with unnecessary and even counterproductive steps.

1.5 RESEARCH HYPOTHESES

A total of three hypotheses were developed based on the established objectives of the study. The first and second hypotheses were developed to study the impact of independent variables on the outcome of dependent variable with respect to the employee satisfaction. The third hypothesis was developed to test the difference in the distribution of the independent variable.

HYPOTHESIS 1: The number of dedicated staff members in the program will have an impact on the employee satisfaction with the performance of the PEP.

HYPOTHESIS 2: The number of products rejected after evaluation will have an impact on the employee satisfaction with the performance of the PEP.

HYPOTHESIS 3: The distribution of initial and technical review duration will have some impact on the employee satisfaction with the performance and communication of the PEP.

1.6 ORGANIZATION OF THESIS

The content of this thesis is presented in seven chapters. Chapter 1 provides a general overview of the current state of practice, the need identified, and the anticipated contribution to the body of knowledge, as well as anticipated research products. Chapter 2 provides a literature review that expresses the importance of evaluation and describes the different parameters offered by an evaluation model. The section analyzes a variety of decision-making models and the impact of organizational change necessary to ensure the successful transition of a given program-level change. Chapter 3 describes the steps involved in the method chosen by the Researcher to accomplish this study. The section also reviews the product evaluation program at NCDOT and other facilitators of product evaluation. Chapter 4 provides the details of the survey questionnaire prepared to study the

state agencies throughout the United States, and a description of the variables used to measure the performance of each agency. Chapter 5 presents the results of the statistical and descriptive analyses of the state agencies using the data collected. Chapter 6 presents the proposed product evaluation model, including any modifications necessary for ancillary methods or processes, to implement the recommendations made herein. Chapter 7 is a discussion of the analyses that have been conducted on behalf of this thesis work, an interpretation of the results, and summary of the conclusions drawn from the overall research.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

The academic literature conducted for this thesis work aims to identify the fundamental attributes of effective evaluation, which will assist in the creation of a consolidated, best practices report to be used as an immediate-use guide for transportation program managers. Evaluations are generally conducted to examine and judge the effectiveness of a program; however, most evaluations are a result of existing dissatisfaction or poor performance, and a desire to implement positive change (Patton, 1990). Therefore, this literature review is not limited to understanding the different fundamentals of evaluation, but also reviews other significant factors involved in effective evaluation processes, including decision-making and organization change. These elements are an extension of evaluation and are necessary for the successful implementation of evaluation findings and results, as initially aimed.

According to Lancaster (1998), the main role of any evaluation is to carry out an assessment and gather information, which can then be used by decision makers to solve underlying issues, as well as to prevent problems going forward. Thus, in addition to the "why, what, when, and where" of evaluation, special attention has been given to literature related to decision-making, helping to inform the discussion through a more wholesome understanding about the most productive methods, and criteria needed, to ensure that an evaluation is both adequate, and easily implementable. The final section of this literature review concludes with a description of organizational change and its impact on enhanced

program implementation, which is intended to guide decision makers through the evaluation process, and to ensure that planned objectives can be successfully implemented.

2.2 EVALUATION DEFINED

In some form or another, people have been using evaluation techniques and processes for thousands of years. As Scriven (1996) said, "the evaluation is a very young discipline - although it is a very old practice." Within the last few decades, evaluation practices have evolved and expanded as a more distinct, and somewhat refined, organizational process. As a result, the term "evaluation" has also evolved to include multiple meanings and is often defined by the type and content in which it is being employed. Some of the more broadly accepted, yet distinct definitions include:

> "An evaluation is performed, not as an intellectual exercise, but to gather data useful in problem solving and decision making" (Lancaster, 1988).
>
> "Evaluation refers to the process of determining the merit, worth, or value of something, or the product of that process. Terms used to refer to this process or part of it include: appraise, analyze, assess, critique, examine, grade, inspect, judge, rate, rank, review, study, test" (Scriven, 1991).
>
> "Evaluation is any activity that throughout the planning and delivery of innovative programs enables those involved to learn and make judgements about the starting assumptions, implementation processes and outcomes of the innovation concerned" (Stern, 2000).

To take advantage of the utility of evaluation, it is important to have some understanding of its basis. Thus, a brief discussion of the history of evaluation follows in the next section.

2.3 HISTORY OF EVALUATION

The development of program evaluation was described by Madaus et al. (2000) and reiterated by Hogan, R. L. (2007) using seven-time periods, predating the 1900s, and going into the early 2000s. The seven development periods are summarized as listed below:

1. The Age of the Reform (1792-1900's) - The first evaluation, documented in 1792, was the quantitative assessment of student's marks in order to analyze the academic performance. The initiative was aimed to improve and formalize the educational system by evaluating the quantifiable data.
2. The Age of Efficiency and Testing (1900-1930) - In this phase, the institutions conducted objective-based tests to check the quality of instruction. The goal was to improve the efficiency of the educational district using the measurement and evaluation results of the performed tests.
3. The Tylerian Age (1930-1945) - This age is named after the father of educational evaluation, Ralph Tyler, who carried out an investigation for eight years at 15 progressive high schools and 15 traditional high schools to assess the outcomes based on objectives set forth. The investigation was based on comparative studies and somewhat responsible in the formation of criterion-referenced testing.
4. The Age of Innocence (1946-1957) - Post World War II, a great growth in the field of educational, personal, and facilities offerings was witnessed, which led to allocation of funds towards their improvement. In the early 1950's, a rapid adoption of Tyler's criterion-referenced testing method helped to create an objective based testing environment. Moreover, the tests were designed and performed based on desired outcomes (Reiser, 2001).

5. The Age of Development (1958-1972) - With the enactment of National Defense Education Act, a large sum of money was dedicated to evaluating and develop a new curriculum in mathematics, sciences, and foreign language (Stufflebeam, Madaus, and Kellaghan, 2000). A major emergence in Tyler's evaluation technique was observed with most groups shifting from norm-referenced testing to criterion-referenced testing. Moreover, the implementation of Elementary and Secondary Education Act introduced the first contemporary program evaluation.
6. The Age of Professionalization (1973-1983) - The evaluation received a wide recognition as an emerging profession, leading to the introduction of evaluation methodology courses at various universities like UCLA, Stanford University, etc., and the initiation of various journals publication.
7. The Age of Expansion and Integration (1983 - 2000) - This phased witnessed a shortage of funding due to an emphasis on cost cutting by the organizations. However, it led to further development of the existing evaluation processes, and integration of new techniques for carrying out other forms of evaluation.

It is evident from the history that the fundamental purpose of evaluation is, and always has been, an effort to generate superior understanding (Taylor-Powell, E. et al, 1996). Moreover, the likelihood of achieving program success and acceptability increases with greater recognition; a widespread understanding and mutual desire to achieve the particular objectives of the given program. Thus, the more an evaluation program's purpose is recognized, the less it can be hindered by fear and misunderstanding of those affected (Shrock, S. A. and Geis,G. L., 1999).

To illustrate the general evaluation process, Figure 2 shows the flow of an evaluation, and identifies the activities carried out at each step. The first step of the evaluation process is called the evaluation assessment or framework. This step can be referred to the planning stage, which primarily sets the foundation or the framework for the upcoming steps. At the planning stage, an investigation is conducted, starting with identification of major concerns, uncertainties, and the key issues, followed by the preparation of a detailed plan, comprised of various techniques and methods to address those problems. The second step deals with carrying out the actual evaluation of a product, process, or the program to assess its performance. The data is collected by performing tests or checking standards and specification. Once there is adequate and sufficient data, the analysis of results will include recommended alternatives, and provide guidance on required steps for improvement. Finally, the decision makers assess the alternatives and the recommended steps to select the best suited option based on the goals and objectives established at the outset (i.e. the planning stage) (Sinha, K. C. and Labi, S., 2007).

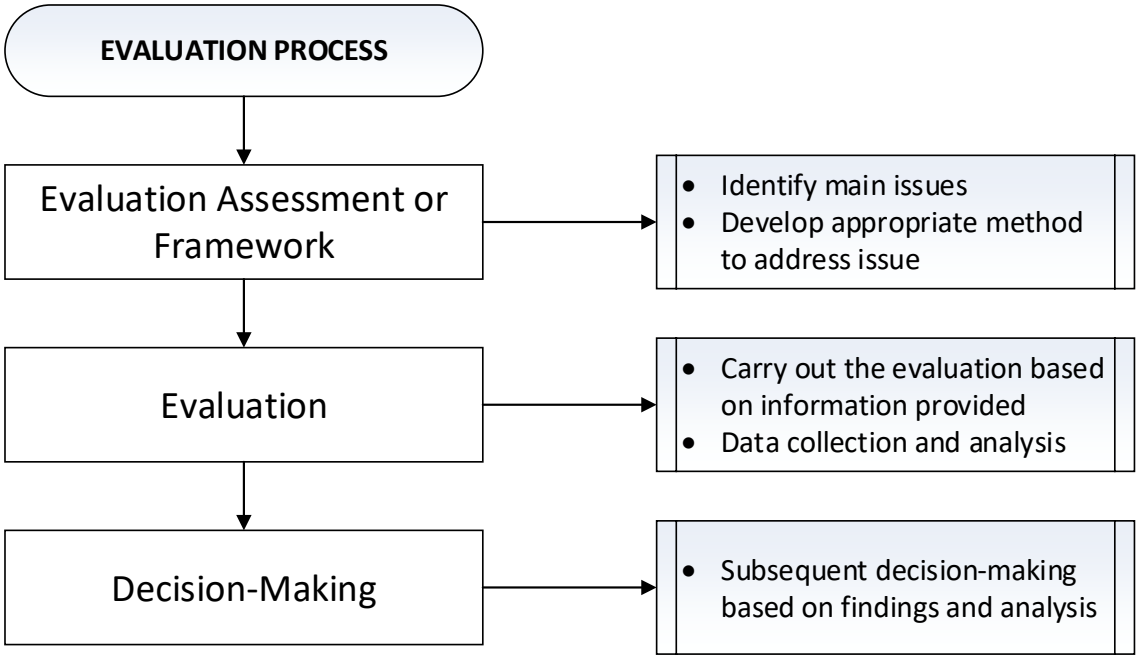

Figure 2:Flowchart of evaluation process (adapted from Sinha, K. C. and Labi, S., 2007).

2.4 PURPOSE OF EVALUATION

The purpose of any evaluation can vary depending upon the aim of the evaluation. Jackson (2001) highlighted several of the common causes for carrying out an evaluation, and explained that the purpose of evaluation is often for one of the following reasons: (a) to examine a program's alignment with a set of goals, (b) gather helpful information, (c) determine the success and failure of a program, (d) gain additional insight through the help of experts, and (e) to evidence the effectiveness, or ineffectiveness, of a program. Conversely, John Owen (1993) provided five different categories for using evaluation as a tool to achieve a desired objective, which are described as:

1. Enlightenment - The evaluation is designed to be illuminative by the revelation of the unknown or unexpected information. The study of Australia's Participation and Equity Program policy in 1984 is one such example, where the evaluation was

conducted to study the policy's impact on the education system. However, the results showed large variations between planning and implementation, and was considered to be the key enlightenment for its performance.

2. Accountability - In this type of evaluation, the results and findings are not limited to account for praise or criticism. Instead, it is used as a tool for the allocation of resources to certain activities, and to the individuals responsible for such activities. Oftentimes, auditors practice this kind of evaluation to meticulously assess the outcomes of financial allocation.
3. Program improvement - The evaluation is conducted on evolving or dynamic programs, also referred to as formative evaluation, to ensure improvement on a continuous basis. It is usually intended to furnish appropriate information to the decision makers for ensuring the most effective usage.
4. Program clarification - The evaluation aims to define the "program logic" of an existing program for the purposes of communicating this logic to relevant stakeholders. It is also referred to as design evaluation and considered as an emerging tool for its contribution towards the effective delivery of outcomes.
5. Program development - The evaluation aims to assess the growing needs or extension of an existing program prior to its implementation for the overall development of the program, this is commonly referred as up-front evaluation.

2.5 PROCESS OF EVALUATION

Before investigating the framework of any evaluation, it is essential to be familiar with the different aspects of evaluation process that have a direct impact on its effectiveness. As stated earlier, an evaluation is comprised of a series of steps or stages.

Though, conceptually, steps are one after the another, the reality is that the steps of evaluation overlap in application. Therefore, the efforts made at each stage will have a significant impact on the preceding or succeeding stages. For instance, there is considerable impact from the data collection stage, on the assessment or findings stage (Owen, J. M., 1993).

The research shows that visualization tools are productive in illustrating the more conceptual aspects of an evaluation framework. Accordingly, Figure 3 shows six different steps or stages involved in an evaluation process with the help of an evaluation framework (Milstein, B. and Watterhall, S. F., 2000).

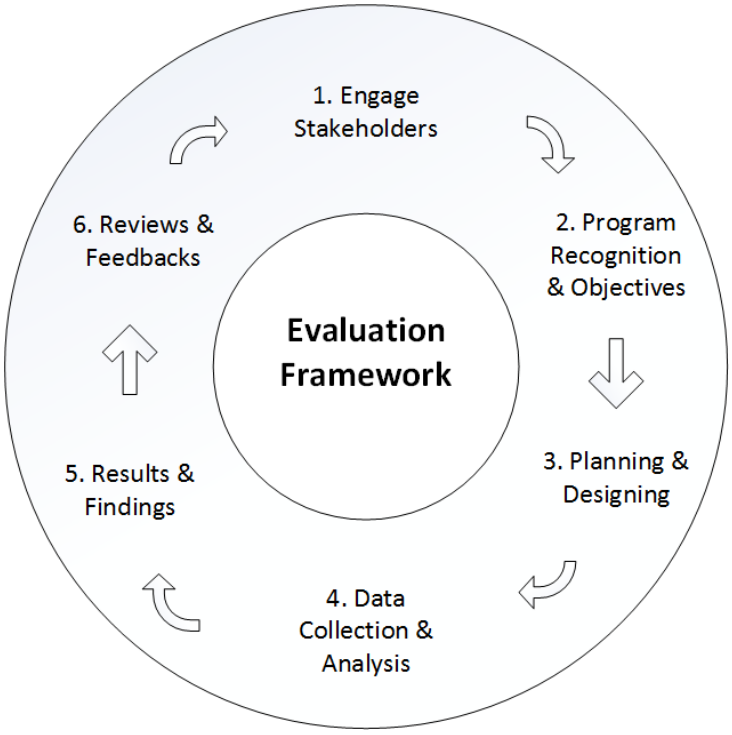

Figure 3: Framework to execute evaluation (adapted from Milstein & Scott, 2000)

An orderly framework that clearly portrays each essential step helps to define the respective program, which lends toward better understanding. When the process is more clearly defined, it allows for improved performance, as seen by the successful completion of tasks, which ultimately helps to achieve the desired results. According to a report by the Center for Disease Control (CDC, 1999) regarding an evaluation framework for the Public Health Department, the necessary activities in an effective evaluation framework should include the following:

1. Stakeholder Engagement: For an effective and comprehensive evaluation, the involvement of internal as well as external evaluator is vital, as it not only helps to provide a fresh outlook, but also furnishes the unbiased opinion towards the evaluation process or the program. The stakeholders can be the end-users, participants or employees of the program, or individuals associated with the program in any other form. The input and feedback of the stakeholders add value and usefulness to the evaluation, guide the objectives towards the desired goals, clarify roles and responsibilities, and avoid conflicts of interest.
2. Program Description: A comprehensive description of the program helps to convey the ultimate goals and objectives underlying its existence and offers a variety of strategies that can be employed to achieve them. Additionally, the description enables the comparison of two likewise programs, and identify different components and their effect on the program (Sanders, J. R., 1994). Few of the key aspects that must be addressed in the program description are:

a. **Statement of Need**: The statement of need highlights the issues and the opportunities that the program aims to address. And, the description of techniques and strategies adopted to encounter them.
b. **Expected Effects**: The program's goals and objectives shall be realistic, not ideal, and their accomplishment shall be considered as program's success. The description provides a realistic perspective of the established goals and objectives (i.e. long term and short term) and assists with accurate prediction of the expected time of accomplishment. Moreover, it defines the motto of the program and eliminates any misunderstandings in relation to the agenda.
c. **Program Activities:** The description of the program activities should include the specific details regarding the logical sequence among involved activities, and their inter-relationship. It has a significant impact on the success of the program.
d. **Resources:** The description should involve the details of available resources (like equipment, technology, information, money etc.) for their proper allocation and effective usage. Moreover, this will ensure smooth operations of activities by eliminating the conflicts of mismatch.
e. **Stage of Development:** The description on the current stage of development reflects the maturity of the program and tracks the current performance of the program. The description must recognize the three stages: planning, implementation, and effect of the program.

f. **Logic Model:** The logic model acts as a communication tool, that uses flowcharts, maps, or tables to describe the sequence or series of events responsible to produce the desired output/results. The logic model helps to identify the missing links, define the strategies, and summarize the program's mechanism.

3. Evaluation Design: All evaluation programs are distinctly designed on the basis of program's needs, purpose, end-users, objectives, and so on, therefore, an equally well-suited design for all kind of evaluation is not ideal. The planning in advance not only aims at identifying the uncertainties or the issues affecting the performance of the program, but, it also helps to develop different methods and strategies to address them. An evaluation design should address the items like purpose of the evaluation, users of the findings, application or uses of the gathered information and results, questions to be addressed, methods employed, and agreements clarifying roles and responsibilities.
4. Data Collection: The main goal of any evaluation is to provide information or gather data to solve problems and make decisions (Lancaster, 1988). The evaluation should seek to collect credible and useful information, as it is the foundation of any effective evaluation. The sources and methods used for collecting evidence also plays a critical role in defining the quality of data/information. At times, the data collected through informal means can be adequate and easily accessed, however, the data's credibility is questionable, as well as the findings and results from the analysis. Moreover, the data management

is as important as the data collection, which acts as a knowledge base for future reference to improve the program's performance (Garces et al., 2016).

5. Results and Findings: The conclusion of any evaluation derives from the analysis of data collected, qualitative or quantitative, that reinforces the utility and accuracy of the program. The findings and results can comprise of the recommendations, best practices, standards, interpretation, judgements, alternatives, and synthesis.
6. Knowledge sharing & Implementation: Evaluation is a learning experience that results in the development of knowledge, however, the evaluation is ineffective if the findings and results are not applied and implemented successfully. It requires strategic thinking and regular supervision to successfully implement the knowledge gained and lessons learned from any evaluation (CDC, 1999). Additionally, the development of common database through knowledge sharing creates a centralized network, reduces efforts and redundancy, benefit local bodies, and saves time and money (Carr, 2002). The four elements to ensure effective use of evaluation includes:

I. The addition of intended uses, benefits, and methods of application in the initial design model.
II. Prepared with appropriate steps for the use of new and enlightening information.
III. Creating feedback and follow-up tools for smooth communication to ensure continuous improvement.
IV. Dissemination of the strategies developed, and the lessons learned during the evaluation, to the stakeholders in an expeditious and consistent fashion.

2.6 ROLES OF AN EVALUATION GROUP

The staff members associated with any sort of evaluation program have a wide array of roles, the common terms used to describe those roles are shown in Figure 4. The evaluators' roles are based on the knowledge, skills, experience, and interaction with stakeholders. However, the distinction in the roles of evaluator can be observed among the internal and external evaluator. The internal evaluator works within the organization and possess great knowledge of the program and the organization but restricted to implement the modifications due to the position held. Whereas, the external evaluators are not a part of the organization or the program and provide a fresher perspective to the evaluation (Mathison, 2005)

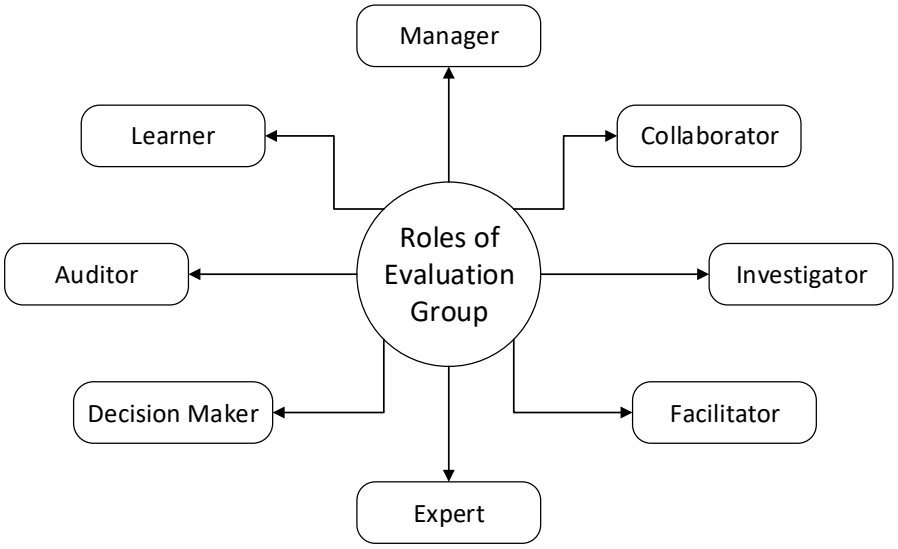

Figure 4: Roles of individuals from evaluation group (Mathison, 2005)

2.7 DECISION MAKING

Based on a 1999 survey, the decision-making process was found to be one of the most critical elements behind the successful implementation of a project (Parr. et al, 1999). Similarly, it has been determined that decision making plays a significant role with respect to evaluation, selection, and implementation processes, in particular (Shakir, 2000). Improved decision-making aids to mitigate the risk of failure by ensuring interests are aligned against mutually desired results and assists to maintain control over the accuracy of evaluation outcomes. In business, companies are often observed making erroneous decisions, either by pursuing the evaluation of a potentially unsuccessful product and wasting resources, or by skipping the evaluation of a potentially successful product (Ozer, 2005). However, the research shows that such erroneous decisions are avoidable, or can at least be mitigated. Through the integration of performance management, better decisions can be made that correctly redirect resources, and help to modify operations by setting achievable goals and priorities, monitoring outcomes closely, and ultimately improving performance (Verbeeten, 2008).

To promote a deliberate and effective approach, this research adapted the decision-making process proposed by UMass, Dartmouth (2018), shown in Figure 5. The decision-making model is based on the identification of the best available alternatives followed by, the thorough assessment of all the choices to select the most suitable option.

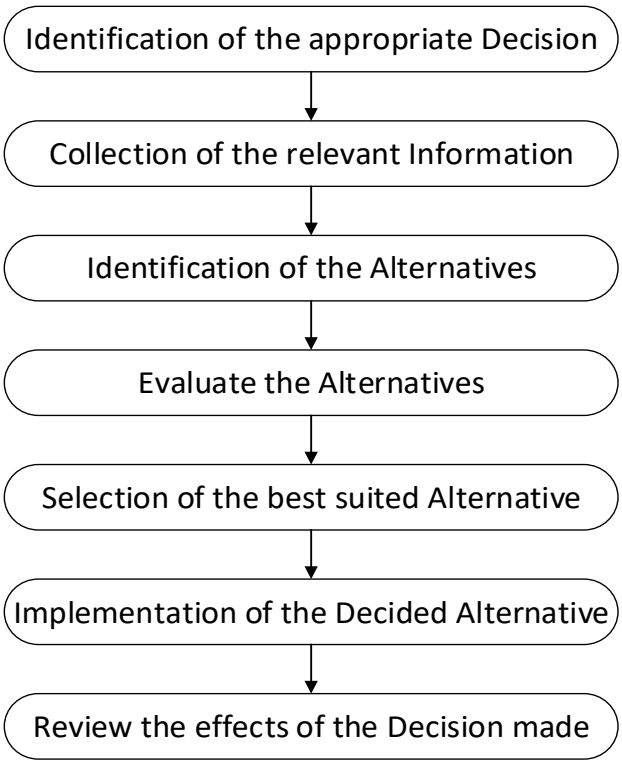

Figure 5: Seven steps of the decision-making model, adapted from "Decision-Making Process," University of Massachusetts at Dartmouth.

The evaluation process involves the participation of various internal and external parties; therefore, the communication aspect of evaluation is a critical part of enhanced and informed decision making, linked to access of information (Ozer, 2005). Table 1 details six decision-making models, including a brief description, and the process by which they can be utilized. Of course, selection of the best suited model is based on the scope of work, and goals and objectives of the program.

Table 1: Decision-Making Models, adapted from Shakir, M., 2000; Hoy et al., 1995

Model	Description	Process
Classical Model	Decision makers select the best alternative in association with the intended goals.	Necessary steps include identification and diagnosis of the problem, development of alternatives and their consequences, evaluation and selection of best suited, implement, and follow-up evaluation.
Administrative Model (Simon, H., 1947)	Decision makers investigate alternatives meeting minimum requirements.	The decision-making process is cyclic, which aims to narrow down the alternatives for the satisfactory solution.
Incremental Model (Lindbolm, C., 1959)	Decision makers initiate incremental changes based on the comparison of initial stages. This model has no set of clear objectives.	Successive comparisons of alternatives guide the usage and assist with the decision-making process.
Adaptive Model (Etzioni, A., 1967)	It is a mixture of administrative and incremental model.	Incremental decisions are made with respect to set objectives and goals.
Irrational Model (March, Cohen, and Oslen, 1972)	The decision is not considered to be a solution for any problem, but, it is a product of organizational events.	The decisions making process is opportunity based, rather than logic based. The decisions are made through scanning existing solution, problems, and participants.
Political Model (Caldas, M. P., 1999)	The model is pursued by the politics instead of the organizational goals.	Decision-makers primarily guides the process.

2.8 UNDERSTANDING ORGANIZATIONAL-CHANGE

A comprehensive review of relevant literature has helped the Researcher to determine whether organizational change is a necessary consideration for improving evaluation programs. At the outset, information was gathered from earlier works that identified some of the problems typically encountered during program implementation. As suggested by Kotter (2007), the most important aspect to bringing about change is to express a vision, communicate a sense of urgency, and then establish the motivation and cooperation needed to pursue it. Kotter further stated that "if you can't communicate the vision to someone in five minutes or less and get a reaction that signifies both understanding and interest, you are not done." Moreover, it is important to understand the need of change in the first place. As mentioned in a study by Armenakis and Bedeian (1998), the stresses resulting from dissatisfactions and inertia (commitment to current strategy) signal a need for change. Therefore, to improve the performance of work, the organization needs to understand the shortcomings and plan to implement change in a strategic manner that matches well with the targeted objectives of its internal and external requirements (Sastry, 1997).

The literature review confirmed that many organizations understand the importance of change and the need for large initiatives to successfully implement it. However, per Kotter's study, well over 50% of companies fail within the first phase of implementing change, often due to a lack of motivation and sense of urgency among the employees. To help address this failure, factors like receptivity, resistance, commitment, and other personal reactions should be considered whenever implementing change (Armenakis and

Bedeian, 1998). Other important factors, like addressing the inherent stress employees experience, whether due to lack of skill for new role, cynicism toward change, in general, or the result of inadequacies in the organization's sharing of information, should also be considered. Likewise, Judson (1991) suggested five phases that must be followed whenever implementing change within an organization, including a (1) planning phase, (2) communications phase, (3) acceptance phase, (4) turnover phase (i.e. moving from the status quo), and finally, (5) institutionalizing the new order. Ultimately, the research supports the notion that proper communication is key to resolving and avoiding many of the problems arising from any transformative process and should be used as a tool throughout the entire process (Kotter, 2007).

CHAPTER 3: RESEARCH METHODOLOGY

3.1 OVERVIEW OF THE RESEARCH METHODOLOGY

The method used by the Researcher to execute the research study included five major steps as illustrated in Figure 6. The research commenced with the analysis of the historic research to develop a firm understanding on the evaluation and its best practices with the help of available resources. The past studies helped to guide the future steps of the research work and provided a foundation to proceed with the current study. The analysis of available literature was divided into two categories: (1) Analysis of the academic literature and (2) Analysis of the industrial literature, to ensure robust assessment of all available resources associated with the present study. The literature focused on the areas of Evaluation, Decision Making, and Organizational Change as a part of the academic literature review; and studied the Product Evaluation Program (PEP) implemented at the NCDOT, nationwide DOTs, and other similar organizations like AASHTO APEL, NTPEP, ASTM, and others as a part of the industrial literature review.

The database created from the analyses of academic and industrial literature helped to prepare a survey questionnaire for nationwide DOTs with PEP to identify the implemented best practices. The review of historic research works on PEP helped to identify different parameters/criteria to be used on the survey to measure its performance. The database of survey responses collected from nationwide state agencies was managed using Microsoft Excel spreadsheet. Furthermore, the database was used to conduct various statistical and descriptive tests to study different characteristics of the PEP. The results of

the analyses helped to identify the best practices of state DOTs with formal PEP and develop a model to ensure high performance with optimal allocation of resources.

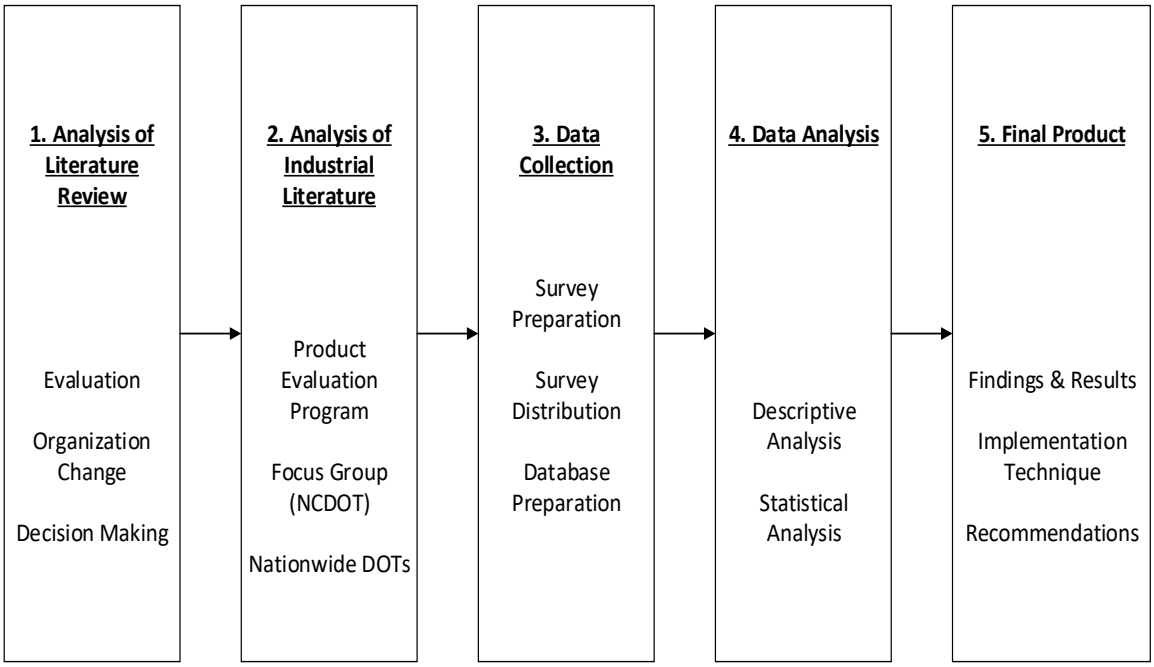

Figure 6: Steps involved in Research Methodology

3.2 EXISTING GUIDELINES & RESOURCES FOR PEPs

The Federal government and state authorities established new product and technology evaluation services like AASHTO APEL, NTPEP, HITEC, ASTM etc. to help the DOTs and other local bodies to gain access to qualified products. These services can be used by manufacturers, allowing them to submit their products for accelerated laboratory test results. Many states utilize APEL to conduct the laboratory evaluation of a product undergoing full scale testing along with field trial. The APEL database comprises of the evaluation reports only, and do not provide a report on the approval for application (AASHTO, 2018). The APEL database of approved/qualified products allow state DOTs with recognized PEP to update/share the evaluation results.

The Highway Innovative Technology Evaluation Center (HITEC) is a collaborative program established in 1992 by the FHWA and CERF. The HITEC program aims to evaluate new and innovative highway technologies and expedite their transfer into practice. The importance of updating the online database by sharing the results of products evaluated by DOTs having an internal evaluation program holds a great value. This is useful, as the common database will help to create a more centralized network, reduce the duplicity of products, and save reasonable time and money for all DOTs. Moreover, states like Maryland and Oregon established their independent product evaluation program and databases because of the failure of other DOTs to contribute to the database (Carr, 2002).

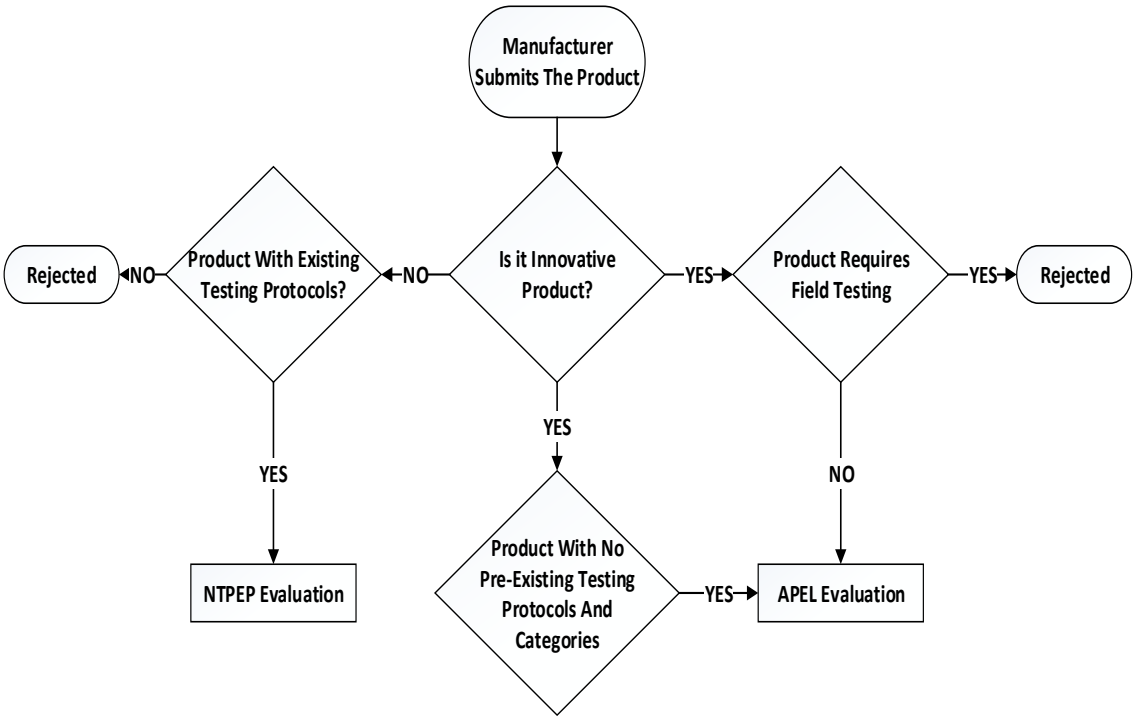

Figure 7: Product evaluation decision tree, adapted from of AASHTO National Transportation Product Evaluation Program (NTPEP)

According to NCHRP Synthesis 328, Carr described several principal concerns that can be anticipated in an evaluation program, such as dedicated staffing, expert committee, infrequent evaluation, program recognition, timing, single-common database, and lack of

dedicated funding. This research builds on that study, allowing it to identify other issues in need of resolution, such as poorly structured applications, irrelevant product information, and lack of communication and feedback tools that hindered with the performance of the evaluation program based on the analysis of available literature. Another challenge is defining and accepting a new product, rather than evaluating it. As per the survey results, Carr noted that "20% of the DOTs consider a product new if it had not been used in practice by the agency, whereas nearly 18% indicated that a product was considered new if it had not been evaluated by the agency" (Carr, 2004). This paper largely focuses on the above concerns in its review of the NCDOT PEP, which is outlined in the following section.

3.3 NCDOT SPECIFIC PEP

A Product Evaluation Program (PEP) serves as a framework for the introduction of new and innovative products to be utilized in the field, and ultimately improves the constructability of DOT projects (Carr, 2001; ADOT, 2012). As an evaluation method, PEP performs critical assurance processes through several methods including laboratory tests, Material and Safety Data Sheet (MSDS) analysis, checking for an internal need, outlining specification requirements, determining availability, and testing for feasibility before a product can be approved for use in the field.

Most DOTs maintain an Approved Product List/Qualified Product List (APL/QPL) that is comprised of various categories of tested and approved products. The product applications may include materials, processes, technologies, and even methods that are not yet part of the APL/QPL but have the potential to be used in projects where its implementation can be shown to foster added benefits for future and existing infrastructure (Appendix 2, Exhibit B).

3.3.1 HIERARCHY/ORGANIZATIONAL STRUCTURE

The product evaluation program is mainly governed by three groups: (a) Value Management Team (VMT), (b) Technical Work Group (TWG), and (c) Maintenance Team. These groups are responsible to carry out entire evaluation from initial part of product submittal till the final decision of the committee and track the performance of approved products that are placed in the field. Figure 8 provides the brief description of roles and responsibilities for each group.

Other commonly used terms associated with PEPs are: Field trial process, appeal, recertification, and product status. The field trial process is an extension of existing evaluation to further review the performance of the product in the field. The manufacturer of the product is responsible to arrange the placement/installation of product in the field and get it re-evaluated with the performance reports. The vendors have a right to appeal the decision made by the technical committee on the product's rejection and resubmit the product application for evaluation with modifications. The products are assigned different status based on the stage or decision of the evaluation. Few of the commonly referred status given to the products include: under evaluation, approved for provisional use, require field trail, approved, or rejected.

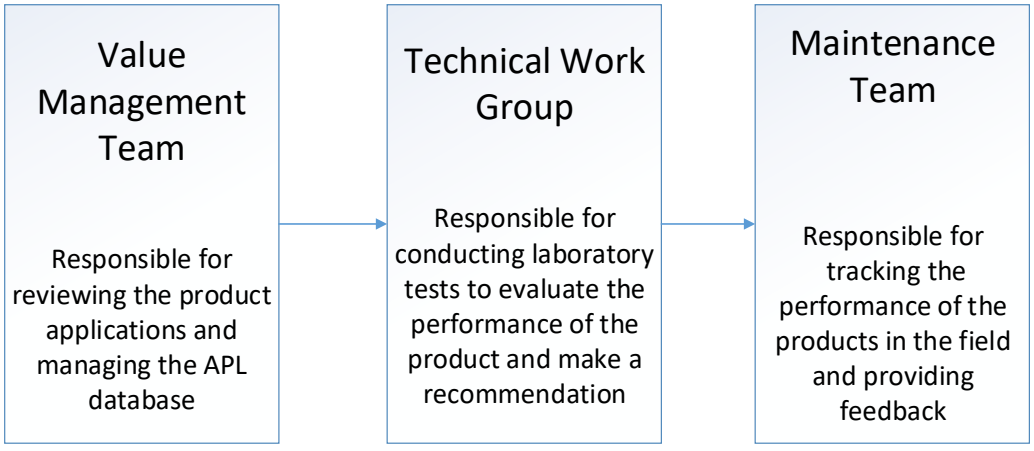

Figure 8: Roles of different groups involved in PEP at NCDOT, adapted from the meeting with NCDOT staff member

3.3.2 DECISION-MAKING AUTHORITY AND PROCESS

The technical committee decides the product's status in numerous ways depending upon the stage of evaluation. The commonly used terms to define the product status are: approved and ready to use in projects, under evaluation, under evaluation and require more information from vendor (additional information required), approved for field trial, approved for provisional use i.e. with restriction or limitation to use, and rejected. The APL database is regularly maintained by the PEP manager with the details of each product along with its status (Appendix 2, Exhibit B).

An applicant-manufacturer or vendor is responsible for submitting the product, along with relevant product details, to the NCDOT website. When a product is rejected, vendors are notified of the committee's decision and given an option to appeal the within a fixed window of time. This provision helps to maintain the transparency in evaluation process and provides an opportunity for vendors to get their product re-evaluated. To keep the APL updated, NCDOT annually conducts recertification of products to check against the modified specifications and guidelines (Appendix 2, Exhibit B). Likewise, more collaborative and inclusive Product Evaluation Programs are widely beneficial, as local organizations that lack resources or funding to implement their own evaluation program can improve the quality of their products and services by accessing the APL/QPL provided by their respective DOT (Carr, 2002).

3.3.3 TIMING

Under the current product evaluation program employed by NCDOT, the evaluation of a single product has a targeted timeline of completion, ranging from two months to one year. Notably, before this formal evaluation process can be initiated, the agency must first review the product application, which takes an average of two weeks (Roskman, 2017).

3.3.4 MISSION/PURPOSE OF PRODUCT EVALUATION PROGRAM

The program aims at evaluating new and innovative products that are needed by the NCDOT, but do not fall within the Approved Product List (APL) at the time of review. Although an on-site engineer has the freedom to use products that are not included in the APL, such decisions depend on the respective project requirements. Currently, the NCDOT does not evaluate products that do not satisfy the prescribed standards and specifications (Roskman, 2017).

3.3.5 IT SERVICES AND SOFTWARE

As of this study, NCDOT utilizes the Highway Construction and Materials System (HiCAMS) software to maintain, update, and inspect the database of the APL. The HiCAMS software is also capable of tracking the product placement and provide notifications to conduct routine inspections to examine the performance of the products placed in the field. The database of the products on the APL is updated and managed by the PEP manager using HiCAMS. Currently, the APL database consist of approximately 220 categories of approved products, and sub- categorized as type-1, type-2, and type-3 for few products depending upon their characteristics. Additionally, the agency has used HiCAMS to control other management tasks, such as costs, testing, and inspection data.

3.3.6 PRODUCT INFORMATION AND FEEDBACK

The primary source of information for any product to be evaluated is the application form and the supporting documents submitted with it. Failure to retrieve necessary information can cause delay during the technical evaluation as the vendors are notified to resubmit the product application for evaluation with the required additional information. Whereas, the information on approved product's performance after the placement in the field is captured using the feedback form filled out by the maintenance team (Appendix 2, Exhibit D).

3.3.7 PRODUCT EVALUATION PROCEDURE

The PEP at NCDOT can be broken down into four major steps from the initial stage to the final stage. Appendix 2, Exhibit A and Exhibit B provides the actual PEP description used by NCDOT to illustrate the process and various technical terminologies. Figure 9 shows the basic structure of PEP at NCDOT and its core objectives.

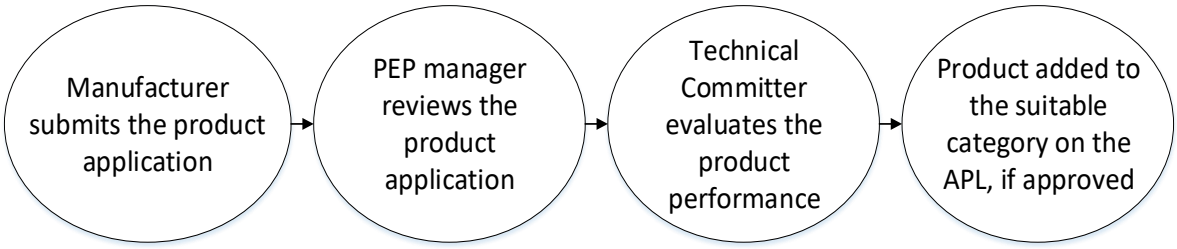

Figure 9: Generalized procedure of the PEP at NCDOT

Step 1: The applicant (vendor) fills out the product application form along with providing 1-3 pages of description of product, Material Safety Data Sheet (MSDS), and associated certified test reports.

Step 2: The product enters the first phase of evaluation, where the PEP manager evaluates the validity of the provided information and check for internal need, commercial availability, and standards and specifications. The first phase of evaluation roughly takes two weeks of time.

Step 3: After the qualification of initial review phase, the PEP manager forwards the product information to the associated Technical Work Group (TWG) based on the type of product under evaluation to carry out other technical tests. The TWG studies the documents and decides the next steps i.e. if the product requires to go through field trial, applicable for provisional use, requires additional information, or the final approval/rejection.

a) Approved for field trial: In this case, the products are approved based on the results of laboratory tests but requires further examination of the performance in the field. Example of such products can be cement, sealant, etc. The vendor is responsible to get the field trial report and get the final approval.
b) Approved for Provisional Use (APU): In this case, the product has been evaluated and approved with restrictions to use based on site specific and/or project specific conditions being met. The conditions are that: (I) the vendor should provide the required product, (ii) the contractor should be willing to use the product, and (iii) the consent of the stakeholder is necessary.
c) Product requires further information: In this case, the product application is put on hold due to the absence of required information to finish the evaluation. The vendor is notified to submit the required additional information on the product within one-month time for the re-evaluation. Failure to do so leads to an automatic rejection of the application.

Step 4: The PEP manager updates the APL database of the finally approved products. However, the vendor has the provision to appeal the decision of TWG on product rejection and request a review of the product along with providing additional information.

3.3.8 OTHER IMPORTANT FINDINGS

1. The cost of evaluating the product is completely bear by the NCDOT unless the product requires test reports from external agencies like NTPEP (National Transportation Product Evaluation Program). In such cases, the vendors are responsible to pay for the tests conducted.
2. The PEP keeps a target of 60 days to finish the entire evaluation process. But, depending on the product and workload, the maximum time for evaluation is one year. The approved products are re-certified on annual basis or on the recommendations of TWG. If the product is rejected, the vendor is provided a window of 30 days to apply with additional information for re-evaluation.
3. The PEP is currently overseen by two dedicated employees. The other members of PEP committee are not solely dedicated to the PEP but are responsible for part-time duties. Moreover, the PEP program does not have a dedicated funding towards the management of evaluation program.

Table 2: Summary of the product applications and results at the NCDOT for the fiscal year 2016-2017, Adopted from the NCDOT PEP Annual Conference-2017

State Fiscal Year Totals	**2015-16**	**2016-17**
Number of Applications Received	342	396
VMT Processing time	4 days	4 days
TWG Decision time	86 days	98 days
Number of Evaluations Finished over one year	2	9
Number of Total Decisions made	297	225

Approved Product List	**2016**	**2017**
Number of Products Under evaluation	106	143
Number of Products that Required Additional information	46	38
Number of Products Accepted for field trial	27	37
Number of Products Approved for Provisional Use	318	352
Number of Products Approved	1389	1438

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3.3.9 CHALLENGES FACED BY PEP AT NCDOT

The Researcher identified the major challenges and problems faced by NCDOT staff members during a meeting with the PEP manager and other committee members. This information helped to ensure the successful operation of the PEP, aided by an analysis of annual reports, past product applications submitted for evaluation, and follow-up talks with the PEP manager and other staff members at NCDOT. One of the major issues identified was the communication gap among different parties involved within the agency responsible for ensuring an effective evaluation program. As a result, the agency faced difficulties to track the placement or performance of the installed products in the field. The members of the maintenance team struggled to provide the feedback on product's performance using the submission of hard copy of the feedback form to the value management team. The value management team struggled to coordinate among different groups involved within the program using e-mails as primary communication channels. Higher management showed little confidence in the PEP objectives due to lack of program recognition. Additional problems regularly faced by PEP staff members were expressed as:

- There are only two designated employees in the value management team responsible to manage the PEP and control the APL database, therefore, the responsibilities were always burdensome.
- The PEP does not have dedicated funds to support the additional expenses for effective product evaluation.

- The PEP committee do not include members from higher management and the experts from different backgrounds.
- The PEP database does not maintain the database of rejected products.
- The agency's IT services or database management software (HiCAMS) require updates and modifications to improve communication and enhance the evaluation process.
- The PEP flowchart is lengthy, complicated, and difficult to understand.
- The electronic mails (e-mails) or phone calls used to communicate with the vendors and other employees are difficult to track.
- The customer management is a challenge due to inefficient communication tools.
- The development of specifications for new product categories require experts' dedicated amount of time.

CHAPTER 4: DATA COLLECTION

4.1 SURVEY PREPARATION AND FOLLOW-UP INTERVIEWS

The Researcher conducted a robust study to prepare a survey questionnaire with questions from a variety of associated backgrounds to understand the best practices, organizational culture, employee satisfaction, communication tools and methods, and overall performance of the PEP. The survey was prepared using the Qualtrics web-based service due to its highly interactive interface and ease of use. The survey was distributed to all 50 state DOTs with the help of a contact list provided by NCDOT, assisting the research team with a 56% response-rate (28 DOTs).

The survey questionnaire included a total of 40 questions, which could be further classified into different categories based on the scope of the study, derivation, and source. The survey preparation began in or about January 2018, and took approximately six to eight weeks to complete, after pursuing several rounds of feedback from members of the research committee, as well as NCDOT staff members associated with the work. The survey required roughly 15 minutes for the respondent to provide answers to 40 questions covering various aspects of the PEP.

The questions were prepared using the help of relevant research work (Carr, 2004), PEP annual reports by various state DOTs (Nevada, Arizona, and others), PEP annual conference of NCDOT, and the recommendation from NCDOT staff members. The distribution of the sources used to prepare the questions have been listed in Table 3. Additionally, Table 4 provides few of the noteworthy questions from the survey that were

aimed to identify the state agencies with improved evaluation program and their best practices.

Table 3: Frequency of survey questions and their source

Source	Number of Questions
Organization Change (Academic Lit Review)	7
PEP (Academic Lit Review)	13
State Agencies Annual Report	7
PEP Analysis at NCDOT	13
Total Questions	40

Table 4: Noteworthy questions used in the survey questionnaire

Noteworthy Survey Questions:
How many staff members have a current and primary responsibility of managing and supporting the Product Evaluation Program (PEP)?
Which acceptance criteria does your state use to evaluate its products?
Compared to 2016, how has the number (#) of product evaluations changed?
How many products did you evaluate, approved, and rejected in the year 2017?
How do you track the placement, installation, and/or use of products in your state?
How satisfied are you with the communication/feedback process between the different stages of evaluation program?
How satisfied are you with the performance of your PEP?

The responses were recorded on the Qualtrics web-servers, which were later exported to the Excel spreadsheet to develop an exhaustive database with essential

information. Additionally, the Researcher conducted follow-up interviews with the PEP manager of state agencies identified as highly responsive to further investigate the evaluation tools and techniques. The interview process lasted for approximately one month with almost 30 minutes spent for each interview. The interviews were critical to obtain detailed information on areas like use of database management tools and techniques, tracking product's performance after installation, IT services and software, resource utilization and allocation, initial and technical evaluation criteria, unique features, challenges, and an overview of the PEP.

4.2 DATA DESCRIPTION

Figure 10 lists a few of the important variables used for the descriptive and statistical data analysis and classify them based on the character of the response. The classification was based on the measure of variables (ordinal, dichotomous, or continuous) and nature of the analysis (independent or dependent) as shown in Figure 10. The ordinal variables were recorded on a Likert scale of 1 to 7 with "1" being "Extremely Dissatisfied" and "7" being "Extremely Satisfied" with the performance and communication of the PEP. The dichotomous variable was recorded as either "yes" or "no" and the continuous variables or the quantitative variables were recorded as real numbers.

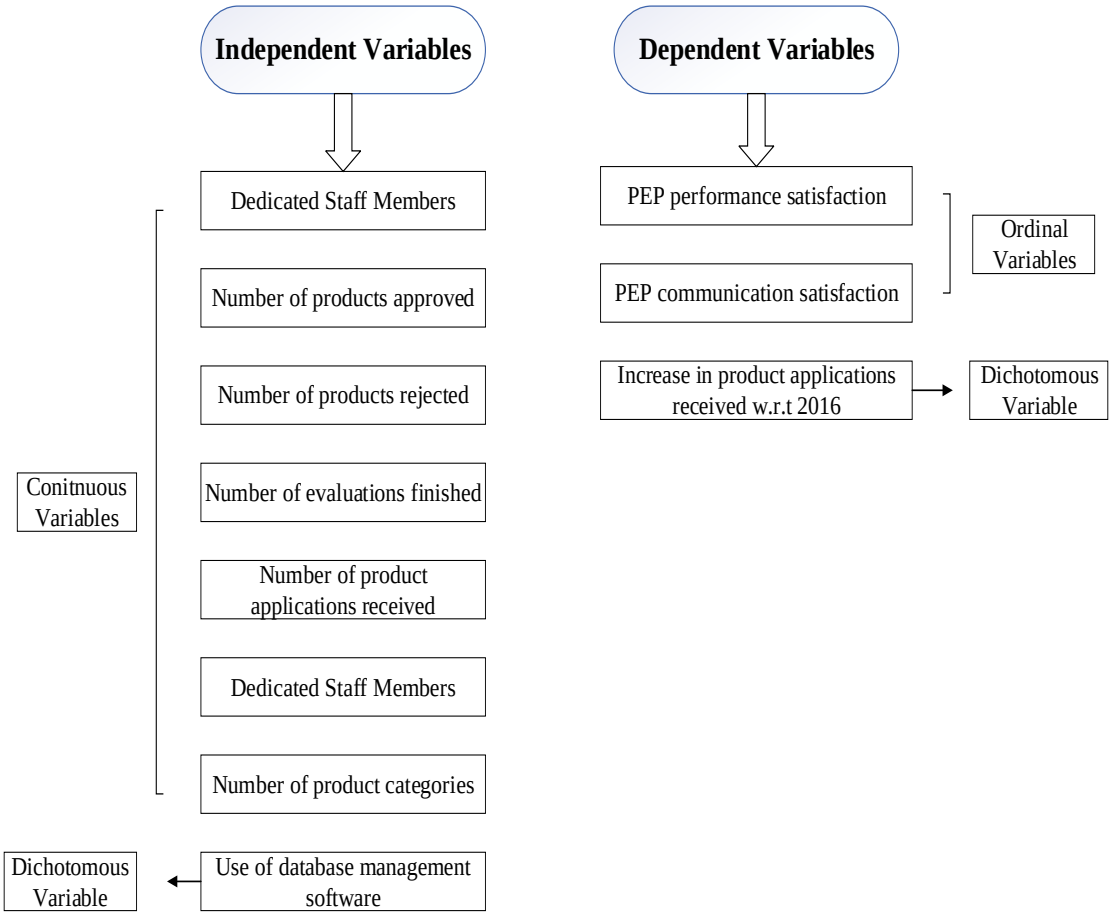

Figure 10: Description of variables used in the study

CHAPTER 5: DATA ANALYSIS

5.1 DESCRIPTIVE DATA ANALYSIS USING IBM SPSS

5.1.1 DISTRIBUTION OF APPROVED PRODUCTS ACROSS 24 DOTs

Table 5 provides the statistical summary of the number of products approved by 24 state DOTs throughout United States to easily understand the data collected through surveys. Moreover, the trend of approved products can be interpreted using the histogram shown in Figure 11, as approximately 65% of the respondents approved 50 products or less in 2017. According to Table 5, the mean number of products approved that same year was approximately 64 products, median of 47 products, and the standard deviation of about 65 products.

Table 5: Summary statistics for the number of products approved among 24 DOTs

Approved Products		
Sample Size	Valid	24
	Missing	0
Mean		63.50
Std. Error of Mean		13.223
Median		47.00
Mode		50.00
Std. Deviation		64.78
Variance		4196.95
Skewness		1.546
Std. Error of Skewness		.472
Range		259.00

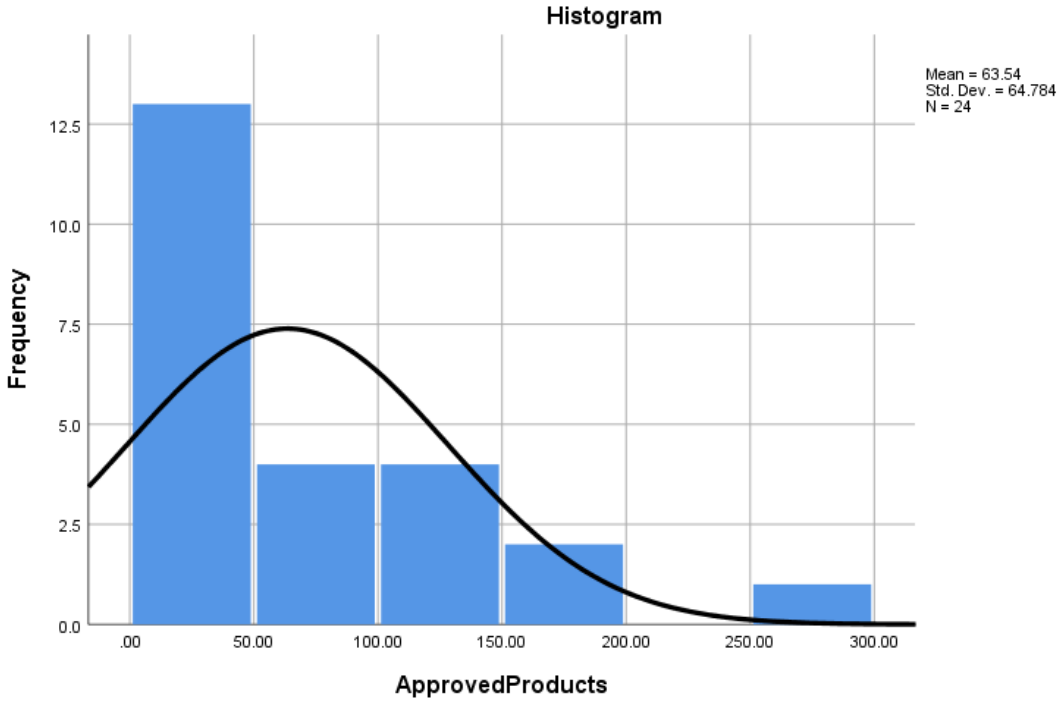

Figure 11: Frequency distribution for the number of products approved among 24 DOTs

5.1.2 DISTRIBUTION OF REJECTED PRODUCTS ACROSS 23 DOTs

As shown in Table 6, the statistical summary on the number of products rejected helps to comprehend the data collected from 23 DOTs, using surveys and follow-up interviews. Moreover, the histogram in Figure 12 provides the visual interpretation of the results and validates that approximately 80% of the DOTs rejected under 25 products in 2017. The number of products rejected in 2017 had a mean of 24 products, median of 10 products, and the standard deviation of about 40 products.

Table 6: Summary statistics for the number of products rejected among 23 DOTs

Rejected Products		
Sample Size	Valid	23
	Missing	1
Mean		24.00
Std. Error of Mean		7.913
Median		10.00
Mode		5.00[a]
Std. Deviation		37.95
Variance		1440.45
Skewness		2.142
Std. Error of Skewness		.481
Range		132.00

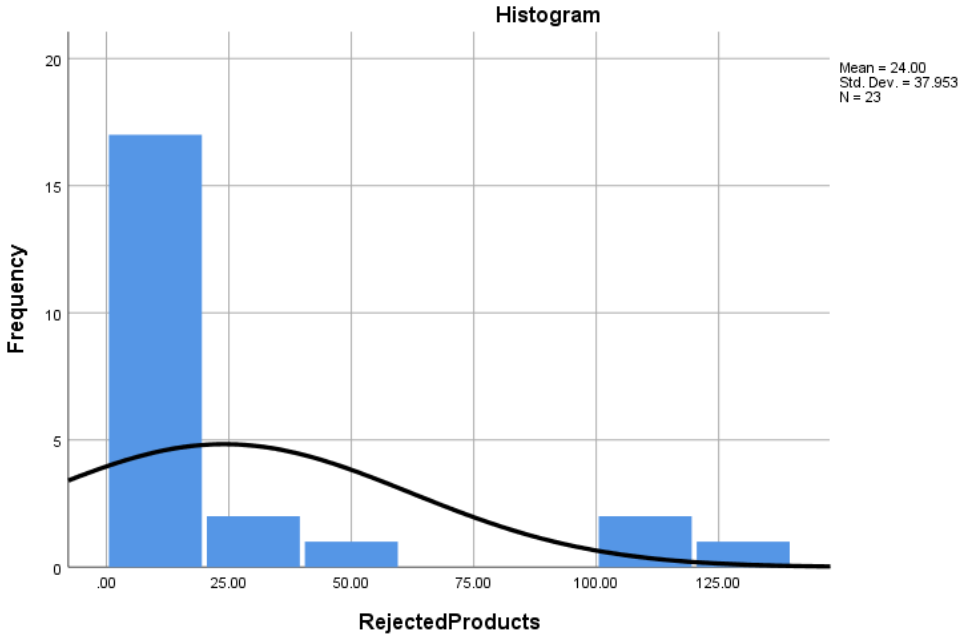

Figure 12: Frequency distribution for the number of products rejected among 23 DOTs

5.1.3 DISTRIBUTION OF EVALUATIONS FINISHED ACROSS 24 DOTs

The statistical summary in Table 7 provides the summarized results of the data collected from 24 state agencies on the number of evaluations finished in 2017. Figure 13 uses a histogram to study the trend and the frequency of the number of completed evaluations. Of the 24 state agencies investigated, approximately 70% finished less than 100 product evaluations, resulting in a mean value of 77 products, median of 40 products, and a standard deviation of about 88 products.

Table 7: Summary statistics for the number of evaluations finished among 24 DOTs

Evaluations Finished		
Sample Size	Valid	24
	Missing	0
Mean		76.40
Std. Error of Mean		17.998
Median		40.0000
Mode		50.00
Std. Deviation		88.17
Variance		7775.12
Skewness		1.473
Std. Error of Skewness		.472
Range		309.00

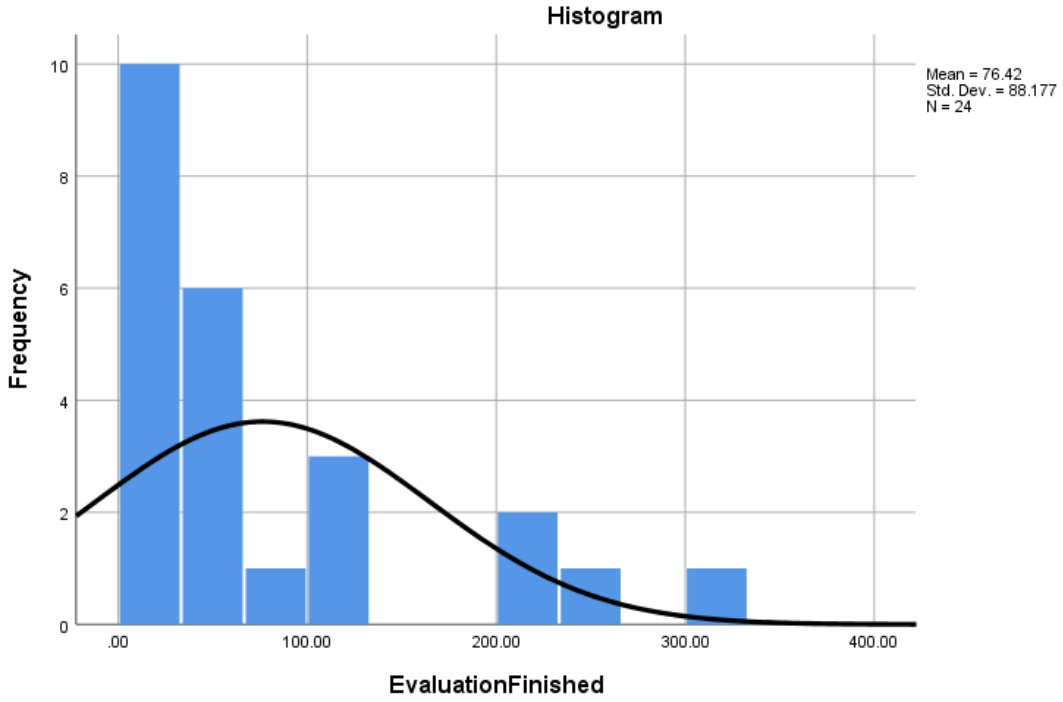

Figure 13: Frequency distribution for the number of evaluations finished among 24 DOTs

5.1.4 DISTRIBUTION OF INITIAL & TECHNICAL PRODUCT REVIEW DURATION

Table 8 provides a statistical summary for the two datasets – (1) the number of days taken to finish the initial product review and (2) the number of days taken to finish the technical product review, that helps to interpret the data from 18 different agencies and compare the two phases of product evaluation. Moreover, the distribution of the agencies with their review duration for both the phases can be analyzed using Figure 14 and Figure 15. A clear distinction can be observed among the two phases using the histogram, as most of the DOTs take considerably more time in the technical review phase. However, the duration for initial review phase is more spread-out.

The number of days taken to finish the initial product reviews conducted in 2017 had a mean value of approximately 30 days, median of 18 days, and a standard deviation

of about 44 days. Whereas, the technical review duration had a mean value of approximately 228 days, median of 143 days, and the standard deviation of about 224 days (Table 8).

Table 8: Statistical summary of the number of days consumed for initial product review and the technical product review for the 18 DOTs responded.

		Initial Review Duration (Days)	Technical Review Duration (Days)
Sample Size	18	18	18
	0	0	0
Mean		32.00	228.10
Std. Error of Mean		-	52.704
Median		18.00	142.50
Mode		1.00a	15.00
Std. Deviation		44.34	223.60
Variance		1966.40	49999.16
Skewness		2.512	1.802
Std. Error of Skewness		.536	.536
Range		179.00	885.00

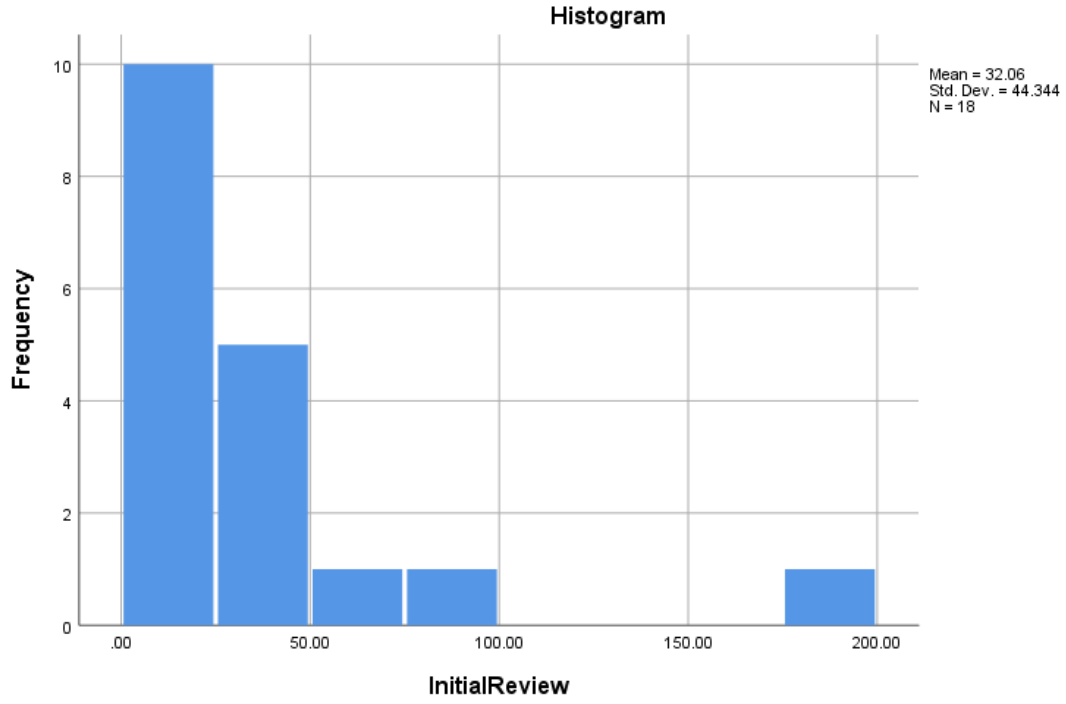

Figure 14: Frequency distribution for the initial product review duration by 18 DOTs

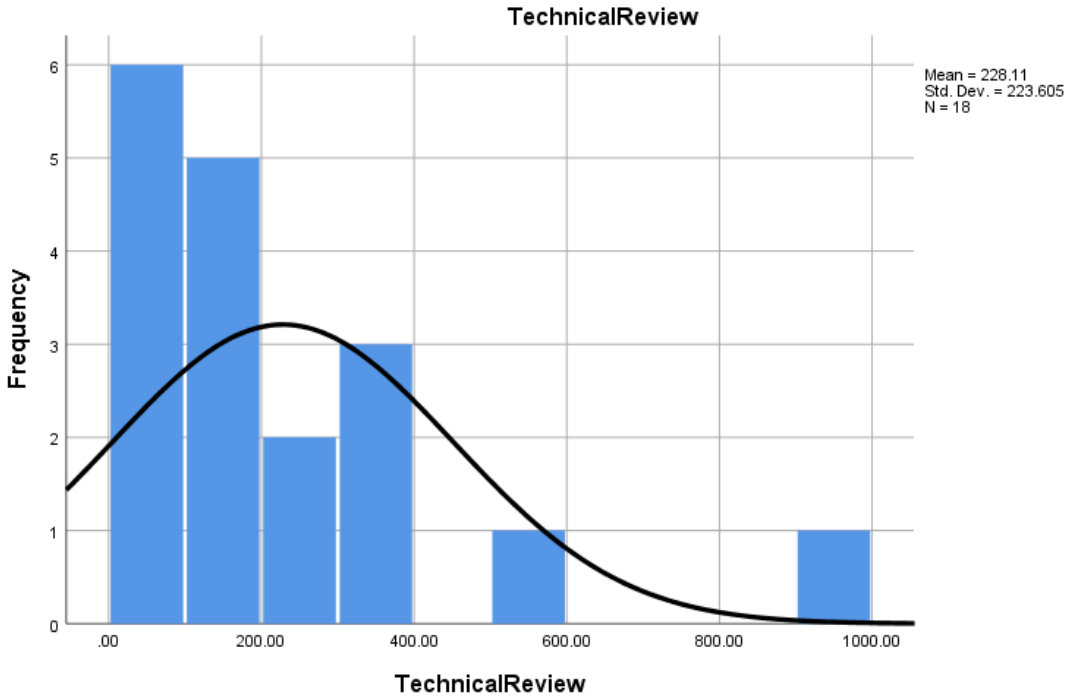

Figure 15: Frequency distribution for the technical product review duration by 18 DOT

5.2 DESCRIPTIVE DATA ANALYSIS USING MICROSOFT EXCEL

5.2.1 PRODUCT APPLICATION TREND

Figure 16 shows the trend of applications received in 2017 with respect to the year 2016. Out of 21 responses collected, 48% of DOTs received about the same number of applications, four DOTs showed an increase of 15%, and three DOTs showed an increase of 30% in comparison with the previous year. Moreover, the Oklahoma DOT showed a tremendous rise with an increase of over 60% in the number of applications received as compared to the previous year. However, the North Carolina DOT, Texas DOT, and Alaska DOT were the only state agencies that showed a decline in the number of applications received in comparison to previous year (these agencies observed a drop of 15%, 30%, and 60%, respectively). According to several PEP managers from different state agencies, the limited growth or fall in applications received was due to a lack of program recognition and/or limited participation of vendors/manufacturers as committee members.

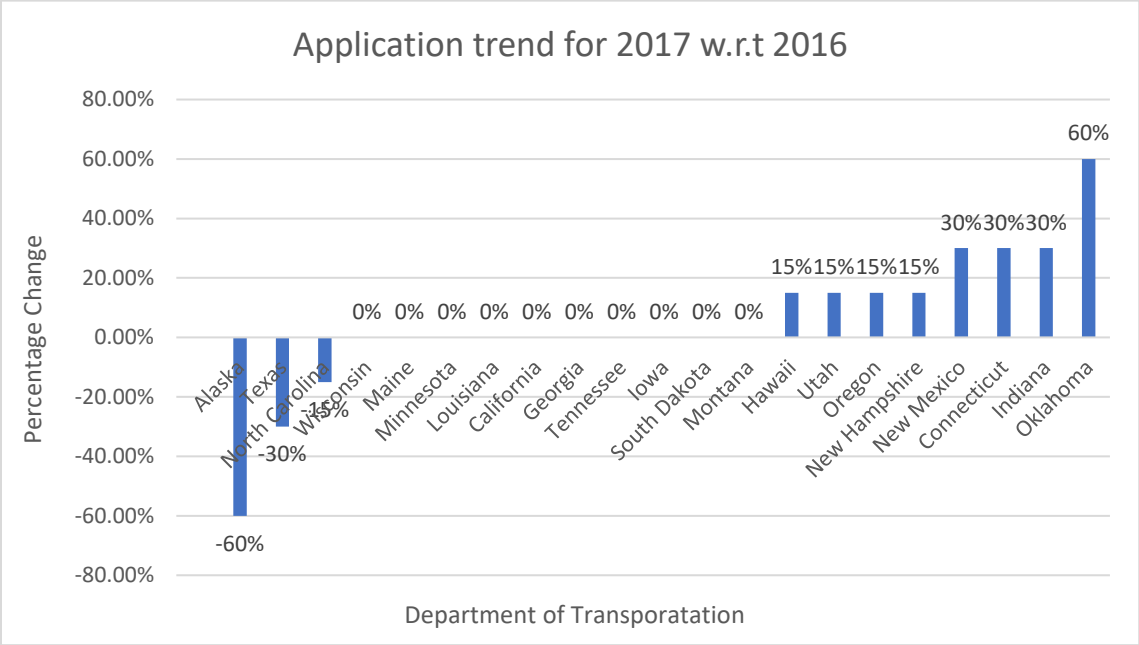

Figure 16: Distribution of the application trend for 2017 with respect to 2016 for 21 DOTs

5.2.2 SATISFACTION WITH PEP PERFORMANCE & COMMUNICATION

Figure 17 shows the level of satisfaction attained by various DOTs with respect to the communication among different parties involved within the agency and the overall performance of the respective PEP. Out of 25 responses observed, 44% of DOTs were moderately satisfied with communication and 68% with the overall performance. However, the DOTs with dissatisfaction or slight satisfaction with the communication and the overall performance accounted for 36% and 20%, respectively. New York DOT and Maine DOT were the only agencies that exhibited extreme satisfaction with the communication as well as overall the performance of PEP.

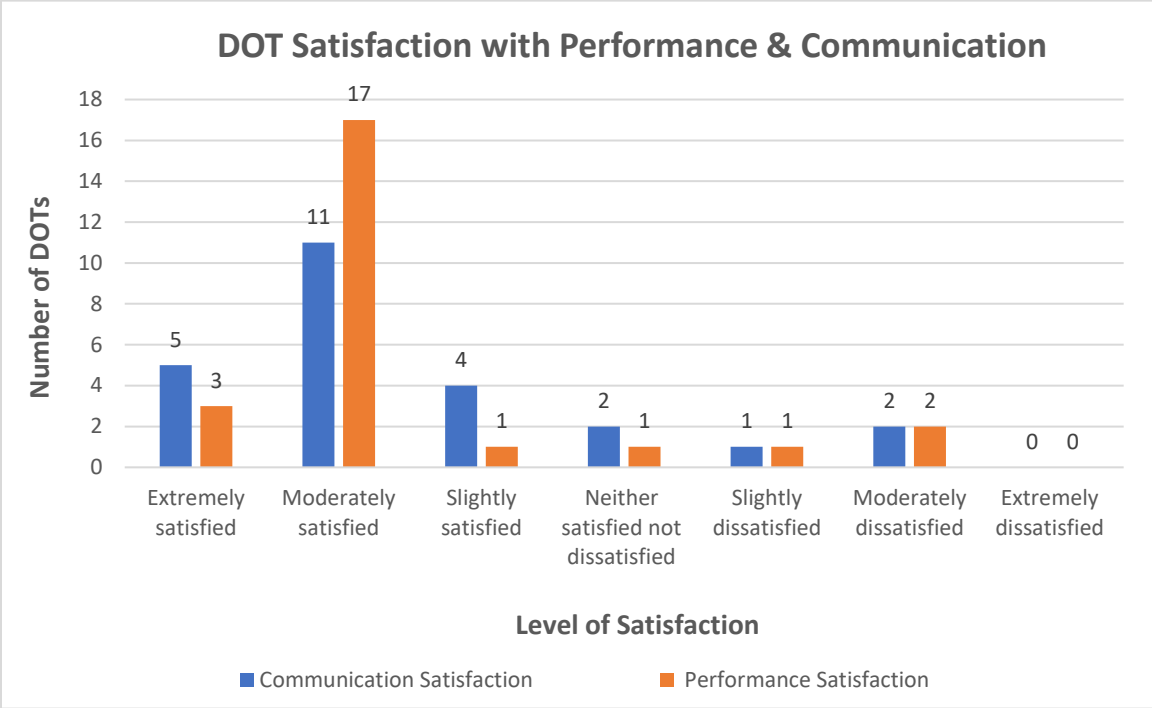

Figure 17: Frequency of the communication and performance satisfaction for 25 DOTs

5.2.3 CRITERIA CONSIDERED FOR APPLICATION / INITIAL REVIEW

The DOTs have defined criteria to conduct the initial product review for potential applicability. Figure 18 shows the most frequently used criteria by the nationwide DOTs. As observed, the lab and field test results along with DOTs established standards and specifications were the two most widely used criteria with 15 votes. The other frequently used criteria were AASHTO's specification, DOT's internal needs, and safety and hazard test results with 12, 10, and 9 votes, respectively.

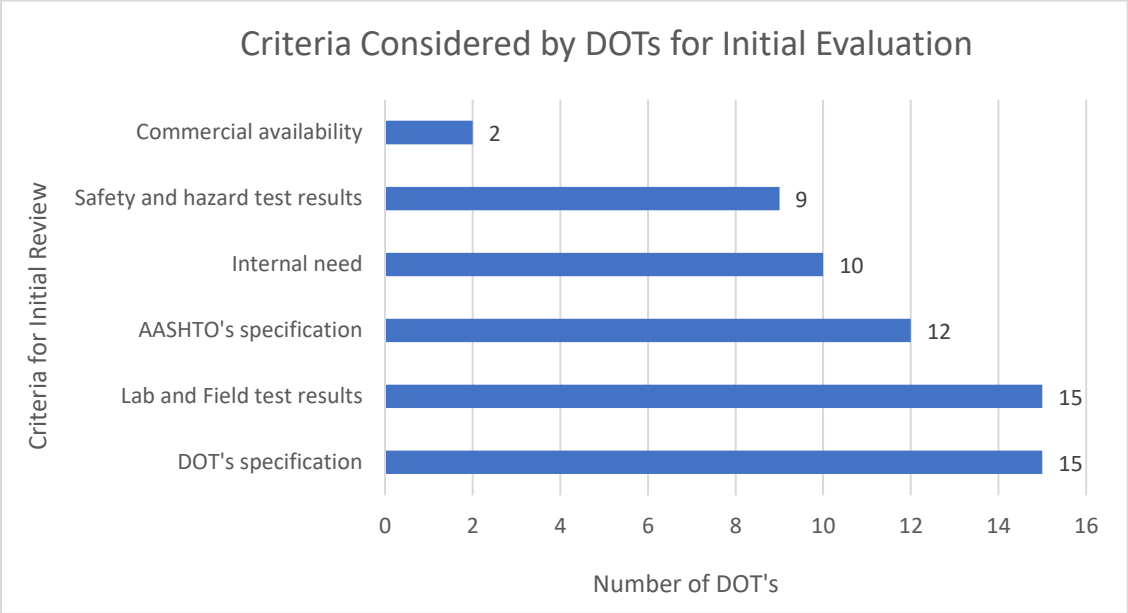

Figure 18: Frequency of the criteria considered during the initial review process for 15 DOTs

5.2.4 DEDICATED STAFF MEMBERS IN THE PEP AT NATIONWIDE DOTs

The analysis captured in Figure 19 represents the distribution of staff members dedicated to overlook and manage the PEP throughout the DOTs. The survey results showed that 40% of DOTs have only one dedicated staff member to manage the entire evaluation program, and 72% DOTs have either two or less than two dedicated staff members. However, agencies like Minnesota, Louisiana, New York, and Kentucky offered 5 or more full-time positions to manage their PEP.

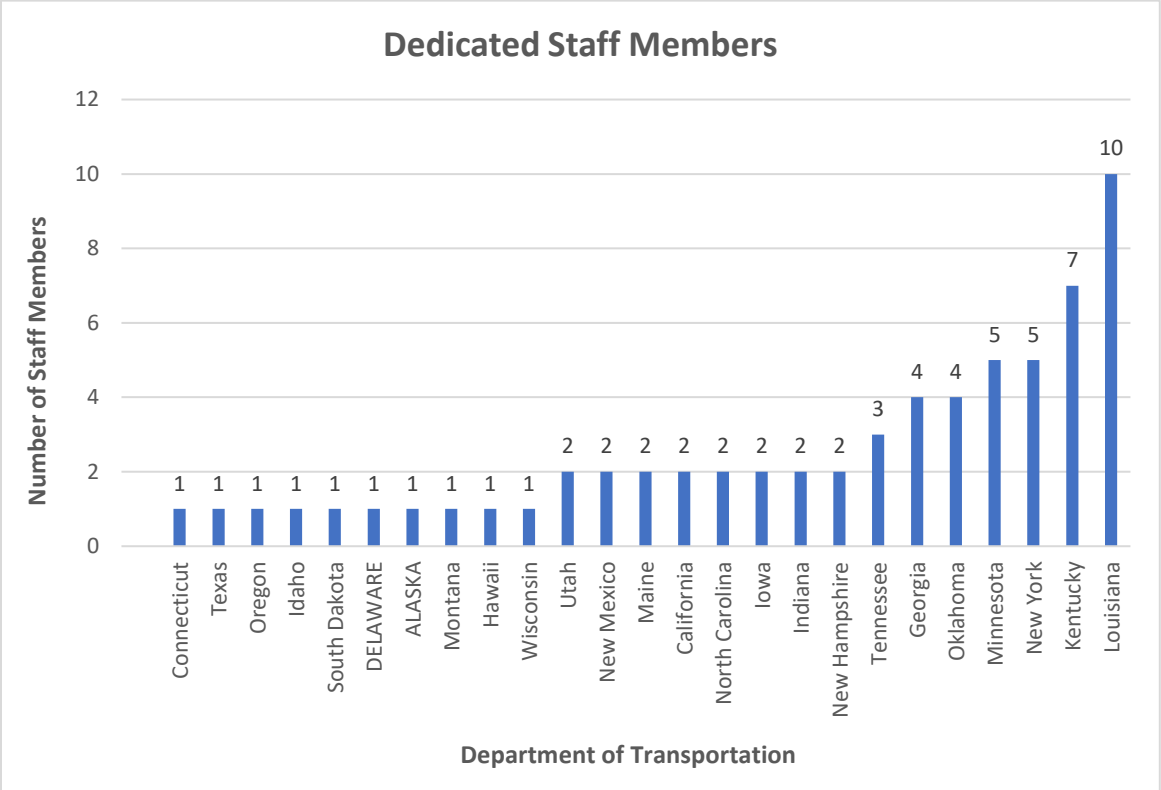

Figure 19: Frequency of the number of dedicated staff members for 25 DOTs

5.2.5 DURATION OF INITIAL REVIEW AND TECHNICAL EVALUATION

The product evaluation was divided into two phases: the first phase included the preliminary investigation of product application and associated documents to check for product's feasibility, and the second phase was the technical evaluation of the product to determine its performance under various condition. As shown in Figure 20, a few agencies, such as Utah, New Mexico, Tennessee, Kentucky, and Oklahoma spent considerable time during the initial review phase and saved substantial time during the technical evaluation phase. However, it was observed that several agencies like Missouri, Connecticut, Texas, Indiana, and South Dakota dedicated little time for the initial review phase but took a significant amount of time during the technical review phase.

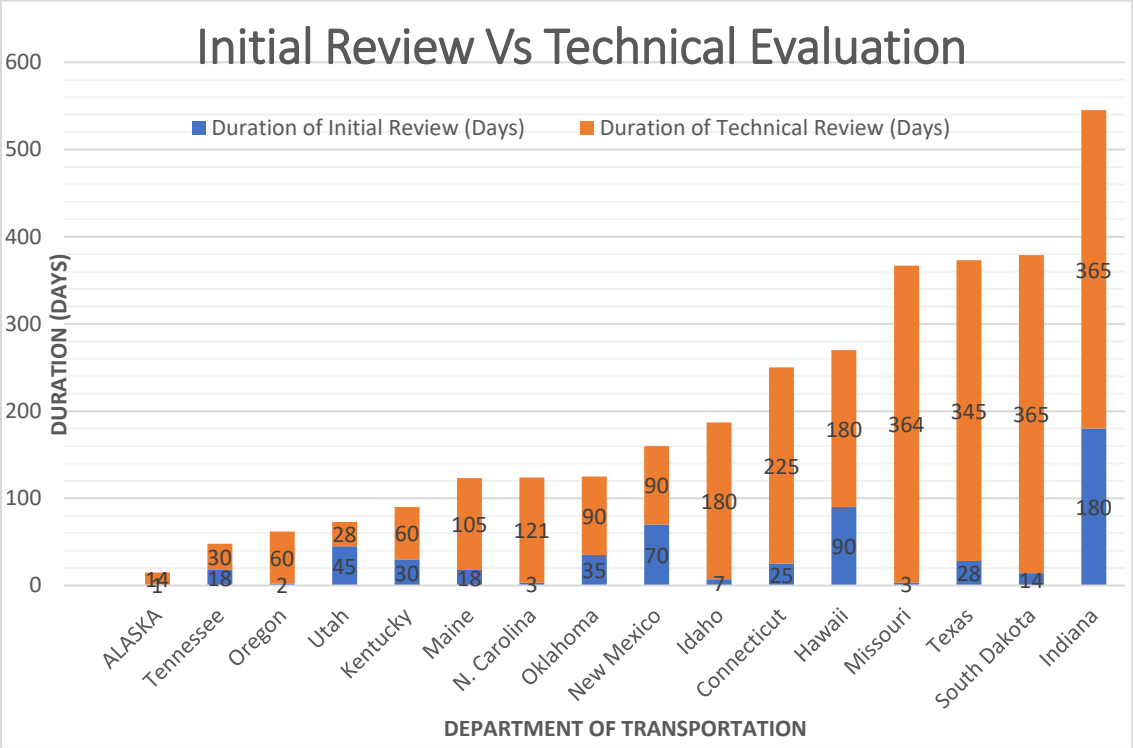

Figure 20: Distribution of the initial review and technical review duration for 15 DOTs

5.2.6 USE OF DATA MANAGEMENT SOFTWARE

As shown in Figure 21, out of 23 responses recorded for the use of data management software to maintain, update, and control product database, 70% of the DOTs use software either created within their agency or adopted industrial software like Oracle, MS Excel, MS Access, and others. The remaining 30% of the DOTs do not use any specialized software to manage or handle their database.

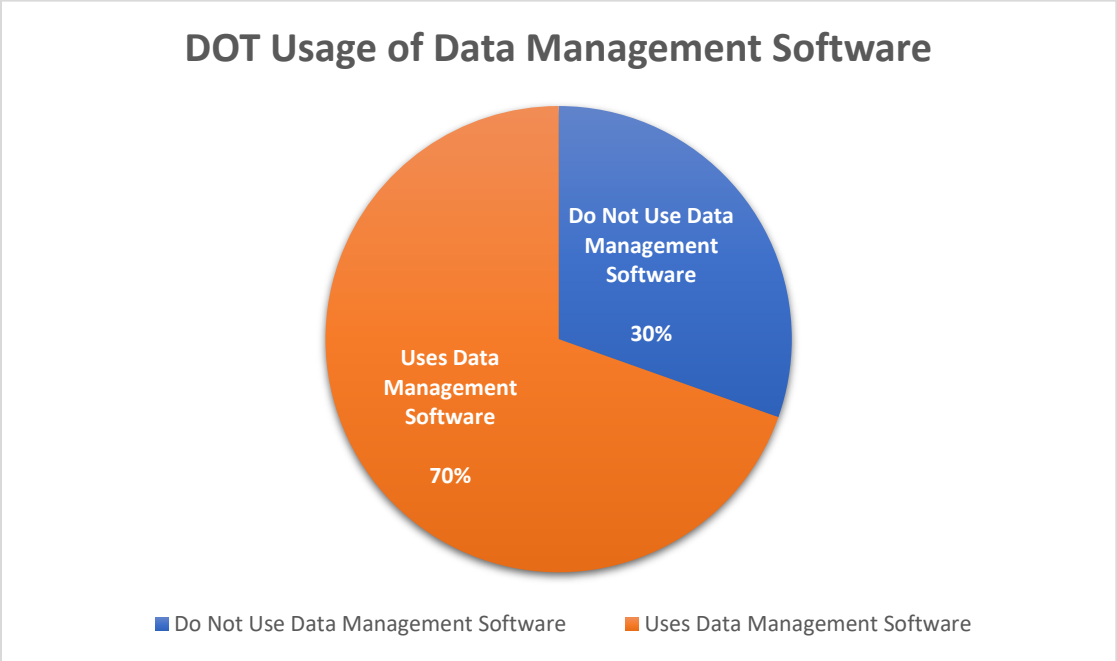

Figure 21: Distribution of state agencies with database management software

5.2.7 DISTRIBUTION OF NUMBER OF CATEGORIES ON THE QUALIFIED/APPROVED PRODUCT LIST ACROSS 21 DOTs

Figure 22 provides the distribution of the number of categories on the QPL ranging from 8 categories for Texas to 200 categories for Iowa. The distribution has a mean value of 64 categories, median of 44 categories, and the standard deviation of approximately 50 categories.

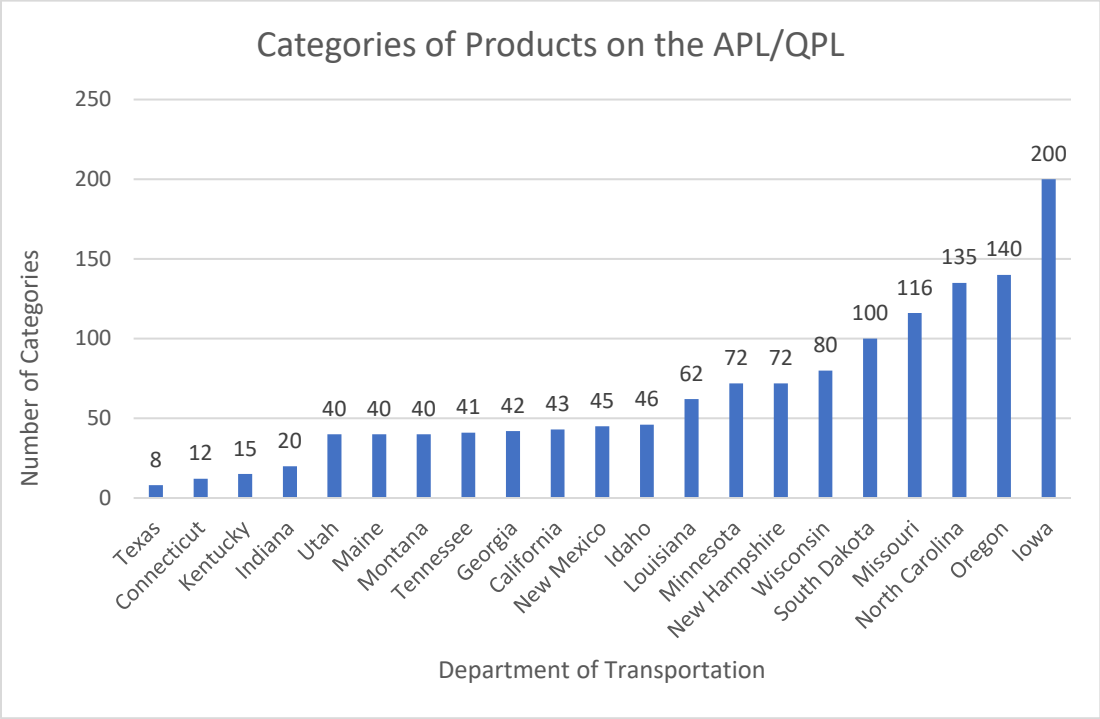

Figure 22: Frequency of the number of product categories on QPL/APL for 21 DOTs

5.2.8 DISTRIBUTION OF PROFESSIONAL EXPERIENCE OF THE PRODUCT EVALUATION PROGRAM'S MANAGER

Figure 23 shows the years of professional experience of the PEP managers responsible solely to oversee and manage the daily operations related to the PEP. As per the results, most of the mangers were well experienced with approximately 40% having 30 to 39 years of professional experience.

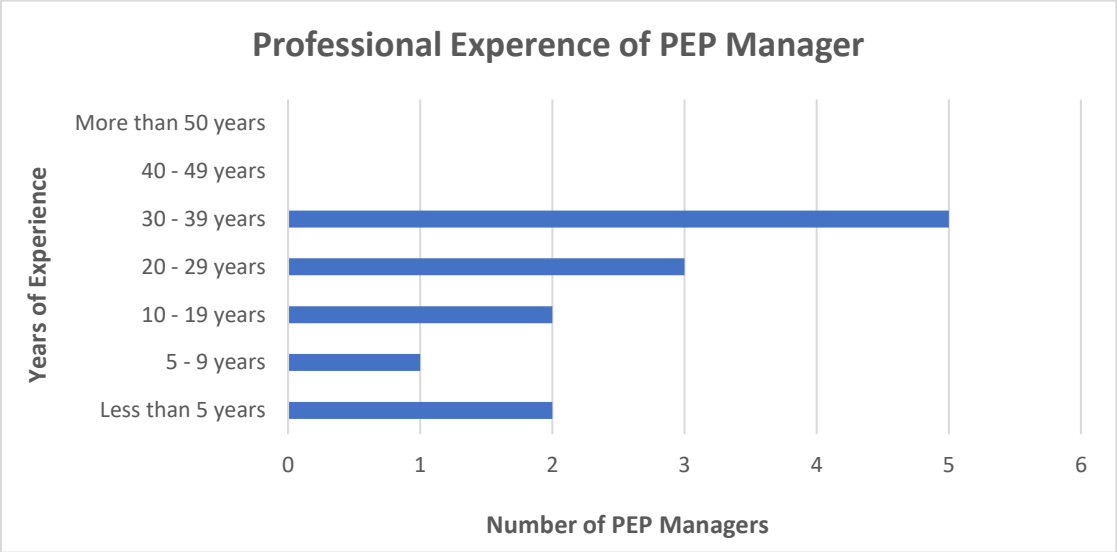

Figure 23: Frequency of the PEP managers with different years of professional experience

5.2.9 JUXTAPOSITION OF DEDICATED STAFF MEMBERS OF PEP IN 2002 AND 2018.

Table 9 compare the number of dedicated staff members employed by the state agencies to oversee and manager the PEP in the year 2002 (Carr, 2002) with the current scenario in 2018 (using current research). The results showed a decline in the number of dedicated staff members for all 10 state agencies in the past 16 years.

Table 9: Comparison of dedicated staff members of PEP between the year 2002 and 2018

State DOT	Dedicated Staff Members (2002)	Dedicated Staff Members (2018)
California	>10	2
Georgia	5 to 10	4
Indiana	5 to 10	2
Kentucky	>10	7
Mississippi	1 or 2	0
Missouri	3 or 4	0
New York	>10	5
Oregon	>10	1
Texas	5 to 10	1
Washington	5 to 10	0

5.3 STATISTICAL ANALYSIS USING IBM SPSS

5.3.1 ORDINAL REGRESSION ANALYSIS

The Ordinal Logistic Regression analysis was performed using the IBM SPSS software tool to determine the statistical effect of continuous or categorical independent variables on the ordinal dependent variable. For this analysis, the Researcher used two continuous independent variables – "Number of Approved Products" and "Number of Dedicated Staff", to study their effect on the ordinal dependent variable – "Satisfaction with Communication", measured on the Likert scale from 1 to 7 with "7" being "Extremely Satisfied" and "1" being "Extremely Dissatisfied". The dataset for the study was prepare through surveys and follow-up interviews across DOTs with respect to the PEP as shown in Table 10.

Table 10: Data setup for Ordinal Logistic Regression analysis

	Independent Variables			Dependent Variables	
	Number of Approved Products	**Number of Rejected Products**	**Number of Staff Members**	**Satisfaction with Communication**	**Satisfaction with Performance**
Alaska	106	10	1	5	6
California	8	3	2	6	6
Delaware	4250	750	1	5	6
Georgia	28	6	4	3	3
Hawaii	45	5	1	4	2
Idaho	16	4	1	2	2
Indiana	5	13	2	6	5
Kentucky	180	20	7	2	6
Louisiana	2	1	10	6	6
Maine	10	5	2	7	7
Mississippi	99	12	0	5	5
Missouri	111	13	0	6	6
Montana	35	5	1	6	6
New Hampshire	13	13	2	7	6
New Mexico	100	113	2	6	7
New York	50	10	5	7	7
North Carolina	49	23	2	5	6
Oklahoma	5	3	4	6	6
Oregon	150	100	1	7	6
South Dakota	25	7	1	6	6
Tennessee	50	50	3	6	6
Texas	20	1	1	6	6
Washington	261	2	0	5	5
Wisconsin	107	133	1	5	5

5.3.1.1 HYPOTHESES FOR OLR

Hypothesis 1:	
Null Hypothesis (H0)	There is no impact of the number of staff members on the satisfaction with the performance of the Product Evaluation Program (PEP).
Alternate Hypothesis (H1)	There is some impact of the number of staff members on the satisfaction with the performance of the PEP.
Hypothesis 2:	
Null Hypothesis (H0)	There is no impact of the number of rejected products on the satisfaction with the performance of the PEP.
Alternate Hypothesis (H1)	There is some impact of the number of rejected products on the satisfaction with the performance of the PEP.

5.3.1.2 CHECK FOR MULTICOLLINEARITY

Prior to conducting the ordinal logistic regression analysis, it is important to check the assumption that the multicollinearity do not exist among the continuous independent variables used in the analysis (here, number of rejected products and dedicated staff members). The multicollinearity can cause a problem when two or more independent variables are co-related in any way as it becomes difficult to distinguish which independent variable had an impact on the dependent variable (in this case, the satisfaction with performance of PEP). As shown in Table 11, the results for multicollinearity can be tested using “Tolerance” or “VIF” values, where VIF (Variance

Inflation Factor) is the reciprocal of Tolerance (i.e., 1 ÷ Tolerance). In other words, the values for VIF and Tolerance help to compare the inflation of regression coefficients to the independent variables when they are not linearly related. The acceptable value for the absence of multicollinearity occurs when Tolerance > 0.1 or VIF < 10 (Laerd, 2015). According to the results as shown in Table 11, the data is free of multicollinearity because the independent variables have the Tolerance value of ".980" or the VIF value of "1.020", well within the acceptable limit.

Table 11: Test for Multicollinearity (SPSS Output)

Independent Variables Used		Collinearity Statistics Parameters	
		Tolerance Value	VIF Value
1	Staff Members	0.980	1.020
	Rejected Products	0.980	1.020
a. Dependent Variable: Performance Satisfaction			

5.3.1.3 FINAL MODEL RESULTS

Table 12 provides the pseudo R-squared (coefficient of determination) values for the ordinal regression model. The R-squared value helps to explain the variation in the data by using the regression model and demonstrate how close the data is to the regression fitted line. In this case, the low R-squared value was observed due to the small sample size with only 23 valid observations, but is not a concern, as 46% of the population is represented in the sample. The three measures used in this study (Cox and Snell, Nagelkerke, and McFadden) are the most common measures of R^2, but they do not have the direct interpretation as in the case of ordinal linear regression. Moreover, these

measures are not universally accepted and therefore referred to as "pseudo" R^2 measures (Laerd, 2015). Table 13 provides the summary of the dependent variable used in the OLR. The Nagelkerke R-square value of 0.092 in Table 12 explains the 9.2% of variation in the performance satisfaction due to the independent variables used in the study.

Table 12: Pseudo R-square values for OLR model (SPSS Output)

Cox and Snell	0.084
Nagelkerke	0.092
McFadden	0.036

Table 13: Case Summary of Performance Satisfaction variable in OLR analysis (SPSS Output)

Variable Used		Number of Observations	Distribution of Responses
Performance Satisfaction	Moderate Dissatisfaction	2	8.7%
	Slight Dissatisfaction	1	4.3%
	Slight Satisfaction	4	17.4%
	Moderate Satisfaction	13	56.5%
	Extreme Satisfaction	3	13.0%
Total		23	100.0%

The results of the regression model can be interpreted using Table 14. The p-value signifies that there exists some statistical effect of the staff members on the performance satisfaction. However, the relatively higher p-value (0.2) denotes that there exists little evidence to support the alternate hypothesis. Furthermore, the odds ratio (Exp.(B)) is used to determine the impact of unit change in the independent variable on the dependent

variable. In this case, the odds ratio value can be interpreted as the unit increase in the number of staff members will cause approximately 1.25 times increase in the performance satisfaction rating.

Table 14: Results for the final model of the OLR analysis (SPSS Output)

	Wald Chi-Square	Exp.(B)	Degree of Freedom	Sig. (p-value)
Staff Members	1.451	**1.248**	1	**0.228**
Rejected Products	0.608	1.009	1	0.436

5.3.1.4 CONCLUSION OF THE ANALYSIS

Hypothesis 1:
We accept the alternate hypothesis as there exist some effect of the number of staff members on the satisfaction with the performance of the PEP.
Hypothesis 2:
We fail to reject the null hypothesis due to lack of evidence on the effect of the number of rejected products on the satisfaction with the performance of the PEP.

5.3.2 BINOMIAL LOGISTIC REGRESSION

The other statistical analysis (Binomial Logistic Regression) performed using the IBM SPSS software aimed at determining the statistical effect of continuous independent variables on the dichotomous dependent variable. For this analysis, the Researcher used two continuous independent variables – "Number of Rejected Products" and "Number of Staff Members", to study their effect on the dichotomous dependent variable – "Was there an increase in the number of applications received last year?", recorded as "yes=1" and "No=0" to conduct the analysis. However, the analysis showed very little evidence for any impact of the independent variables on the dependent variable. See Tables 15 and Table 16 for R-squared values and p-value (sig.), respectively.

Table 15: Pseudo R-squared value

Cox & Snell R Square	Nagelkerke R Square
0.050	0.069

Table 16: P-value (sig.) of the variables used in the analysis

	B	S.E.	Wald	Sig. (p-value)	Exp(B)
Staff Members	-0.092	0.293	0.100	**0.752**	0.912
Rejected Products	0.009	0.012	0.586	**0.444**	1.009
Constant	-0.687	0.962	0.509	**0.475**	0.503

5.3.3 KRUSKAL-WALLIS H TEST

Figure 24 shows the relationship between the average performance and communication satisfaction of the employees from 17 state agencies and the percentage of time dedicated for initial review. The attribute on y-axis denotes the employee satisfaction level with “100%” being “Extremely Satisfied” and “0%” being “Extremely Dissatisfied”. The x-axis denotes the percentage of time dedicated for the initial review phase with the duration for entire product evaluation process being “100%” (i.e., initial review time + technical review time). As per the results, the highest level of satisfaction (over 90%) for the performance as well as the communication was observed when the duration for the initial and the technical review process were equally divided (i.e., between 40% and 60%). The lowest level of satisfaction (below 45%) was observed when the over 60% of time was dedicated during the initial review phase.

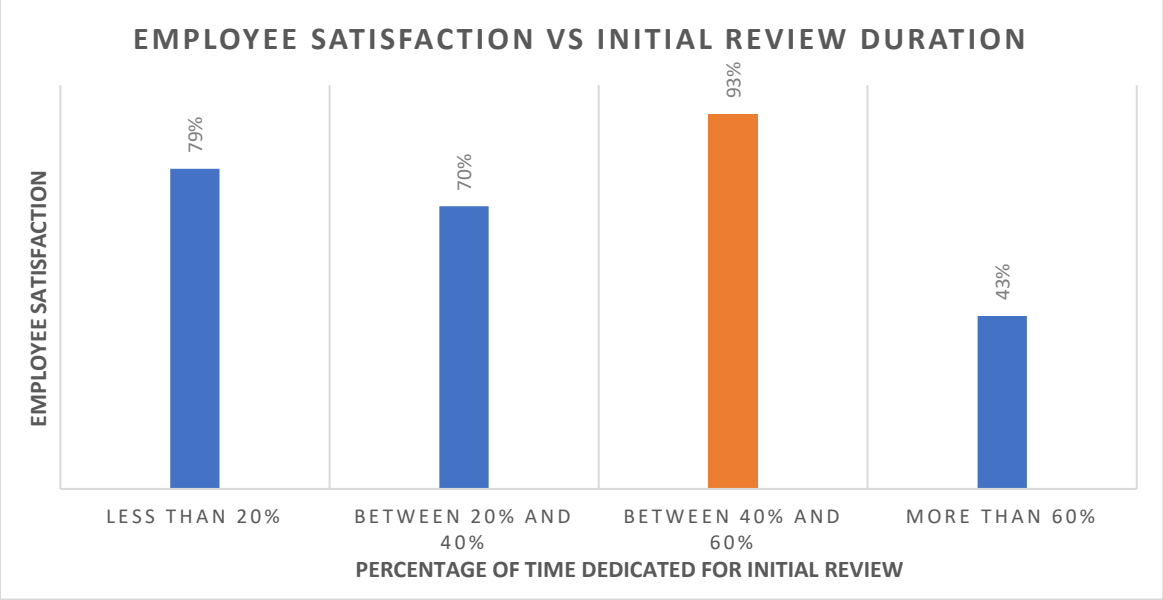

Figure 24: Relationship between employee satisfaction level and the dedicated time for the initial review process.

The results of this descriptive analysis were further corroborated using the Kruskal-Wallis H test (a.k.a. one-way ANOVA on ranks) to determine if there existed any statistically significant difference between different distributions of the initial product review duration. Figure 4 shows the distribution of percentage of time dedicated for the initial product review across different state agencies and the corresponding satisfaction level for each group. Figure 4 also provides the results for Kruskal-Wallis H test with the p-value (sig.) of 0.08, which is within the acceptable limit i.e. p-value less than 0.1. The results show that there exists statistically significant difference between the distributions developed based on the time dedicated for the initial product review and the corresponding satisfaction level achieved.

Therefore, the results of Kruskal-Wallis H test support the findings from descriptive analysis (Figure 3), hence, the state agencies with equal distribution of time for the initial and the technical review process can lead to higher level of employee satisfaction with respect to the performance of PEP and the communication within the different involved parties.

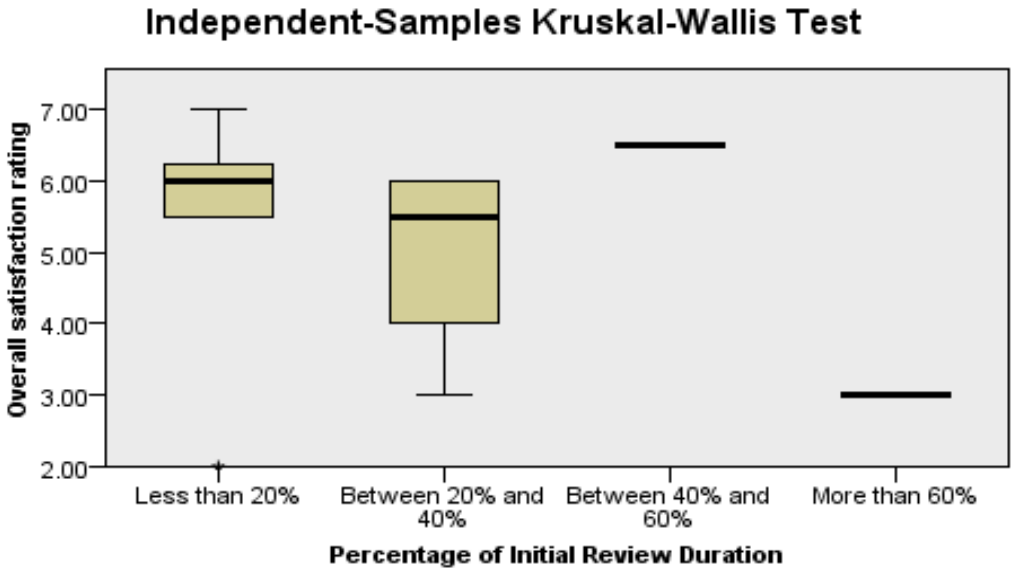

Figure 25: Distribution of satisfaction level for different initial review duration groups using the boxplot

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Overall satisfaction rating is the same across categories of Percentage of Initial Review Duration.	Independent-Samples Kruskal-Wallis Test	.080	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .10.

Figure 26: Test summary for the Kruskal-Wallis H Test

5.4 ANALYSIS OF PRODUCT EVALUATION PROGRAM ACROSS DOTs

5.4.1 OVERVIEW

This section describes the responses of DOTs that provided extensive information through a comprehensive survey and a series of follow-up interviews. Each section identifies the individual DOT, its geographical affiliation, and the general structure and process of its respective product evaluation program (PEP). Where applicable, it also

details any software, staff, management, objectives, challenges, and satisfaction or dissatisfaction expressed with respect to its PEP. Unless stated otherwise, the contents of each section are a direct product of the surveys and/or interviews. The list of DOTs analyzed in this section are: Alaska, Idaho, Indiana, Iowa, Kentucky, New Hampshire, New Mexico, New York State, Oklahoma, Tennessee, and Texas. Table 17 highlights successes and challenges for California, Connecticut, Delaware, Maine, Minnesota and Utah state DOTs with a formal PEP.

More than 90% of the agencies have a formal evaluation process but only half had a dedicated staff to manage the entire evaluation process and keep the database updated. In addition, it takes availability and expertise of proper staff to successfully evaluate, deploy and implement an approved product (Carr, 2002).

As per research manual by Nevada DOT, the formal evaluation process should comprise of high-level managers from the major operating divisions to ensure all facets of evaluation process work to produce products of higher quality, create better communication channels between districts and divisions regarding product applications, and maintain transparency among vendors for unbiased treatment (NDOT Research Manual, 2003).

The primary objective for any evaluation program is the product acceptance and implementation, and the key to achieve it is the timeliness (Carr, 2002). Furthermore, it is necessary to have a structured work plan to create an efficient evaluation program. The Pennsylvania DOT (PennDOT) Bureau of Material Services (BMS) project team started with developing the work plan during the implementation of New Product Evaluation Program (NPEP). The project team prepared a list of performance tasks; established

dates, timelines, and milestones to achieve an evaluation process that would enhance cost savings, safety, maintenance, and durability. The NPEP of PennDOT saved $161,853 within year and a half of its existence and showed steady growth (Gray and Roback, 2007).

5.4.2 PEP ANALYSIS OF ELEVEN DOTs

5.4.2.1 ALASKA DOT

The product evaluation program of the Alaska State DOT runs under the authority of a single, dedicated staff member, who's responsible for the full-time supervision and maintenance of its QPL, as well as other day-to-day operations. Throughout the fiscal year 2017, the agency received over 150 applications, and finished approximately 115 evaluations, resulting in a product approval rate of 92%. To qualify for the initial review, and move on to the technical evaluation, vendors must satisfy the product submission requirements, which include a general application form, test reports from agency-approved labs, and must meet the standard specifications of the applicable product category. The Department does not review new products without meeting pre-qualified standards and specifications due to the unavailability of independent labs that can test the performance and ensure compliance according to pre-established criteria. Approved products held on the Department's QPL must be re-submitted every three years to confirm that the product continues to meet any current or revised specifications. Six months prior to a product's expiration date, the vendor will receive a notification to take action; no action results in the removal of the product from the QPL. Although the agency does not have a formalized product tracking tool, it does utilize a feedback form to capture the performance of products post-installation.

According to the Alaska DOT Product Manager, the QPL is a “time-saving tool” that allows project managers to choose from a list of well-qualified products, that have been vetted and chosen over comparably suitable products, allowing them to allocate necessary resources in a timely manner, as well as to successfully meet the future needs and challenges of their respective projects. In recognition of the importance of having an advanced database management system to maintain, control, and update the agency’s QPL, the Alaska State DOT aims to migrate its systems to AASHTOWare by 2021. Likewise, the Program Manager recommended the implementation of a National Qualified Product List (NQPL), with uniform standards and specifications, that will allow all 50-state DOTs to share their data and avoid redundancy in the product evaluation process. For example, most guardrails used in various projects are manufactured by no more than three different manufacturers; however, despite the consistent product details already in existence, most DOTs devote significant resources to perform evaluations on the same guardrails, which increases record-redundancy, rather than expanding on the data with new or necessary product information.

5.4.2.2 IDAHO DOT

The Idaho State DOT’s evaluation program includes a team of 22 staff members, including five managerial positions, and one program administrator. The managers have part-time responsibilities, while the administrator supervises the entire process, full-time. The QPL has approximately 46 categories and is managed by the administrator through MS Access.

The DOT takes seven days to carry out the initial review of a single product application. The initial review uses the MUTCD and agency-specific standards and specifications to

determine whether the product is eligible for technical evaluation. If approved for further review, the product details are sent along to the technical team, and can be evaluated in as few as 10 days, or take as long as two years, depending on the type of product, and required tests. According to the PEP administrator, the overarching issue with the DOT's PEP is a lack of dedicated and experienced staff members, despite the involvement of 22 part-time staff members in the process. To address this issue, the Idaho DOT plans to hire full-time, dedicated staff to its PEP working group, as well as strengthen the overall program by limiting the number of approved products for a single or similar category, to reduce instances such as approving too many products for one category and losing time to consider others. Accordingly, the Department hopes to optimize the individual responsibilities, as well as the quality and breadth of products considered for the approved product list. Among the 28 DOTs surveyed, Idaho appears to be the least satisfied with the current performance and communication process within its PEP.

5.4.2.3 INDIANA DOT

The Indiana State DOT's product evaluation program is monitored and maintained by a committee composed of volunteer staff members that work on PEP-related tasks on a part-time basis. Though many of these volunteers offer a variety of skill sets and possess diverse proficiencies, the program lacks dedicated, full-time management. At present, most of the PEP responsibilities are tasked between two committee members, who carry out the administrative tasks related to the program. However, without a fully dedicated management team, the agency currently takes around six months to investigate whether a product application satisfies the requisite standards, fills an internal need, or complies

with NTPEP and APEL specifications. In other words, a vendor can expect to wait approximately six months before knowing whether the product submitted may even be evaluated at all. In addition to the initial evaluation period, it can take as long as two years to test the performance of the product under the technical evaluation process. As of 2017, the agency received 20 product applications, and finished 18 applications, achieving an approval rate of 28%, and a rejection rate of 72%, approximately. The current QPL database has 20 different categories, and is primarily managed, controlled, and updated using MS Excel software tool. However, the agency does not maintain a separate database for products rejected after the evaluation.

The department tracks the approved products using a separate Active Product List (APL), which allots a unique identification number to each product, along with other details like installation time, location, and others. Similarly, to the QPL, there are two designated staff members from the committee responsible for carrying out the APL requirements; although, these members work only part-time.

5.4.2.4 IOWA DOT

The Iowa State Department of Transportation (IDOT) has two staff members solely dedicated to overseeing and managing its PEP, having a Qualified Product List (QPL) with 200 product categories. The agency uses an in-house software program, MAPLE, which allows the PEP team to modify, manage, and update its QPL database; however, IDOT does not have a system in place to track the performance of its installed products. To address this gap, the Program Manager recommended the implementation of a system that will allow PEP staff members to track the placement and activity of any product held on the QPL. Likewise, the IDOT aims to diversify the list of approved products given

within a singular product category, which it believes will facilitate competition amongst vendors, and contribute to a more superior list of quality product options (Carr, 2002). The PEP manager further suggested that a training program be introduced prior to any member joining the PEP committee, to ensure new staff members are sufficiently oriented before taking on the position. Although the agency expressed disappointment over its lack of dedicated staff members and committee experts, the Program Manager was neutral with respect to the performance of the overall PEP, as well as its level of communication across departments involved in the evaluation process.

5.4.2.5 KENTUCKY DOT

The Product Evaluation Program at Kentucky State DOT proved to be one of the most improved programs when compared to the results of the other state agencies assessed on behalf of this research. The Kentucky PEP committee involves over 40 employees, each with part-time responsibilities for supervising the program, and as many as seven employees dedicated to the full-time monitoring, administration, and control of the program's daily operations. The product evaluation application is investigated for one month, as part of the initial review, which identifies whether the product meets the basic criteria, including specifications, feasibility, potential category, and future use. Once the initial evaluation is completed, it takes approximately two months to conduct the technical review process. In 2017, the agency finished the evaluation of all 200 applications received, of which 90% were approved for installation, and only 10% rejected.

The agency credits most of its program's success to the database/QPL management software/tool created and administered by officials of the University of Kentucky. The

software allows the PEP team to manage, maintain, control, and track the performance of products included on the QPL and the overall database. The software helps to create a centralized network that allows all the committee members and vendors to access it and update the information on the QPL based on their respective authorization. However, the biggest challenge faced by the agency deals with the recognition and use of the software by each and every authorized user.

5.4.2.6 NEW HAMPSHIRE

New Hampshire State DOT represents one of the most fast-paced product evaluation programs in terms of the time it takes to complete the two primary evaluation phases (i.e. initial review and performance analysis). In 2017, the agency received 45 applications. Of those applications, 38 products were evaluated, with only 33% of those products being approved. An additional 33% of applications were rejected, while the remaining 44% received a conditional approval or required a field trial for further evaluation. The agency uses web based QPL and an electronic-submittal for product review that allows vendors to update the information during the evaluation. Currently, the Department uses MS Access to log all the product information and manage the database; however, it aims to implement more formal and efficient database management system to track the performance of the products and create a centralized network.

The PEP representative also noted that the interns hired by the Research & Development Department, from the University of New Hampshire, contributed immensely toward the participation of different bureaus in the regular meetings, and the promotion of the program's objectives.

5.4.2.7 NEW MEXICO DOT

The Product Evaluation Program at the New Mexico State DOT is primarily managed by the Product Evaluation Coordinator, and the Product Evaluation Engineer, who are responsible for carrying out most of the PEP operations. Their responsibilities span from initial product review, to controlling the QPL database, which maintain over 45 product categories. The MS Access tool is used to manage the database of approved products, and also serves to monitor the functionality of traffic devices after installation; however, the Department plans to migrate to a more advanced platform.

According to the 2017 survey, the agency observed a 25% growth in the number of product applications received, as compared to the previous year, and recorded the completion of almost 200 product applications, at least half of which were approved. The initial review of the product takes up to two months, followed by three months for the technical review, which establishes the appropriate product category, and tests the performance of the product under different conditions. The agency is focused on promoting the goals and objectives of the PEP and hopes to encourage better participation from top officials and experts. The Department identified the presently limited contribution from experts and higher management as a product of the Department's failure to properly communicate the importance of the PEP. In addition to enhancing collaborative efforts and improving its communications around the PEP, the Department aims to ensure that every product implemented in the field is first established on the Approved Product List.

5.4.2.8 NEW YORK STATE DOT

Nearly two decades ago, it was reported that New York State Department of Transportation (NYSDOT) implemented a new evaluation process with the ability to expedite product reviews and facilitate faster installation of newly approved products (Carr, 2002). Despite the optimistic announcement of such a program, the recent interview with NYSDOT's Program Manager revealed that the Department has been struggling to find ways to speed up its lengthy evaluation process, resulting in a backlog of product applications, a growing population of frustrated vendors, and less approved products, overall. The initial product review includes a series of guidelines, each of which must be checked against before a product can be sent to the technical team for field and/or lab evaluation. The specifications and standards governing this initial review include the NYSDOT's established guidelines, AASHTO's specifications, the existence of internal need, any lab or field test results, as well as safety and hazard testing results. Though the NYSDOT does not track the performance of an approved product once it has been implemented in the field, it does maintain a record of the placement for a few particular products. Primarily, NYSDOT records placement data related to particular product materials, including bridge deck repair materials and overlay, joint systems, and paving materials.

The NYSDOT has more than five staff members dedicated to the management and supervision of its PEP; however, none of the PEP staff includes top level management, leading to some delay in completion of product evaluations. However, the agency represented extreme satisfaction with respect to the performance of its PEP, including

with the communication and feedback provided between the various stages of the process.

5.4.2.9 OKLAHOMA DOT

The Oklahoma State DOT's eleven staff members are assigned with partial duties to carry out the tasks of the product evaluation program, of which five positions are designated to the managerial level. However, the agency does not have any full-time employee dedicated to administering, maintain, or control of the QPL and the evaluation program. The 2017 survey showed that the agency received 10 product applications, finished 8 evaluations, ultimately rejecting 3 and approving 5 of those evaluated. The initial review of each product takes approximately five weeks to examine the requisite criteria, such as specifications and safety data, and up to three months for the technical investigation to examine the product's performance, which is conducted using the quantitative measures from various lab tests. Despite the limited number of applications, both received and evaluated, the agency expressed extreme satisfaction with the performance of its PEP, and reported a growth of 60% in the number of product applications received from the prior year.

5.4.2.10 TENNESSEE DOT

The product evaluation program at Tennessee State DOT was one of the few other recognized agencies due to its expeditious evaluation time, higher satisfaction ratings with respect to performance and communication, as well as consistent growth. The program has three dedicated positions - manager, senior engineer, and technician - each conducting full-time duties to oversee, manage, and maintain the QPL and other necessary operations related to the PEP. To qualify for employment within the program,

potential employees need to go through a formal training, followed by on-the-job training.

The agency uses AASHTOWare site manager as the primary tool to manage, control, and update the QPL database, having over 41 different product categories. The product's initial review takes approximately 18 days to check the necessary documents appended to the product application submission, and another month to test the product's performance under the different conditions required to qualify the technical evaluation. According to the program manager, the performance of the evaluation process is highly satisfactory, but the communication between the various staff members could be improved. In particular, PEP manager recommends shifting from e-mails to a more enhanced communication tool.

5.4.2.11 TEXAS DOT

The Texas State DOT Product Evaluation Program maintains a reputation of being one of the most important sections of the DOT and receives annual funding of $30,000 to carry out various operations. The Program has a single designated position responsible for the full-time management, control, and oversight of the entire process; although, the committee is composed of various experts and top-officials having partial duties that span across the different departments within the agency. The product database and the QPL, which includes about eight product categories, is managed using the MS Excel tool. The PEP representative noted, however, that the department aims to migrate to a better tool due to the existing system's slow performance.

Since 2016, the agency has observed a decline of more than 25% in product application submittals, and attributes it to a slower evaluation process. The initial review takes up to

a month to check the application and other submitted documents. Meanwhile, the technical review process can take anywhere from eight to fifteen months, depending on the type of product. Overall, the department finished 40 products evaluation in 2017, approving 20, rejecting 1, and providing 4 conditional approvals, with 15 requiring a field trial. The agency identified its biggest challenge as the need to hire more staff, and to implement a faster product evaluation process.

Table 17: Analysis of Other DOTs with PEP:

State DOT	Specialties / Unique Points
California	**Successes:** • Revamped the program and specifications to create more transparency • Uses a centralized program to minimize the wastage of resources from evaluation of redundant products (Carr, 2002) **Challenges:** • Lack of response from some technical committees on the product review • Do not include personnel from top management in the evaluation program committee
Connecticut	**Successes:** • Use Oracle software to manage the approved product list database • Dedicates significant time for employee training • Plans to create a miscellaneous category for products with unique features and specifications. • Extra care and documentation for potentially hazardous products • Receives an annual funding of approximately $200,000 for the management of evaluation processes **Challenges:** • Require a product champion to review, test, and create specification for the product • Difficult to accommodate and manage large number of products in a single category within a QPL. • Hard to find the right fit or category for few unique products
Delaware	**Successes:** • All products must be tested and approved each time before usage • Conduct follow-up inspections to track the product's performance • Modify/update specifications based on the analysis of products with poor track records **Challenges:** • Do not maintain an Approved Product List (APL) • Additional work load due to the repeated evaluations of same product • Do not evaluate new products without pre-defined standards and specifications.

Maine	**Successes:** • Aims to enforce a system that boots non-active and obsolete products from the approved product list • Maintain extra documentation for products with fly ash • Uses a program called what's new to update the content on the web server **Challenges:** • Does not track the performance of the products on the approved list • Weak communication among the people in the field and in the office
Minnesota	**Success:** • Tracks the installation of various products on the approved list **Challenge:** • The changes in the evaluation program are poorly communicated
Utah	**Successes:** • Allows vendors/manufacturers to provide input • Test results from the independent labs must be within one year of the submittal date • The APL database is used throughout the Utah DOT **Challenges:** • The Regional Engineer can choose a product that is not on APL • It is difficult to ensure the validity of the information provided by the vendor

CHAPTER 6: DELIVERABLES AND RECOMMENDATIONS

6.1 OVERVIEW OF PRODUCT EVALUATION PROCESS

As described in Chapter 1, the product evaluation process generally consists of two phases, the length and extent of which heavily depends on the complexity of the product being evaluated. The first phase represents the initial product review, which serves to ensure the product is eligible for review based on pre-established criteria. This criteria typically includes the nationally accepted standards and specifications, agency-specific requirements, as well as any potential use or existing need for the product under review, according to the evaluating agency. Once the requisite criteria is considered to be satisfied, the product is then submitted for the second phase, and handed over to the designated technical committee, for field or laboratory testing. The technical committee will usually test the product in an approved laboratory, under a variety of conditions, to ensure the satisfactory performance of the product. If the product is approved for use, the technical committee with assign a product-type, to identify the appropriate category in which the product should be listed on the respective product list. This list is often referred to as either an Approved Product List (APL) or Qualified Product List (QPL), depending on the agency.

The analyses of the product evaluation processes of various state transportation agencies (STAs) revealed that most product evaluation programs designate agency-specific roles, responsibilites, resources, goals and objectives for the intial review phase, but have little to do with defining the operational roles and testing standards that govern

the technical review phase. The results of this analysis further revealed that there is significant variation amongst STAs and the time taken to complete the intial review process, ranging from 1 day to 180 days, with substantial spread between the respective agencies. Conversely, the technical review requires the technical committee to follow pre-defined tests and procedures, leaving little room for any modification to the second phase of the product evaluation process. Accordingly, since the norms for an initial product review can be tailored according to the needs, goals, and objectives of an agency's evaluation program, the Researcher developed a model to ensure the optimum allocatation of available resources and use of recognized guidelines for the initial review phase.

6.1.1 MODIFIED PRODUCT EVALUATION COMPONENTS

The modified product evaluation model was inspired by Garces' theory, which states that all product review models should aim to increase the probability of the product's acceptance, and minize the risk of a new product's rejection, pursuant to a rigourous evaluation program (Garces et al., 2016). Moreover, this follows the logic presented by Ozer (2015), that a review model should be developed to control the accuracy of an evaluation process, as the outcome is often beyond one's reach. In addition to the aforementioned guiding principles, the ultimate evaluation model is a product of a comprehensive study of past academic research, analysis of relevant industrial resources, and embrace of identified best practices. This model should assist STAs to deliver a systamatic, structured, and extensive procedure for product evaluation, at least at the initial review phase, that minizes the chances of a product being rejected,

and maximizes the overall output of the evaluation program, including the performace of its approved products.

Figure 27 illustrates the proposed break-down of the evaluation process in the final model and infers its impact on the duration of the technical evaluation, ensuring an expeditious technical review, as well as a speedy overall product evaluation process. However, the duration of the technical evaluation cannot be predicted accurately due to the inherent variability in the time required for different types of materials/products, and their respective performance measures.

The model aims to improve the evaluation techniques used during the initial review phase with respect to the colllection of information from vendors, review period of the application and other relevant documents, associated risk and safety hazard, established priorities, and employee satisfaction with the performance and communication. To ensure the successful implementation of improved practices, three components were deveoped as a part of the initial review process, in order to capture the product's initial performance:

i. Modified Product Evaluation Application

ii. Past Performance Survey

iii. Initial Evaluation Checklist

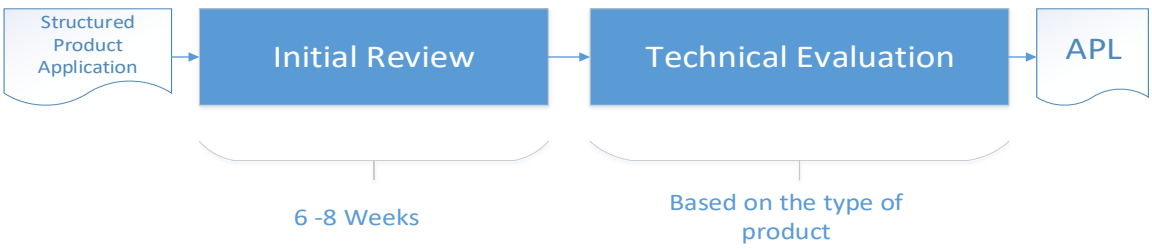

Figure 27: Proposed hypothetical break-down of the evaluation process

6.1.2 MODIFIED PRODUCT EVALUATION APPLICATION

The content included in the modified product evaluation application is the result of a thorough analysis of previously submitted product applications, and accompanying files, from more than twenty departments of transportation (DOTs). Based on this review, the Researcher was able to identify the best means available for retreiving the information necessary to achieve a more productive and expeditious initial review process, which was drafted into a modified product application form (Appendix 1, Exhibit A). The modified application form is the result of a comprehensive examination of various product evaluation forms and question types, each of which has been cross-referenced against the PEP forms of other DOTs, to ensure only the most productive and pointed questions have been selected for inclusion. For example, the motivation behind the question asking vendors to specify whether their product serves as an alternative product for one already listed on the APL/QPL was meant to promote more informed applicants by encouraging each vendor to conduct his or her research before submitting the product for evaluation (i.e. a "know your product" approach). The state agencies deemed to have the most effective product evaluation forms, due to the quality and clarity provided by the information requested, were identified as Georgia, Maine, Nevada, Arizona, and California.

Product evaluation is an extensive process that demands a significant amount of time, money, and work hours to conduct. In addition to the basic demands of the evaluation process, several DOTs have also encountered products that require additional information, sometimes later on in the review phase, causing a significant delay in the overall evaluation process. The modified product application helps to minimize the

likelihood of a product being approved for further evaluation without first ensuring complete and sufficient product information exists at the outset (i.e. upon receipt). Table 18 illustrates a few of the recommended questions in the modified product application, as well as a list of supporting documentation that should be included with the initial product submission.

Table 18: Features of the modified product evaluation application

Recommended New Questions from Analyses of other DOTs
Product was previously submitted for evaluation?
What is the installation cost?
Any special equipment required for installation?
What is product's shelf life?
Alternate for what existing products on APL/QPL?
Educational courses or videos available?
Currently/previously applied for evaluation at any other governmental agency/DOT?
Product demonstration provided by the vendor?
Product's outstanding benefits (30 words)?
Applicable attachments required as part of the submittal:
Technical Data Sheet
Installation Details
Safety Data Sheet
Test Data
Design Sheets
Laboratory Reports
Certificate of Compliance
Life Cycle Cost Analysis
Quality Control Plan

6.1.3 PAST PERFORMANCE SURVEY

A questionnaire is a necessary component of any application used for evaluation to ensure easier and faster product review (Garces, et al., 2016). The Researcher developed and added a questionnaire as a part of the product submittal to avail the feedback from the previous users of the product. The surveys act as an integral part of the application and must be submitted by the vendor, as an attachment, along with a maximum of three references. The use of the survey is only applicable to those products that were previously used on projects, and does not apply to products that are new to the market. The questionnaire has seven criteria to provide the feedback on the product's performance, based on a Likert scale of 1 to 10, with 10 being excellent. Table 19 shows the recommended criteria used in the survey and the complete past performance survey is provided in the Appendix 1, Exhibit B.

Table 19: Criteria for the product's past performance survey

No.	CRITERIA	UNIT	RATING
1	Risk associated with safety and health	(1-10)	
2	Availability of the product	(1-10)	
3	Quality of the product	(1-10)	
4	Installation of the product	(1-10)	
5	Product compliance with standards & specifications	(1-10)	
6	Overall professionalism and responsiveness to requests	(1-10)	
7	Overall client satisfaction with the product	(1-10)	

6.1.4 PRODUCT EVALUATION FORM

The evaluation checklist is a major component of the final model and has a significant impact on the initial product review phase. As a result, it has been adopted into the modified product evaluation model because of its broad and proven applicability, as seen by those state agencies identified as having the most improved PEP. The evaluation checklist provides a standard, yet easily customizable platform, to review the products by using the established criteria, as well as the support of committee members, to ensure higher transparency and uniformity in the evaluation process. Likewise, to reduce the confusion inherent when attempting to consume too much information, the checklist also assists the investigator by ensuring the application captures only necessary information, and that each input can be checked against the established criteria. It not only supports the ease and speed of initial reviews, but it helps to weed out those product applications that do not fully satisfy the requisite information. Thus, a technical evaluation will only be initiated by a full and complete product application, enabling more efficient use of time and resources, while also reducing the likelihood of its rejection.

The criteria in the checklist are used to rate the product application on a scale of 1 to 10, with “10” being excellent, based on the quality and conformity of the provided information. Moreover, the criteria are assigned weights to account for the agency’s priorities, needs, and requirements while computing the overall score of the product application. The checklist and weights are intended to aid to the objectivity of the process and mitigate any room for bias or subjective consideration. While the proposed checklist is based on a generalized product application form, the ultimate checklist will be easily

modified according to the respective agency's norms for initial product review. The product's final score, after the initial and technical review, can be used to arrange the products on the QPL/APL as a means of enhanced product selection for use on a given project. Likewise, the approved products with lower final score should be flagged as those products requiring additional performance tracking, prompting the respective project manager to monitor the particular product post-installation. Finally, the checklist, weights, and overall scores should promote the competitiveness in the market-place, as well as motivate vendors to conduct the due diligence necessary to ensure the application qualifies for the initial review phase. Table 20 provides the checklist of criteria developed based on the modified product evaluation application, whereas the proposed product evaluation checklist is shown in the Appendix 1, Exhibit C.

Table 20: Checklist used to rate the product application

Criteria	Applicable ☐Yes / ☒No	Weight	Score (1-10)
Product Fits the Established Priorities	☐		
Product Within the Established Cap	☐		
Product Availability	☐		
Established Need and Benefits of The Product	☐		
Safety and Health Review	☐		
Environmental Impacts	☐		
Availability of Resources to Carry Out Technical Review	☐		
Warranted Background Information and Research Test Data	☐		
Product Supported by Other Technical Committee Members	☐		
Past Performance Survey	☐		
Product Warranty	☐		
Safety and Health Review	☐		
Environmental Impacts	☐		
Life Cycle Cost Analysis	☐		
Quality Control Plan	☐		
Overall Product Performance	☐		

6.2 MODIFIED PRODUCT EVALUATION PROCESS

The work conducted on behalf of this research led to the development of tools and techniques to be applied to an improved PEP. However, the success of a new PEP is highly dependent on the success of its implementation. Therefore, this section entails the necessary steps required for a user to understand the evaluation process and successfully implement the recommended changes. Furthermore, the flowchart in Figure 28 provides the overview of the modified initial review process for easier understanding of the involved steps.

Step 1: The applicant submits the modified application form, past performance survey (maximum 3 surveys), and other required documents as a part of the product submittal to the state agency.

Step 2: The PEP manager with the help of product evaluation form checks whether all the required information on product application form and the supported as part of the product submittal.

Step 3: If the product submittal is missing any required information, the PEP manager notifies the vendor to provide the missing information within a given time or reject the product application. However, if the product submittal meets the required standard then the product qualifies for the initial review.

Step 4: The product information is assessed against the criteria on product evaluation form. The product is rated on a scale of 1-10 against all the applicable criteria. Additionally, the past performance survey is analyzed and rated similarly.

Step 5: The product's overall score/rating is calculated using the product evaluation form to compare against the minimum cut-off score required for qualification.

Step 6: The qualified products are assigned a suitable committee for the technical evaluation based on the type of product and requirement of the tests.

Step 7: The product is placed in the queue of products waiting for technical evaluation and positioned based on the overall score for the initial review phase and the priority status established with the support of the other committee members.

Step 8: The technical committee evaluates the performance of the product under various conditions with the help of lab tests and complete Part-B of the product evaluation form.

Step 9: The final score is computed by adding the scores for initial and technical review phase, which is later used to arrange the products on the QPL/APL under similar category.

6.3 PEP FLOWCHARTS

Figures 28 and 29 include flowcharts representing the different steps involved in the initial product review process, and the overall evaluation process, respectively. The flowcharts were developed with the help of findings from the analyses of nationwide DOTs and the best implemented practices of each program. In contrast with the proposed flowchart for the PEP at NCDOT (Appendix 1, Exhibit A), the flowchart in Figure 29 helps to simplify the complexities involved in the evaluation process, by removing unnecessary steps or activities, and communicating them using only 16 steps. The existing flowchart for the NCDOT PEP takes approximately 36 steps to illustrate the same procedure, which can be difficult to use as a tool for delegating duties and tracking changes in the workflow.

6.3.1 INITIAL REVIEW PROCESS FLOWCHART

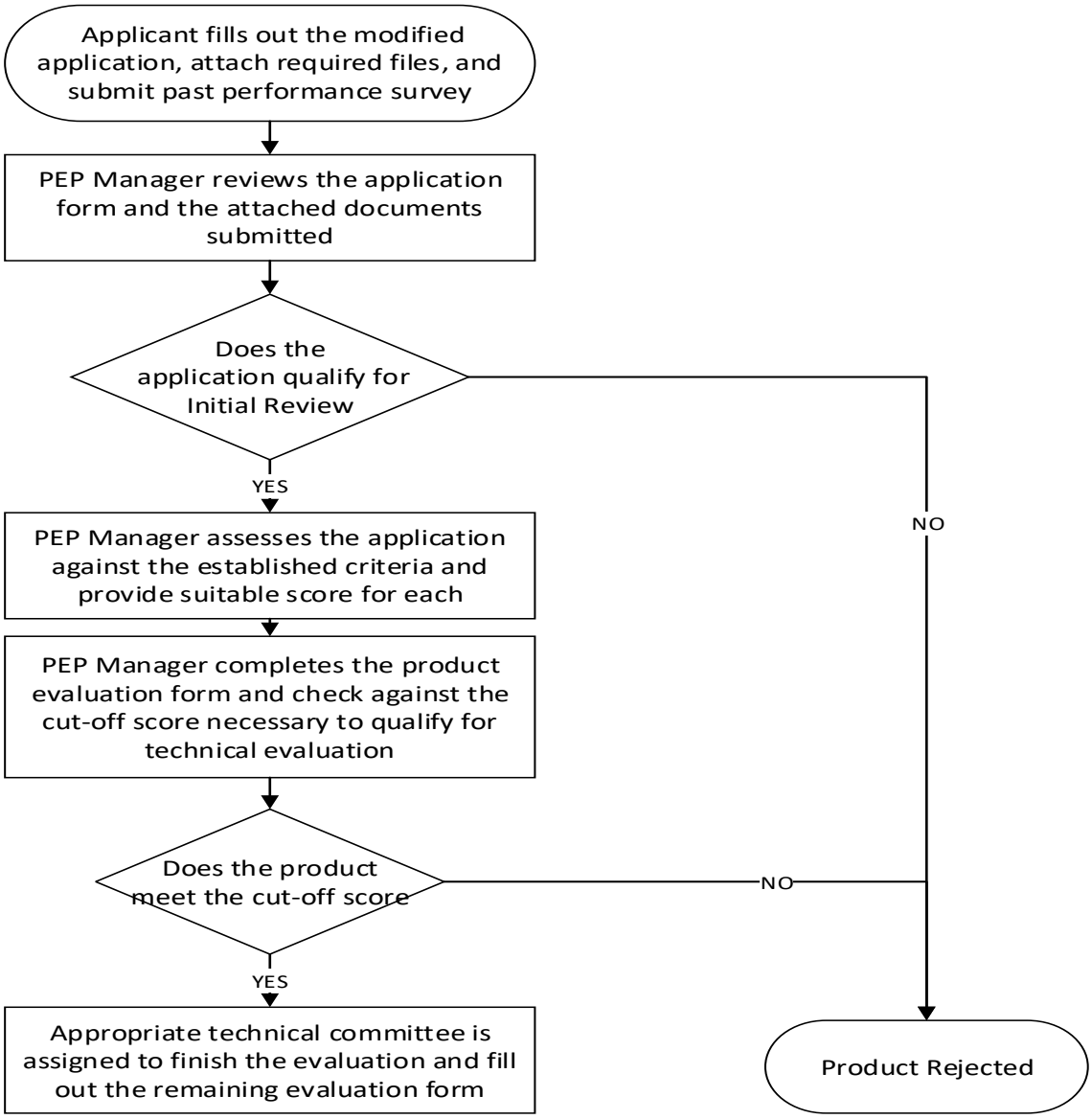

Figure 28: Flowchart of the initial review process

6.3.2 MODIFIED EVALUATION PROCESS FLOWCHART

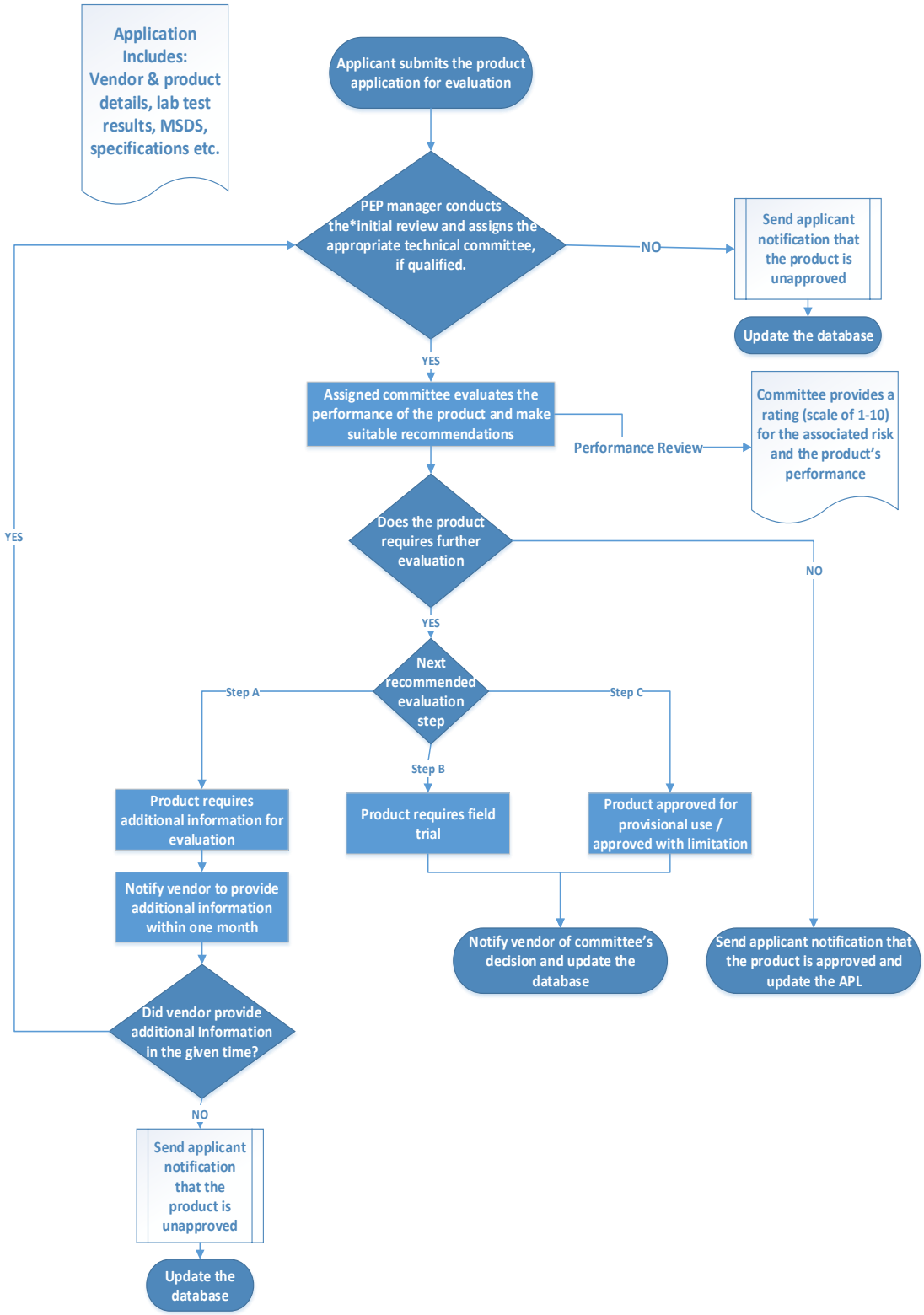

Figure 29: Modified flowchart for overall product evaluation process

6.4 RECOMMENDATIONS

The final output of this research includes a model, comprised of modified tools and techniques, along with the instructions to successfully implement them. The aim of the final model is to enhance the evaluation process by essentially improving the initial product review, and have a corresponding impact on the technical product review process, as a result. During the investigation of the state agencies nationwide, the Researcher recorded a few important characteristics that could be implemented along with the modified practices of the final model to enhance the performance of the initial review process. The following recommendations can be implemented in conjunction with the final model:

- Assign more staff members to the PEP with partial or full-time duties depending on the work load.
- Allocate more time to review and examine the information retrieved from product submittal and necessary to complete the technical evaluation.
- The product application with incomplete information or unavailable documents required to finish the evaluation should not qualify the initial review phase.
- Collect no more than three past performance surveys from the clients that have used the products in the past projects. The vendors or manufacturers must be responsible to submit the completed survey with the product application.
- Use product evaluation form to rate the products and arrange them in the QPL based on their overall scores to ensure effective and expeditious selection by the project managers.

- Establish a priority list of highly-demanded products with the support of technical team, maintenance team, and project managers that are needed urgently on the current or future projects but not available on the QPL/APL.
- Establish a limit on the products of the same category or type on the QPL with the support of committee members to reduce the workload due to evaluation of redundant or unnecessary products.
- Require an application fee for the product evaluation to eliminate the spam applications, with a possible cost-incentive for innovative and proven products.
- Allow the vendors or manufactures to provide the feedback/review on their experience with the product evaluation process and the suggested changes for the program.
- Maintain exhaustive database of approved, rejected, and under evaluation products using advanced software or database management system.
- Create a centralized database by sharing the evaluation results with the other state agencies and existing bodies with evaluation program like APEL, ASTM, and others.
- Implement a formal training program to educate the employees before joining the PEP.
- Use advanced software or IT services to manage the QPL database and ensure proper communicate the changes or updates on the QPL among the involved groups within the agency (e.g., AASHTOWare).

Several of the major recommendations, such as collection of a past performance survey, arrangement of products on the QPL according to a product score, maintenance of a

priority list, required application fee, and feedback from vendors/manufacturers are the most practical and cost-effective means to achieve an improved PEP, and can be used toward an existing program structure.

The other recommendations suggested by the Researcher are discussed below and are critical for all state agencies nationwide to achieve an improved PEP. The recommendations are based on the analysis of the past research and state agencies identified as having an effective PEP. It was observed that the agencies used flowcharts, tables, posters, and other graphic tools to communicate the goals and objectives of the program and illustrate the evaluation procedure.

With today's age of advanced technology, it is essential for all state agencies with PEP to use available Information Technology (IT) services to manage, update, and control the QPL database, as well as to track the performance of products placed in the field. Notably, those agencies that outsourced the management and control of their approved/quality product database, either to local universities or other qualified institutions, showed highly satisfactory and compelling results in support of the program.

The literature review illustrated the importance of decision making in the PEP. Furthermore, the analysis of state agencies revealed that involvement of higher management officials and technical experts from diverse background assist with making informed decisions. Additionally, the participation of higher authorities in monthly or quarterly meetings help to boost the confidence of the employees and promote the program's goals and objectives.

The researcher found that a few state agencies appoint interns from the local universities to help with the daily operations of the initial review process, which supports similar data

showing the contribution of academic resources to be extremely helpful toward a given evaluation program. The state agencies should enforce a formal training program to educate the employees or interns on the complexities of the PEP process before delegating any duties. In order to implement all the recommended changes and ensure an improved and effective PEP, the state agency must have a proper source of funding to bear the cost of additional tasks necessary to ensure successful management and operation of the evaluation process.

6.5 BENEFITS OF IMPLEMENTATION OF THE FINAL MODEL

The final model was designed to shorten the total evaluation time by determining the optimal allocation of resources for both phases of evaluation - the initial review phase and the technical review phase - and reduce the workload of the technical experts by eliminating the products with a lower potential to succeed in the initial review phase. The modified product application form ensures the collection of comprehensive and reliable information from the vendor. The past performance survey is a part of the product submittal that allows the evaluator to capture the product's performance based on its use in previous projects. The product evaluation form allows a formal and structured initial review of the product application. It helps to grade the product application using recognized criteria, owing to the availability of the required product information, and ensure an expeditious review process. The addition of criteria like "rating for the associated risks of the product" are useful to identify the potentially hazardous products and track their performance after the installation. The arrangement of the approved products based on their overall score on the QPL helps to distinguish the hazardous products from those which are less susceptible to failure. The modified QPL makes the

selection of approved products from the same category easier for the project manager due to their order of arrangement on the QPL and the provided summary with scores for each criteria.

The model developed for the initial review encourages state agencies to allocate resources (e.g. time, money, and labor) more effectively, in order to finish the initial product review process quickly and efficiently. The rating system with the assigned weights helps to consider the agency's needs and priorities and provide a transparent platform to conduct an objective and realistic evaluation. As a result, the agency can expect fewer litigation issues or appeals against the final decisions made by the evaluation committee. The rigorous and systematic evaluation process in the initial phase can ensure the lower probability of a product's rejection or re-evaluation due to insufficient information in the later stages of evaluation. The modified evaluation process flowchart and the initial review flowchart were designed to promote easier communication of the evaluation program's ideas, objectives, and goals. Additionally, the flowcharts and other graphical representations act as an effective tool to educate the staff members of their roles and responsibilities, and demonstrate the changes or modifications in the evaluation process, under any given product evaluation program.

6.6 PRODUCT ALIGNMENT MATRIX

The product alignment matrix (Table 22) provides a summary of the final model based on an analysis of the best practices identified from 28 states DOTs, and compares them with NCDOT's current PEP structure, to address the gaps between the two studies. The last section of Table 22 highlights the additional features of the final model, that are missing in the PEP at NCDOT. The applicable benefits of implementing the

feature/recommendation of the final model are denoted using the identification numbers (ID) ranging from 1-8 as listed in Table 21.

Table 21: List of benefits with identification number used in the matrix.

Identification Number (ID)*	Benefit(s)
1	Save Time
2	Save Money
3	Improved Communication
4	Employee Satisfaction
5	Reduced Workload
6	High Performance
7	Comprehensive Database
8	Uniformity and Transparency

Table 22: Product alignment matrix to compare best practices of the final model with PEP at NCDOT

Category	**Sub-Category**	**Features of the PEP at NCDOT**	**Features of the Final Reserach Model (FM)**	**IDs***
Product Evaluation Applicat-ion Form	**Questions related to Product Performan-ce**	Was product previously submitted for evaluation within the agency?	Provide the result/status of the product submitted for evaluation at the local or other state agency?	1,2,5
		Approval from other agencies/DOTs?	Alternate/Replacement for what existing products on APL/QPL?	1,2,5
		Submission of material/product safety data-sheet and independent lab tests reports?	Submission of past performation survey from the clients who previously used the product (Maximum 3)	4,6,7 ,8
			Pre-defined list of required documents to ensure the submission of all required document with the product application as an attachment	1,5,7 ,8

		State product's advantages & limitations	State product's outstanding benefits and limitations within 30 words for each section	1,5,7
	Product Installation Details		Requires to submit the educational video or tutorial for the installation of the product	3,5,7
			Provide the shelf life and seasonal availability of the product	7
			Ask for the requirement of any special equipment to instal the product in the field	1,5
	Application Fee	Do not have an application fee to submit the product application	An application fee of $50 is imposed for the submission of product application to avoid spam	1,2,5
Initial Product Review Phase	**Review Prcedure**	PEP manager checks product specification against the established guidelines	Products are reviewed using the evaluation form, the product is scored against the pre-defined criteria developed with the help of technical committee	1,4,5 ,6,8
		Assigned two staff members dedicated to conduct and manage the review process	The pre-defined critera are assigned weights to accommodate agency's priorities and goals	1,4,5 ,6,8
			Initial review qualification depends on the documents submitted, information provided, and the overall score achieved by the product	5,6,7
	Duration	Initial product review takes upto two weeks	Initial review takes from six to eight weeks of time	4,5,6
	Technical Review Duration	Technical product review takes approximately four months of time	Technical product review takes from six to eight weeks of time	1,6

Miscellan-eous Features & Recomm-endations	**IT Services**	Use HiCAMS to manage and update the APL database.	Outsource the IT services to experts or use industrial software like AASHTOWare to manage the database of the QPL/APL	1,3,4,5,6,7
			Use IT services to obtain the feedback from the staff members on the product performance and vendors on the evaluation experience	1,3,4,7
	Database Managem-ent	Maintain the database of approved products, approved for the provisional use, and products under the field trial	Maintain the database of approved, rejected, under field trial, and provisional use products	6,7
	PEP Flowchart	Use single flowchart to explain the entire evaluation process using 36 steps	Use separate flowchart to illustrate initial review process and overall evaluation process using eight and sixteen steps, respectively	3
	Additional Features		Arrange the products on the QPL based on the overall score achieved for easier selection	1,4,5,6
			Enforce a formal training program for the new employees assigned to the PEP	3,4,6
			Establish priority list with the support of committee members to expedite the evaluation of urgently needed products	1,4,5,6
			Track the product performance after the placement in the field using the overall scores or risk rating on the evaluation form	1,2,5,6

6.7 COMMON CHALLENGES OF TRANSPORTATION AGENCY PEPs

An analysis of the historical data against the results of the current study revealed significant overlap between the problems faced by product evaluation staff members to successfully execute the goals and objectives of Product Evaluation Programs (PEPs) throughout state transportation agencies across the nation. Common challenges identified by a majority of the state agencies included a lack of dedicated staff, with full-time duties to manage the program activities; a lack of designated funding to bear the additional costs for acquiring industrial tools to ensure effective evaluation; a failure to track the performance of products onced installed in the field; and a persistent communication gap among the different groups involved within the evaluation program. In addition, the Researcher identified a number of other problems facing PEP managers on a delay basis, including:

- PEPs struggle to gain acknowledgement and confidence from higher-level management and experts within the organization.
- Many officals of the PEP committee do not possess adequate knowledge of the program.
- The agencies use obsolete or outdated software to manage and update the QPL database.
- The officials found it difficult to ensure that the products being used in agency-sponsored project are listed on the QPL.
- The agencies struggle to keep a track of the approved product's status, location of installation, and performance in the field.

- Ensuring the participation of all the PEP committee members in the monthly or quarterly meetings remains challenging.
- The implementation and usage of modified tools or software by all staff members proves to be problematic for most agencies.
- The PEP managers struggle to define a limit or cap on the number of approved products for a given type or category on the QPL.
- Difficultly with ensuring the validity of product test reports from independent labs.
- Inconsistent information provided with the product submittal documents, some of which is either too overwhelming to review, or too limited to initiate the review.
- Inability of agencies to acquire information on a product's performance that has been used in the past projects.
- Project Manager uncertainty inhibiting the selection of most the qualified product on the QPL for a product under the same category (i.e. where there is a list of similar products).
- Difficulty or impossibility of collecting feedback, from either project managers or members of a maintenance team, regarding an approved product that has been placed in the field.

CHAPTER 7: RESULTS AND CONCLUSION

7.1 DISCUSSION OF THE RESULTS

The objective of this research was to identify the best practices underlying a successful product evaluation program (PEP) with respect to operational time, product performance tracking, team member communication, evaluation framework, database management, and overall program performance. By identifying the model processes for the most effective PEP, the researcher was able to develop a model evaluation process in which state transportation agencies (STAs) could implement easily and uniformly, while also accounting for areas of distinction. The proposed model is the result of a comprehensive analysis based on data retrieved from a variety of sources: decades worth of academic and industry-based research; data retrieved from industries notorious for success in product evaluation, including technology and business sectors; timely data retrieved through the investigatory phase of this research, which incorporates individual feedback from members of product evaluation teams throughout the country. In addition to pinpointing the primary characteristics of a model PEP, the Researcher was also able to identify the common inconsistencies and significant challenges faced by many existing PEPs, such as understaffing or insufficient funds, all of which was considered and addressed during the preparation of the final model.

In comparison to the results of a 2002 study, this study determined that ten agencies with a recognized PEP experienced a decrease in the number of staff members responsible to the oversight and management of its program. The survey results and follow-up interviews revealed that many officials at higher levels of management lack the

confidence in PEP's importance and contribution to the high-quality transportation infrastructure. Based on the findings, the Researcher suggest the inclusion of experts and higher level of management in the PEP committee, in conjunction with full-member participation at monthly or quarterly meetings.

A trend analysis was conducted by quantifying the number of product applications submitted and evaluated across state agencies, and used to identify any variances that may exist in the workload. This study showed that the average number of product evaluations finished in 2017 was an average of less than 80 products, with most agencies approving 50 products or less, and rejecting 25 products or less. In other words, the number of products rejected accounted for approximately 50% of the number of products accepted. Additionally, an average of 10 products were approved with certain restrictions of use.

The evaluation time was a major area of investigation for this research and therefore modified techniques were developed to expedite the evaluation process. The two phases of evaluation were addressed separately to study the different characteristics involved in each phase and identify the techniques to optimally allocate the resources. The mean time dedicated for the initial review process accounted for 1 month, and almost 8 months for the technical evaluation phase. Moreover, the Kruskal-Wallis test, with a significance value (p-value) of 0.8, supported the finding that equal distribution of time for both review phases helps to attain a higher level of employee satisfaction with respect to the overall performance and quality of the program.

The descriptive analysis of the data collected on 28 state agencies revealed many interesting findings. The study showed that for about 40% of state agencies investigated,

an average growth of approximately 30% in the number of product applications received in comparison to the previous year. Additionally, as many as 70% of the state agencies used database management software to maintain, update, and manage the QPL database, which have an average of 60 product categories on it. However, more than 75% of the state agencies have as few as two employees to oversee and manage the entire PEP.

The ordinal regression analysis was conducted to test the hypothesis that there existed some impact of the number of staff members dedicated full-time and the number of rejected product applications on the employee satisfaction with the performance of the PEP. The results showed little evidence (p-value = 0.2) of the relationship between the number of staff members employed and their performance satisfaction, however, the results did not show enough evidence for the impact of number of rejected products on the employees' performance satisfaction. The result of ordinal regression analysis can be interpreted as the unit increase in the number of employees dedicated full-time to manage the program can boost the employee satisfaction with performance by 1.25 times.

After the completion of analysis, the Researcher developed a final model that incorporated the recommended changes and the modified tools and techniques to enhance the product evaluation process for the nationwide state agencies with PEPs. The model aims to simplify and expedite the evaluation process with the usage of modified tools developed for the initial phase of the product investigation. The survey results showed that an average of 25% of the product applications are resubmitted for the evaluation due to missing or insufficient information necessary to finish the evaluation. As a result, the agencies encountered significant delays with timely completion of product evaluation and suffered from the wastage of time, money, and other resources.

7.2 CONCLUSION

It is important to identify the need for improvement before implementing any change or modification, therefore, the evaluation process should be correctly implemented to provide with the evidence necessary to make informed decisions (Yusuf, J.E. and Jordan, M.M., 2017). The state product evaluation program is one such effort to improve the national transportation infrastructure by ensuring the use of highly qualified products and superior technology for the construction projects.

In this study, the Researcher examined the PEPs across DOTs and identified the best practices, unique features, advanced technologies, and other evaluation techniques. The database prepared using the survey and the follow-up interviews with nationwide DOTs was analyzed to successfully implement the findings and recommended changes. The team prepared a final model that comprised of the modified tools and practices to enhance the product evaluation process. The final model aimed to improve the initial review phase with the help of modified tools developed to acquire comprehensive and accurate product information and conduct an extensive and systematic initial review with the help of advanced scoring system for the recognized criteria.

The model was inspired from the Ozer's study, where it was suggested that firms often make two erroneous decisions: a) pursue the evaluation of a potentially unsuccessful product leading to wastage of time, workload, and other valuable resource and b) fail to evaluate a highly potential product (Ozer, 2005). The modified evaluation process facilitates a systematic, expeditious, and transparent approach to ensure the higher probability of product approval after the qualification of initial review phase and

reduced workload on the technical committee due to the availability of exhaustive and accurate product information.

The final model comprised of three components for the initial review phase: a) modified product application form, b) past performance survey, and c) Product evaluation form. The past performance survey is only applicable if the product was previously used on projects and it requires to be submitted along with the product application. The modified product application form was designed to obtain the necessary information required to conduct the initial as well as the technical investigation of the product. Finally, the evaluation form helps to examine the products with the help of recognized criteria that are assigned weights based on the agency's priorities and goals to develop an enhanced QPL.

The key findings of the research included the identification of factors having significant impact on the employee satisfaction with respect to the performance the PEP and the communication among the different involved groups within the agency. The data analysis backed with statistical test showed that the higher number of staff members with dedicated positions in the PEP had a positive impact on the employee's satisfaction with the performance. Moreover, the Kruskal-William H test supported the analysis showing that equal distribution of time for initial and technical review phase leads to higher overall satisfaction of the employee.

7.3 CHALLENGES FACED BY THE RESEARCHER

The Researcher faced multiple challenges starting from the limited availability of the past research to the smaller sample size to conduct the statistical analysis of the data collect from 28 (56%) state agencies across DOTs. In the past, only one study was

conducted by William P. Carr and dedicated to improve the practices implemented in the PEP across DOTs (Carr, 2002). The data was collect using the survey and follow-up interviews. It took approximately three months to collect data using survey and follow-up interviews from 28 state agencies, approximately 33% of responses either had invalid or missing information due to improper management of the database. However, the response from the remaining 22 state agencies were not received due to the unavailability of a direct point of contact or lack of interest by PEP representatives to participate in the study.

7.4 RECOMMENDATIONS FOR FUTURE WORK

The Researcher developed an exhaustive database from the analysis of 28 (56%) state agencies with the help of survey and follow-up interviews of the PEP managers. However, the data analysis as discussed in chapter 5 demonstrates the shortcomings in the results of statistical analysis due to invalid or missing information from approximate 30% of the state agencies. For the future work, the Researcher recommends preparing a strong database with no missing or invalid responses from at least 30 DOTs (i.e., more than 60% response rate).

In future research, the continuous dependent variables like the percentage of products approved after the qualification of the initial review process, number of days consumed during the initial and the technical review process (evaluation time), the annual expenses incurred by the PEP (evaluation cost), and others can be used to perform the statistical analysis to measure the performance of the PEP using the quantitative analysis. The statistical analysis with a greater sample size and continuous dependent variables can produce statistically significant results (higher R-squared value and lower p-value.

Additionally, the state agencies with modified PEP that implemented the recommended changes from this study shall be examined to determine the impact of the modified practices on the performance of PEP. A separate study can be conducted to study the impact of IT services on the management of QPL and the overall performance of PEP across state agencies. The study should identify the industrial software or database management systems with impressive records of managing QPL, product submittal documents, investigation records, feedback / reviews from the end-users, and tracking the performance of the products in the field.

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APPENDIX 1: COMPONENTS OF RESEARCH FINAL MODEL

EXHIBIT A - MODIFIED PRODUCT EVALUATION FORM

1. Vendor Information

Manufacturer:	Click here to enter text.
Contact Name:	Click here to enter text.
Email:	Click here to enter text.
Title:	Click here to enter text.
Address:	Click here to enter text.
Telephone No:	Click here to enter text.
E-mail Address:	Click here to enter text.
Website Link:	Click here to enter text.
Company's Background:	Click here to enter text.

2. Product Information

Product Name:	Click here to enter text.
Model Number:	Click here to enter text.
NCID Username:	Click here to enter text.
APL Category:	Click here to enter text.
APL Sub-Category (If Applicable):	Click here to enter text.
Product Website Link:	Click here to enter text.
Material Composition:	Click here to enter text.
Product Was Previously Submitted for Evaluation:	☐**Yes** ☐**No**
If Yes, Tracking Id:	NP_____-_____
Product Cost:	Click here to enter text.
Unit of Measurement:	Click here to enter text.
Installation Cost:	Click here to enter text.
Special Equipment Required for Installation:	Click here to enter text.

Material Composition:	Click here to enter text.
Country of Manufacturing:	Click here to enter text.
Availability (*Seasonal/Non-Seasonal*):	Click here to enter text.
Product Shelf Life:	Click here to enter text.
Alternate for What Existing Products On APL:	Click here to enter text.
Recycled Materials (%):	Click here to enter text.
State Recycled Materials Used:	Click here to enter text.
Hazardous Materials (%):	Click here to enter text.
State Hazardous Materials Used:	Click here to enter text.
Educational Courses or Videos Available *(Provide Link)*	Click here to enter text.

Agenda	**Applicable**		**Details/Results**
	Yes	**No**	
Currently/Previously Applied for Evaluation at Any Other Governmental Agency/DOT	☐	☐	Click here to enter text.
Product Warranty	☐	☐	Click here to enter text.
Product Is Biodegradable	☐	☐	Click here to enter text.
Product Is Permeable	☐	☐	Click here to enter text.
Product Demonstration Provided by The Vendor	☐	☐	Click here to enter text.
Product Delivery at Site	☐	☐	Click here to enter text.
Patented in U.S.	☐	☐	Click here to enter text.

Product Description:	Click here to enter text.
Product Primary Use:	Click here to enter text.
Product Secondary Use:	Click here to enter text.
Product Outstanding Benefits (30 words):	Click here to enter text.

Product Limitations (30 words):	Click here to enter text.

3. Specification Information

Agency	Applicable		Details
	Yes	No	
DOT Standard Specifications	☐	☐	Click here to enter text.
DOT Special Provisions	☐	☐	Click here to enter text.
AASHTO	☐	☐	Click here to enter text.
ASTM	☐	☐	Click here to enter text.
MUTCD	☐	☐	Click here to enter text.
Other DOT approvals (List)	☐	☐	Click here to enter text.
Other Agency Approvals (List)	☐	☐	Click here to enter text.

4. Testing Information

Agency	Applicable		Test Data / Results
	Yes	No	
AASHTO	☐	☐	Click here to enter text.
ASTM	☐	☐	Click here to enter text.
Other Nationally Recognized Agency	☐	☐	Click here to enter text.

5. Attachments

Attached File	Applicable		Details
	Yes	No	
Technical Data Sheet	☐	☐	Click here to enter text.
Installation Details	☐	☐	Click here to enter text.
Safety Data Sheet	☐	☐	Click here to enter text.
Test Data	☐	☐	Click here to enter text.

Design Sheets	☐	☐	Click here to enter text.
Laboratory Reports	☐	☐	Click here to enter text.
Certificate of Compliance	☐	☐	Click here to enter text.
Life Cycle Cost Analysis	☐	☐	Click here to enter text.
Quality Control Plan	☐	☐	Click here to enter text.

EXHIBIT B – PAST PERFORMANCE SURVEY

PROPOSING COMPANY NAME is performing Past Performance Questionnaires for PRODUCT'S NAME used in one of their projects. This survey is provided to evaluate our performance for the product identified in Part A.

PART A – CLIENT REFERENCE & PROJECT INFORMATION

Client:	Insert	Project Name:	Insert
Reference:	Insert individual person's	Product Name:	Insert
Job Title:	Insert individual person's role	Product Unit Cost ($):	Insert
Email:	Insert e-mail address.	Phone:	Insert

PART B – COMPANY & PERSONNEL BEING EVALUATED.

Name of the Past Project/Installation: Insert Project Name

Name of the Consultant: Insert Proposing Company's Name

PART C – PERFORMANCE EVALUATION

Please rate your level of satisfaction with the product's performance on a scale of 1 to 10 (with 10 representing that you were very satisfied and 1 representing that you were very unsatisfied).

- Ratings will be applied for (a) our company overall, and (b) the listed product in Part A above.

No.	CRITERIA	UNIT	RATING
1	Risk associated with safety and health	(1-10)	
2	Availability of the product	(1-10)	
3	Quality of the product	(1-10)	
4	Installation of the product	(1-10)	
5	Product compliance with standards & specifications	(1-10)	
6	Overall professionalism and responsiveness to requests	(1-10)	
7	Overall client satisfaction with the product	(1-10)	

Please provide any recommendations or lessons learned from your project experience:

Click here to enter text.

Printed Name of Client Reference _____ Job Title _____ Signature _____

Thank you for your time and effort in assisting us in this important endeavor!

Please return the completed survey to: <<Insert proposing company's contact info>>

EXHIBIT C – PRODUCT EVALUATION FORM

1.) Evaluation checklist filled out by the **product evaluation program manager**:

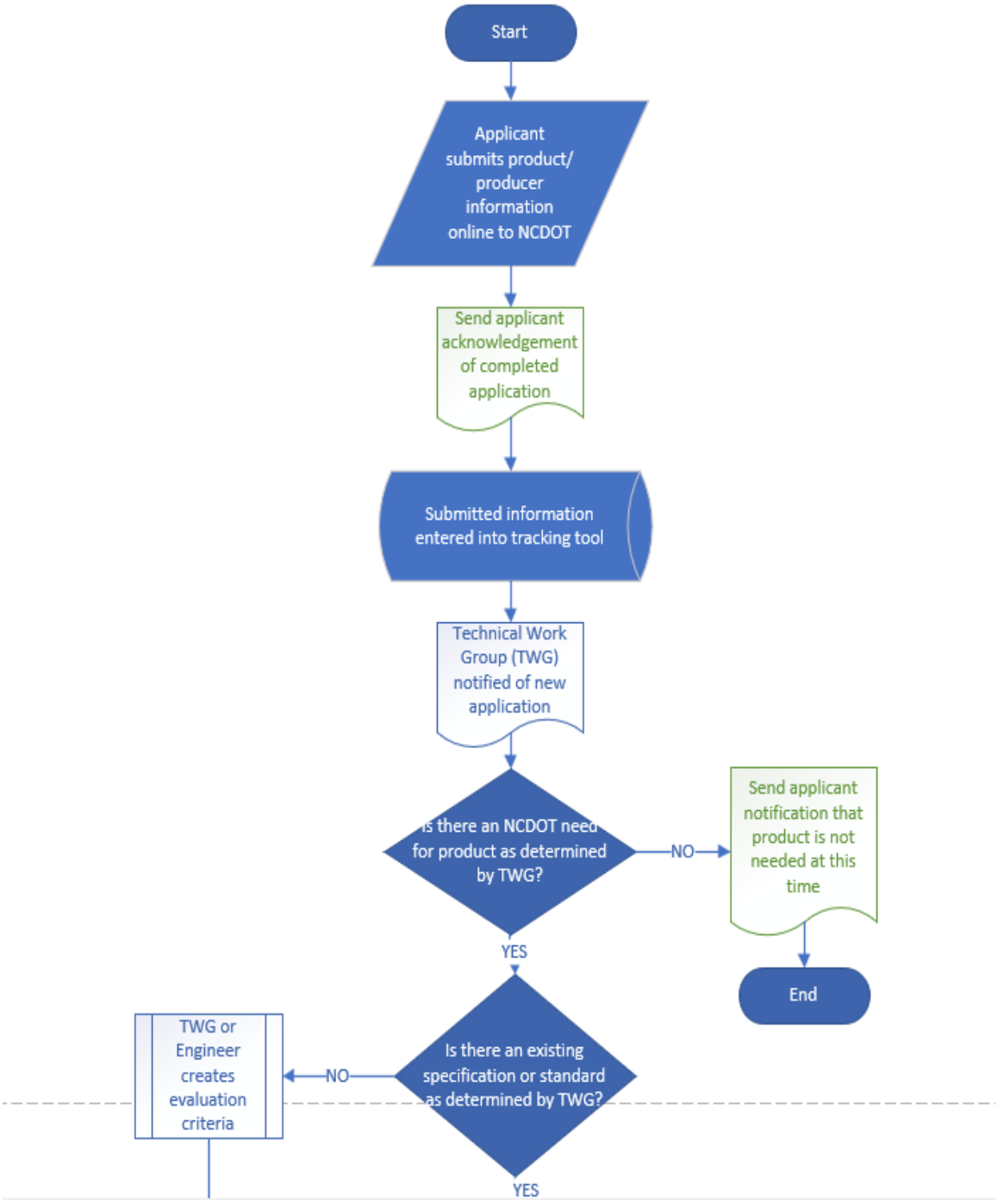
Criteria	**Applicable** ☐**Yes /** ☒**No**	**Weight**	**Score (1-10)**
Product Fits the Established Priorities	☐		
Product Within the Established Cap	☐		
Product Availability	☐		
Established Need and Benefits of The Product	☐		
Safety and Health Review	☐		
Environmental Impacts	☐		
Availability of Resources to Carry Out Technical Review	☐		
Warranted Background Information and Research Test Data	☐		
Product Supported by Other Technical Committee Members	☐		
Past Performance Survey	☐		
Product Warranty	☐		
OVERALL SCORE			

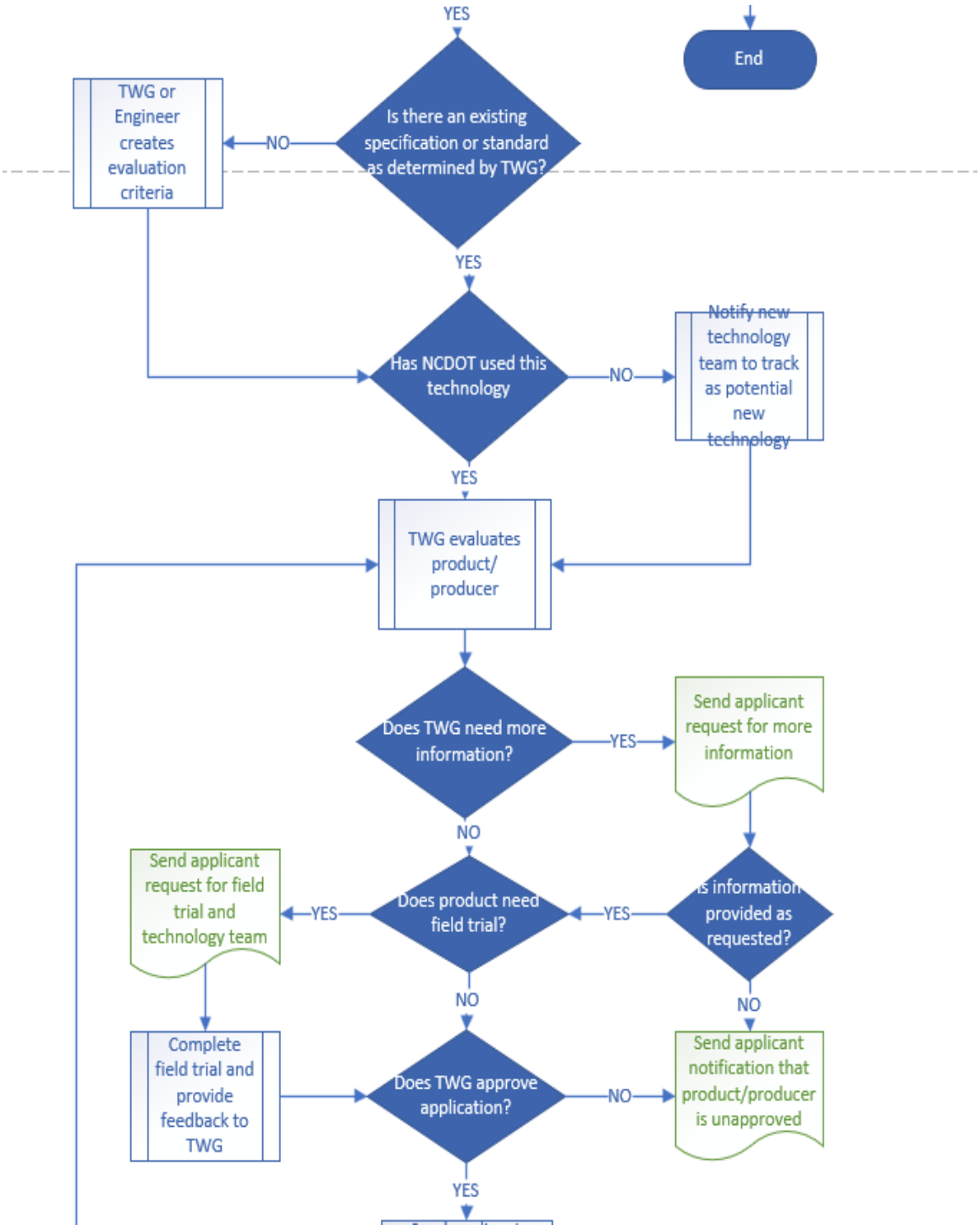
2.) Evaluation checklist filled out by the assigned **technical committee member**:

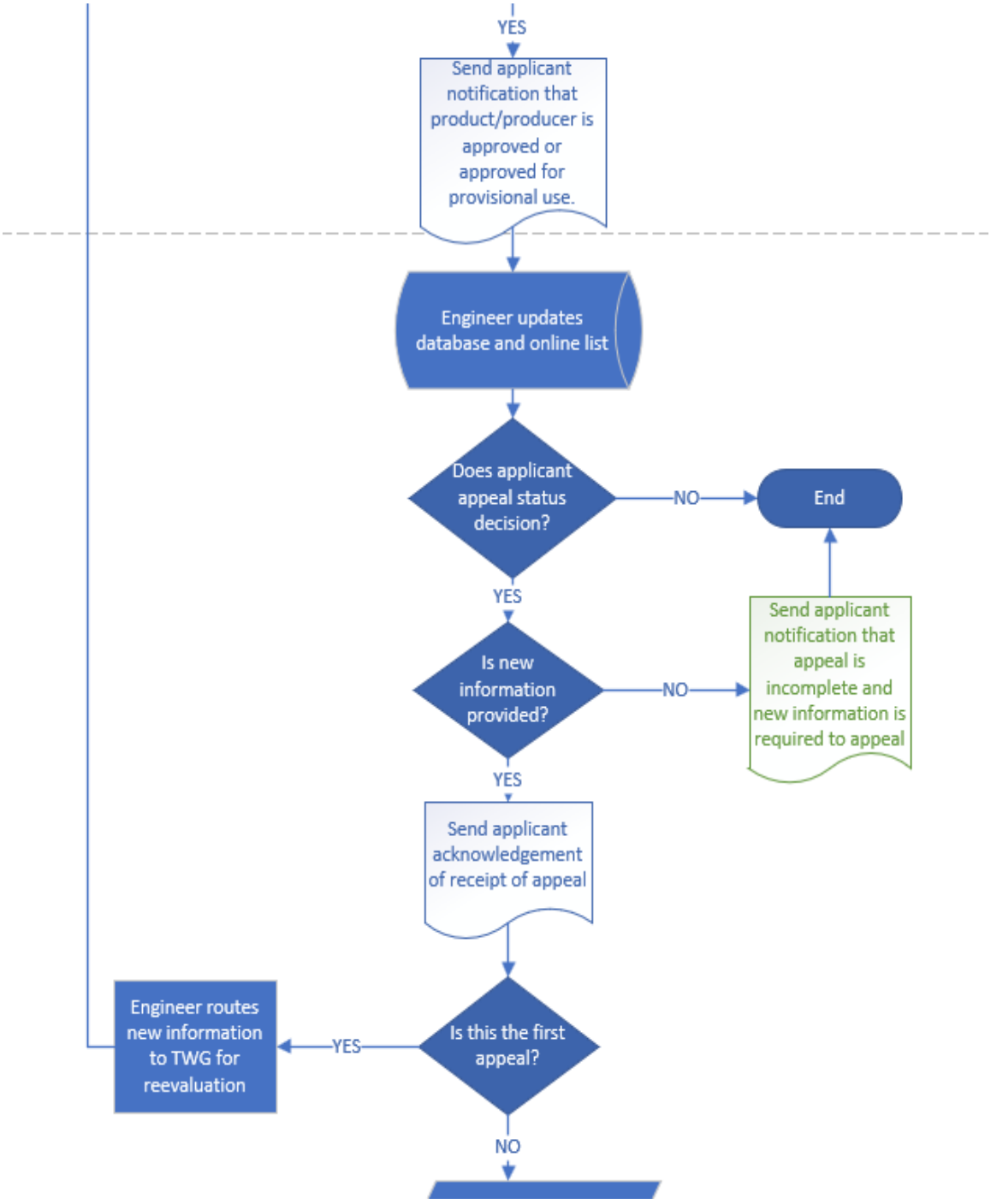
Criteria	**Applicable** ☐ **Yes /** ☒ **No**	**Weight**	**Score (1-10)**
Safety and Health Review	☐		
Environmental Impacts	☐		
Life Cycle Cost Analysis	☐		
Quality Control Plan	☐		
Overall Product Performance	☐		
FINAL SCORE (OVERALL SCORE + Technical Evaluation Score)			

APPENDIX 2: NCDOT PRODUCT EVALUATION DOCUMENTS

EXHIBIT A - PROPOSED PEP FLOWCHART OF NCDOT




YES
End
TWG or Engineer creates evaluation criteria
NO
Is there an existing specification or standard as determined by TWG?
YES
Has NCDOT used this technology
NO
Notify new technology team to track as potential new technology
YES
TWG evaluates product/ producer
Does TWG need more information?
YES
Send applicant request for more information
NO
Send applicant request for field trial and technology team
YES
Does product need field trial?
YES
Is information provided as requested?
NO
NO
Complete field trial and provide feedback to TWG
Does TWG approve application?
NO
Send applicant notification that product/producer is unapproved
YES


YES
Send applicant notification that product/producer is approved or approved for provisional use.
Engineer updates database and online list
Does applicant appeal status decision?
NO
End
YES
Is new information provided?
NO
Send applicant notification that appeal is incomplete and new information is required to appeal
YES
Send applicant acknowledgement of receipt of appeal
Engineer routes new information to TWG for reevaluation
YES
Is this the first appeal?
NO

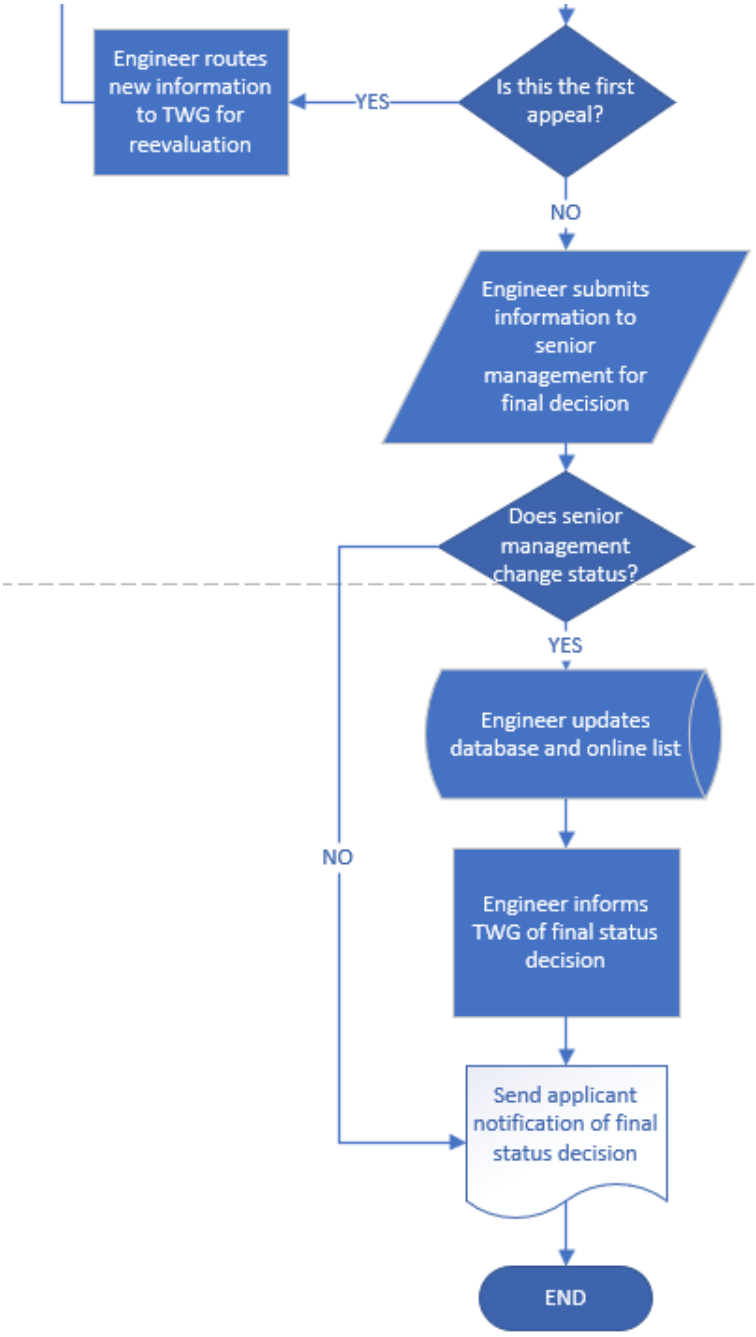

Is this the first appeal?
YES
Engineer routes new information to TWG for reevaluation
NO
Engineer submits information to senior management for final decision
Does senior management change status?
YES
NO
Engineer updates database and online list
Engineer informs TWG of final status decision
Send applicant notification of final status decision
END

EXHIBIT B – PEP PROCESS AT NCDOT

1.0 Product Evaluation Program (PEP)

1.1 Purpose

The purpose of the Product Evaluation Program (PEP) is to provide a comprehensive evaluation of products to make NCDOTs network safer, move people and goods more efficiently, and make the infrastructure last longer. Another purpose of the Program is to determine if evaluated products are viable for use in North Carolina's infrastructure by monitoring installations and providing documentation on their durability and performance.

Products evaluated are typically those that have not been previously evaluated by NCDOT and where a NCDOT Standard Specification does not exist, or products that have a NCDOT Standard Specification but require evaluation prior to approval.

Refer all product inquiries to the PEP Engineer:

- PEP Customer Service Line: (919) 707-4808
- PEP Email: productevaluation@ncdot.gov
- PEP Website

1.2 Goals

The Department receives numerous requests for evaluation and approval of innovative technologies and products for use on NCDOT transportation infrastructure projects. The primary goal of the PEP is to enable NCDOT to provide objective, impartial, and consistent evaluation of products and technologies for use in the construction, maintenance, and operation of the State's transportation system. Only innovative technologies and products that are fully developed, commercially available, and serve a useful function within NCDOT operations will be evaluated.

1.3 Definitions

Approved Product List (APL) – A list of innovative technologies and products that have been evaluated and approved by NCDOT for potential use on NCDOT projects.

Product – A fully developed, commercially available tangible item for use in the construction, maintenance, and/or operation of the State's transportation system.

Product Evaluation Program (PEP) Engineer – The central point of contact for management of the PEP.

Status Code – The standing assigned to a product or technology as it moves through the decision process. The status codes are as follows:

"Under Evaluation": Product or technology is undergoing evaluation consisting of, but not limited to, technical evaluation, laboratory review, and/or calculation verification.

"Accepted for Field Trial Use": The product or technology has been evaluated to the extent possible and the further review of the product or technology is pending the receipt of a field trial report from the vendor.

"Appeal": The vendor has requested a review of the TWG's status decision of the product or technology and has provided additional information to facilitate that review. Products and technologies with this status code are not posted on the APL.

"Approved": The product or technology has been evaluated and is approved for use.

"Approved for Provisional Use" (APU): The product or technology has been evaluated and is approved for use based on site specific and/or project specific conditions being met. (NOTE: Traffic Management products are given an APU status when they are to be used in the field prior to being given a full "Approved" status. The vendor must contact Traffic Management prior to using it on a NCDOT project.)

"No Status": The product or technology has not been evaluated and is awaiting further action by the TWG or vendor. Products and technologies with this status code are not posted on the APL.

"Request Additional Information": The review for the product or technology is pending the submission of additional or supporting documentation from the vendor.

"Unapproved": The product or technology has been evaluated and currently does not meet either the specifications or the needs of the Department. Products and technologies with this status code are not posted on the website. Additionally, a status may be changed to "Unapproved" if any of the following conditions occur: (Note: this list is not all inclusive)

- Unsatisfactory performance
- Product failure resulting in serious injury or death
- Unsafe product or installation
- Warranty not honored
- Insolvency

- False information submitted on any application, statement, certification, reports or records
- Debarred by Federal or State Agency
- Failure to furnish a non-collusion affidavit upon request
- Evidence of collusion among vendors
- Failure to meet the requirements of an existing guarantee

"Void": The product or technology failed to recertify or is no longer being considered for evaluation or use. Products and technologies with this status code are not posted on the APL.

Technology – An application of knowledge used to improve the functionality of a given product or process used in the construction, maintenance, and/or operation of the State's transportation system.

Vendor – The entity (typically the product manufacturer or distributor) that submits an application for product evaluation.

1.4 PEP Submission Processes

Products submitted to NCDOT for evaluation must meet the following criteria:

- The vendor must use Web-Based PEP Application and submit electronically;
- The vendor must identify the proposed use of the product or technology;
- The product or technology must be directly related to the transportation system; and,
- The product or technology must be fully developed, marketable, and commercially available.

A. Web-Based Application

1. Visit the PEP Website and sign up for a NCID Account by using the NCID instructions.
2. Once you have a NCID Account, click the "Register your NCID" button on the PEP Webpage and send the following information to productevaluation@ncdot.gov.
    a. Name of Account Owner
    b. Phone Number
    c. Email Address
    d. NCID Username

3. Please note that the PEP Team must register your NCID in order for you to have access to the web-based application. It may be 10 business days before you are granted access.

EXHIBIT C – PRODUCT FEEDBACK FORM

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
PRODUCT EVALUATION PROGRAM
PRODUCT FEEDBACK FORM

Direct all questions regarding this feedback form to productevaluation@ncdot.gov or 919-707-4808.

INSTRUCTIONS

Please provide factual information related to your experience using a product or innovation on an NCDOT project, save the form, and submit the completed form and other supporting documentation/photos to productevaluation@ncdot.gov. Additional blank forms are available here.

PROJECT INFORMATION (Fill in at least **ONE** answer in this section to identify the project.)

NCDOT Contract Number/WBS: _____

Route or Location: _____

County/Counties/Division: _____

NCDOT Engineer/Contact: _____

Prime Contractor (Company Name): _____

Company Installing Product: _____

PRODUCT INFORMATION (Fill in at least the information marked with **.)

** **Product Name:** _____

Product Model: _____

Product Manufacturer: _____

Product Distributor: _____

Approved Products List NP Number: _____

Date(s) of Installation: _____

Identify Location Installed/Used: _____

Describe Product Use: _____

Observed Product Performance: _____

Possible Reasons for Performance: _____

Recommendations for Future Use: _____

The name below certifies that the information herein is correct. Email to productevaluation@ncdot.gov.

Name _____
Date _____
Email _____
Phone _____ Ext _____

EXHIBIT D – CHANGE NOTIFICATION FORM

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

PRODUCT EVALUATION PROGRAM

CHANGE NOTIFICATION FORM

I. INSTRUCTIONS

1. This form is only for vendors wishing to notify the NCDOT of changes to their product and/or contact information. This form will not be accepted for the annual recertification requirement.
2. Find your current Approved Products List data at https://apps.dot.state.nc.us/vendor/approvedproducts/.
3. Complete the Product ID field in Section II and complete other sections as needed. Fields in Sections II, III, and IV may be left blank if the information does not need to be updated.
4. The Approved Products List will be updated to directly match the updated information.
5. Click the save button ( ) found at the bottom of the form to save a copy of the completed form.
6. Email the completed form and/or questions to productevaluation@ncdot.gov.

II. PRODUCT INFORMATION

Product ID: NP –

Previous Product Name:

Updated Product Name:

Previous Model Number:

Updated Model Number:

Description:

Website:

III. CONTACT INFORMATION

MANUFACTURER / MAIN

Previous Name: Email:
Contact Name: Title:
Address: Phone: Ext:
City: State: Zip Code:

Updated Name: Email:
Contact Name: Title:
Address: Phone: Ext:
City: State: Zip Code:

DISTRIBUTOR / OTHER

Previous Name: Email:
Contact Name: Title:
Address: Phone: Ext:
City: State: Zip Code:

Updated Name: Email:
Contact Name: Title:
Address: Phone: Ext:
City: State: Zip Code:

IV. ADDITIONAL PRODUCT CHANGES

Describe any product change(s) since NCDOT's last review of this product:

V. CERTIFICATION

The name below certifies that the above information is correct.

Name:
Date:
Email:
Phone: Ext:

APPENDIX 3: SURVEY QUESTIONNAIRE

The North Carolina Department of Transportation, in partnership with UNC Charlotte, is conducting a national survey to better understand product evaluation practices across DOT agencies in the United States. The survey will take about 5 minutes to complete. Your individual responses will remain confidential.

Q2 Please enter the following details and then click the arrow below to continue.

o First and Last Name (4) _____

o Job Title (6) _____

o Email Address (5) _____

Q3 Which state DOT agency do you represent?

Q5 Approximately how many staff members have a current and primary responsibility of managing and supporting the Product Evaluation Program?

o 1 person (1)

o 2 people (2)

o 3 people (3)

o 4 people (4)

o More than 4 people (5)

o Don't know (6)

Q6 How satisfied are you with the performance of your product evaluation program?

o Extremely dissatisfied (1)

o Moderately dissatisfied (2)

o Slightly dissatisfied (3)

o Neither satisfied nor dissatisfied (4)

o Slightly satisfied (5)

o Moderately satisfied (6)

o Extremely satisfied (7)

Q7

Can you tell us a little bit more about why you provided this rating?

_____

_____

_____

_____

_____

Q8 How satisfied are you with the communication/feedback process between the different stages of evaluation program?

o Extremely dissatisfied (1)

o Moderately dissatisfied (2)

o Slightly dissatisfied (3)

o Neither satisfied nor dissatisfied (4)

o Slightly satisfied (5)

o Moderately satisfied (6)

o Extremely satisfied (7)

Q9 Can you tell us a little bit more about why you provided this rating?

_____

_____

_____

_____

_____

Q10 Does your state's evaluation program include personnel from the top level of management?

o Yes (1)

o No (2)

o Don't know (3)

Q11 When products are received for evaluation by your agency, who typically pays for the different tests used to evaluate the product?

o State DOT (1)

o Vendor (2)

o Vendor & DOT share expenses (3)

o Other(s): (4)

Q11.1 What are the other sources?

_____

Q12 Does your state have dedicated software to update, modify, or control the Approved Product List?

o Yes (1)

o No (2)

o Don't know (3)

Q12.1 Please provide the name and a brief description of your software.

_____

_____

_____

_____

_____

Q13 Does your state use any of the following resources / software in the management of your Product Evaluation Program? Please select all applicable options.

▢ AASHTOWare (1)

▢ AASHTO National Transportation Production Evaluation Program (2)

▢ NONE - we do not use any software or other resources (5)

▢ AASHTO Product Evaluation List (APEL) (3)

▢ Other(s): (6)

Q13.1 What are the other resources/software?

_____

Q14

Which acceptance criteria does your state use to evaluate its products? Please select all applicable options.

▢ DOT's specification (1)

▢ AASHTO's specification (2)

▢ Internal need (3)

▢ Other(s): (4)

▢ Commercial availability (5)

▢ Lab and Field test results (6)

▢ Safety and hazard test results (7)

Q14.1 What are the other acceptance criteria?

_____

Q15

Great work! Just a few more questions.

Thinking about your agency's Approved Product List over the past 12 months, please estimate the number (#) of products that were...

o ...under evaluation (#) (1) _____

o ...approved (#) (2) _____

o ...unapproved (#) (3) _____

o ...submitted w/o required information (#) (4) _____

o ...placed in a field trial for evaluation (#) (5) _____

o ...approved with restriction on use (#) (6)
_____

Q16 Thinking about your agency's Approved Product List over the past 12 months, please estimate the number (#) of...

o ...applications received (1) _____

o ...evaluations finished (2) _____

Q17 Compared to 2016, how has the number (#) of product evaluations changed?

o More than 25% decrease in products evaluated (1)

o About 5-24% decrease in products evaluated (2)

o About the same (3)

o About 5-24%% increase in products evaluated (4)

o More than 25% increase in products evaluated (5)

Q18 About how many (#) categories/types of products exist on the Approved Product List?

_____

Q19 Within the last 12 months, about how much time, if any, did your agency spend reviewing the product application/submittal package prior to beginning the evaluation?

EXAMPLE: 2 weeks

_____

Q20 Within the last 12 months, about how much time did it take to evaluate and reach a decision on a product?

EXAMPLE: 5 months

_____

Q21Do you track the placement, installation, and/or use of products in your state?

o Yes (1)

o No (2)

o Don't Know (3)

Q22 What types of products do you track? Please elaborate.

_____

_____

_____

_____

_____

Q23 Do you use any software for product tracking? If applicable, please specify.

o Yes (1)

o No (2)

o Don't know (3)

Q23.1 Which software do you use for product tracking?

_____

_____

_____

_____

_____

Q24 Does your state provide feedback to vendors on unapproved products?

o Yes (1)

o No (2)

o Don't know (3)

Q25 Does your state maintain a database of unapproved products?

o Yes (1)

o No (2)

o Don't know (3)

Q26 in your opinion, how important is the Product Evaluation Program as a means of ensuring safety and long-term performance of approved products?

o Not at all important (1)

o Low importance (2)

o Slightly important (3)

o Neutral (4)

o Moderately important (5)

o Very important (6)

o Extremely important (7)

Q27 Does your agency typically consider new and innovative products, without specifications, for evaluation?

o Yes, we consider all products. (1)

o Yes, but with terms and conditions (2)

o No, we do NOT evaluate new products (3)

o Don't know (5)

Q28 Please identify the typical job titles (e.g., Program Engineer) of those who manage/work with the Product Evaluation Program:

_____

_____

_____

_____

_____

Q29 Approximately how much money ($) does your state spend annually for the management and evaluation processes for the Product Evaluation Program?

_____

Q30 What are the biggest challenges you face with product evaluation?

_____

_____

_____

_____

_____

Q31 What changes would you recommend to your product evaluation program if you had no constraints?

_____

_____

_____

_____

_____

Q32 If needed, would you be available for a brief follow-up discussion regarding your responses?

o YES - please feel free to contact me (1)

o NO - please do not contact me (2)

Q33

Please answer the following questions thinking about your agency from an OVERALL perspective.

How OFTEN does your agency...?

	Never (1)	Very Rarely (2)	Rarely (13)	Unsure (4)	Often (5)	Very Often (6)	Always (7)
Scan and examine the environment to anticipate change and prevent risks. (1)	o	o	o	o	o	o	o
Create and innovate continuously. (2)	o	o	o	o	o	o	o
Develop a culture of change among employees. (3)	o	o	o	o	o	o	o
Use effective processes to make decisions quickly when circumstances change. (4)	o	o	o	o	o	o	o
Seize new opportunities for development. (5)	o	o	o	o	o	o	o
Identify and rapidly seize the best opportunities which come up in your environment. (6)	o	o	o	o	o	o	o
Clearly distribute company strategy to all hierarchical levels. (7)	o	o	o	o	o	o	o
Communicate about the agency and its action plans in terms easily	o	o	o	o	o	o	o

understood by all. (8)							
Inform employees about upcoming changes and their implementation. (9)	o	o	o	o	o	o	o

Q34 How many years of DOT / business / professional experience do you personally have?

o Less than 5 years (1)

o 5 – 9 years (2)

o 10 – 19 years (3)

o 20 – 29 years (4)

o 30 – 39 years (5)

o 40 – 49 years (6)

o More than 50 years (7)

Q35 What is your generational affiliation?

o Traditionalist (born prior to 1946) (1)

o Baby Boomer (born 1946 – 1964) (2)

o Generation X (born 1965 – 1978) (3)

o Generation Y (born 1979 – 1997) (4)

o Generation Z (born 1998 – present) (5)

Q36 Please indicate the role that best describes your current job position.

o Senior Executive (CEO, CFO, COO, CIO, etc.) (1)

o Vice President or Assistant Vice President (2)

o Regional Manager / Director / Local Office Supervisor (3)

o Project Lead / Crew Lead (4)

o Project Team Member / Crew Member (5)

o Other: (6)

Q36.1 Please specify your current job role?

_____

APPENDIX 4: SURVEY QUESTIONNAIRE FROM PAST STUDY (CARR, 2002)

Below, please provide the information requested for the person completing this questionnaire or for someone else who may be contacted to obtain any needed follow-up information.

Name: _____

Title: _____

Agency: _____

Street Address: _____

City/State/Zip: _____

Telephone: _____ Fax: _____ E-mail: _____

1. Does your state have a formal program for new product evaluations?

   _____ Yes _____ No

   Comment: _____

   _____

2. What is the average number of products received for evaluation and potential implementation application each year over the last ten years?

   ☐ 1
   ☐ 2 to 5
   ☐ 5 to 10
   ☐ 10 or more

   Also, please attach copies of any information concerning the frequency, content, costs, and other relevant information regarding product evaluations that your agency may have compiled.

   Comment: _____

   _____

3. If few or no products were received for evaluation, check the box that best describes your opinion as to why this is the case?

   ☐ The agency rarely, if ever, receives requests for new product evaluation.
   ☐ The evaluation program is in the development stages and not fully functional.
   ☐ The evaluation program is not widely known outside the agency.
   ☐ Other reasons, please explain:

   _____

   _____

4. How does your agency define a new product or candidate for evaluation?

   ☐ It is defined as one not previously used by the department.
   ☐ It is defined as one not previously evaluated for application.
   ☐ Any request submitted by an internal or external source is considered to be a potential candidate for evaluation.
   ☐ Only requests from outside sources are considered for evaluation.
   ☐ Other, please explain:

   _____

   _____

Also, please attach the agency's specification language addressing the definition of a "new product" or "candidate for evaluation," if it exists.

5. What types of products have been evaluated? (Check all that apply).

☐ Materials
☐ Equipment
☐ Processes and practices
☐ Traffic control
☐ All the above

Comment: _____

_____

_____

6. What are the acceptance criteria that have been used to evaluate the product?

☐ State specifications
☐ Laboratory and field testing results
☐ National product testing center results such as NTPEP, APEL, etc.
☐ Other state's best practices or recommendations
☐ Demonstration projects or experimental feature applications
☐ Other, please explain:

_____

_____

_____

7. What acceptance options have been used? (Check all that apply).

☐ Approval based upon a certification of compliance with existing state specifications.
☐ Approval based on test specified by the state's evaluation program.
☐ Conditional approval on a project-by-project basis.
☐ Reciprocity with other states or regional collaborations.
☐ General approval for all applicable projects.

Comment: _____

_____

_____

8. What procedures are used to implement new products that have been approved for application? (Check all that apply).

☐ A qualified products' list (QPL)
☐ Incorporating a QPL into standard specifications
☐ A new specification development and revision
☐ A listing of approved products
☐ Other, please explain:

_____

_____

_____

Please attach a copy of relevant provisions if set forth in state specifications.

9. Once new products are approved for application, how is the use of these products implemented?

☐ The use of these products becomes optional.
☐ The use of these products becomes recommended.
☐ The use of these products becomes required.
☐ Other, please explain:

_____
_____
_____

10. Does your state have staff committed to new product evaluation activities on a full time basis?

_____ Yes _____ No

Comment: _____
_____
_____

11. Does your state use a committee or task force to oversee new product evaluation?

_____ Yes _____ No

Comment: _____
_____
_____

12. If the answer to Question 11 is yes, how many state personnel actively and regularly participate in the evaluation program?

☐ 1–2 individuals
☐ 2–5 individuals
☐ 5–10 individuals
☐ More than 10 individuals

13. What is the average frequency of committee or task force meetings conducted to consider product evaluations?

☐ Once per year
☐ 2–5 times per year
☐ 6–11 times per year
☐ Monthly
☐ Other, please explain:

_____
_____
_____

14. Has your state received claims of bias or unfair evaluation conclusions from sources requesting an evaluation?

_____ Yes _____ No

Comment: _____

_____

_____

15. Through claims, proposals, requests for reconsideration, or other means have outside sources that have submitted products for evaluation requested compensation for any claims of bias or unfair evaluation?

_____ Yes _____ No

Comment: _____

_____

_____

16. Does your state have a dedicated funding allocation set aside for new product evaluations?

_____ Yes _____ No

If yes, please explain:

_____

_____

17. Does your state have a clearly identified contact person for vendors to contact for new product evaluations?

_____ Yes _____ No

18. Any final comments?

_____

_____

_____

THANK YOU!

Remember! Please enclose any information that you believe is relevant to the answers given in the questionnaire, including applicable research results, policies, specification language, program documentation, and other information that might be of interest to other states.

APPENDIX 5: PEP FLOWCHARTS OF DOTs

EXHIBIT A – CALIFORNIA DOT

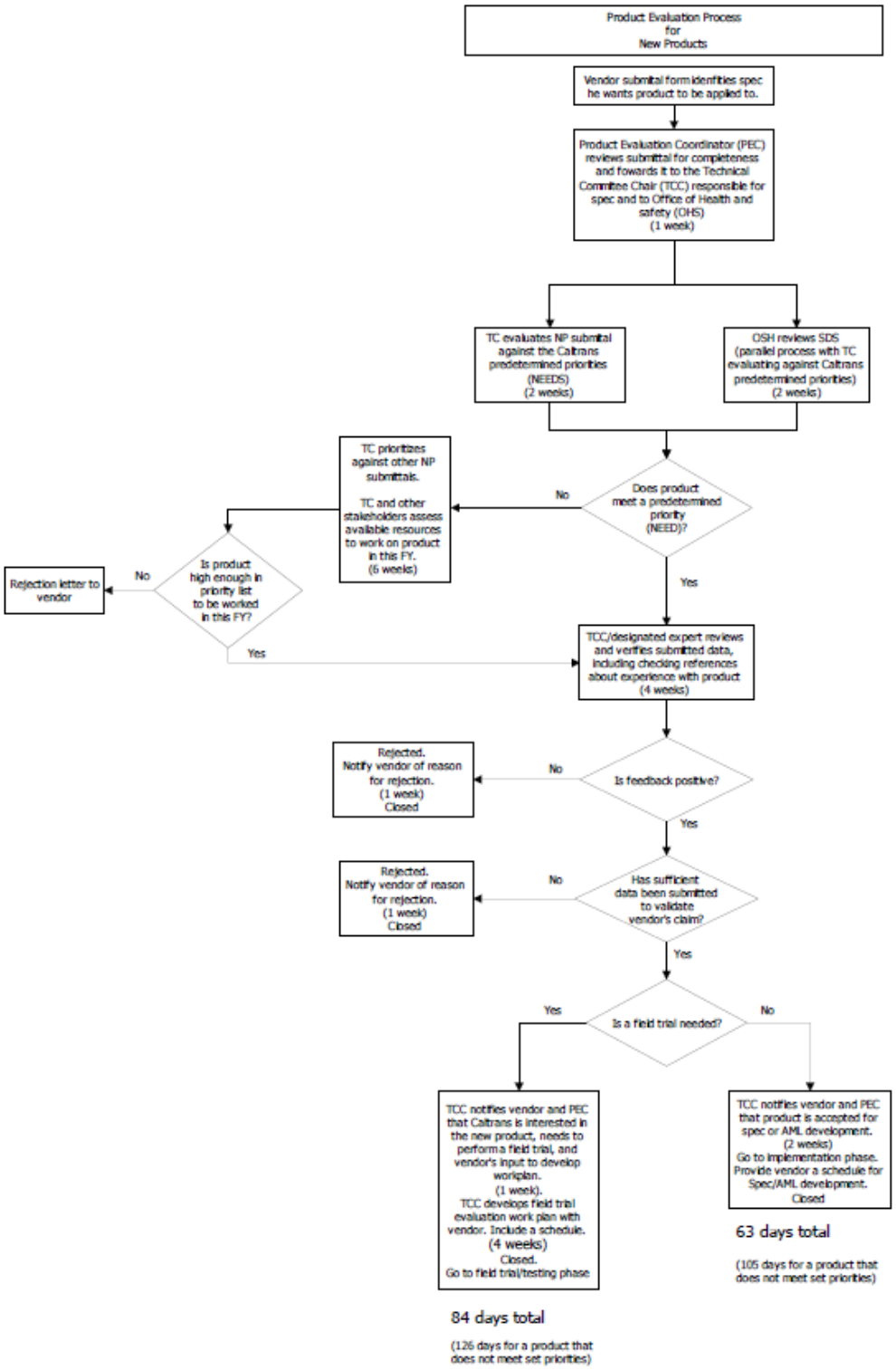


EXHIBIT B – NEW JERSEY DOT

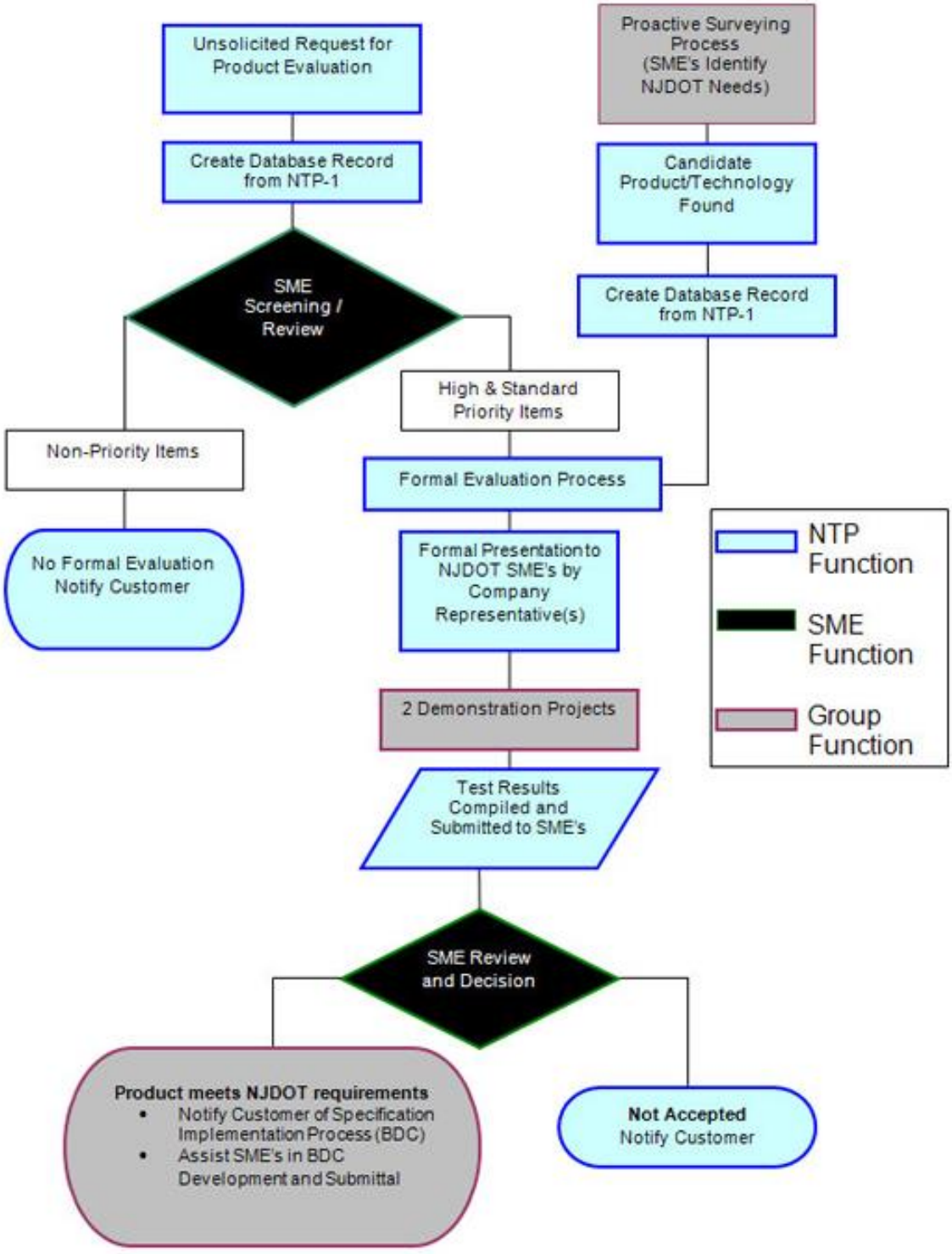


EXHIBIT C -

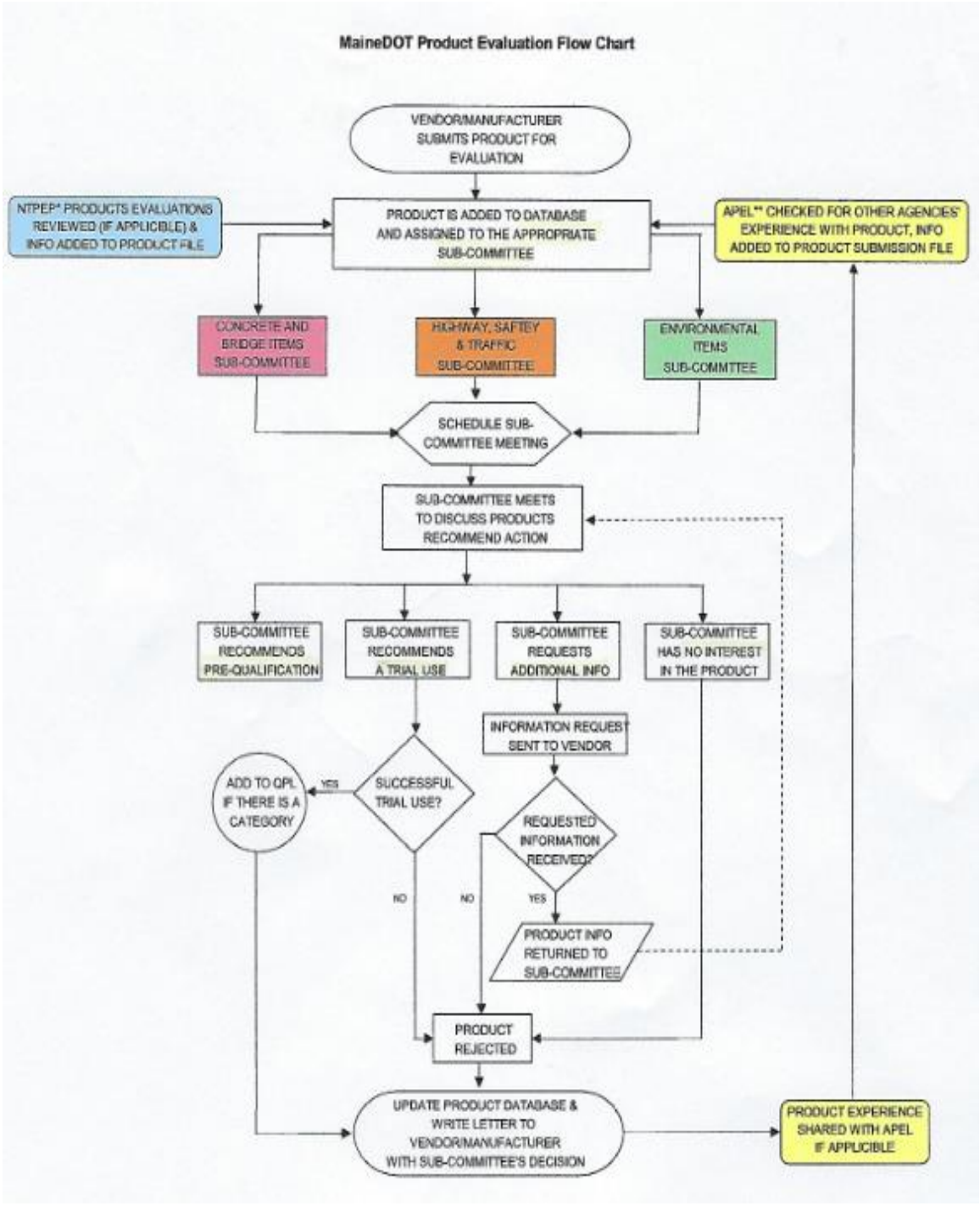

MaineDOT Product Evaluation Flow Chart
VENDOR/MANUFACTURER SUBMITS PRODUCT FOR EVALUATION
NTPEP* PRODUCTS EVALUATIONS REVIEWED (IF APPLICBLE) & INFO ADDED TO PRODUCT FILE
PRODUCT IS ADDED TO DATABASE AND ASSIGNED TO THE APPROPRIATE SUB-COMMITTEE
APEL** CHECKED FOR OTHER AGENCIES' EXPERIENCE WITH PRODUCT, INFO ADDED TO PRODUCT SUBMISSION FILE
CONCRETE AND BRIDGE ITEMS SUB-COMMITTEE
HIGHWAY, SAFTEY & TRAFFIC SUB-COMMITTEE
ENVIRONMENTAL ITEMS SUB-COMMTTEE
SCHEDULE SUB-COMMITTEE MEETING
SUB-COMMITTEE MEETS TO DISCUSS PRODUCTS RECOMMEND ACTION
SUB-COMMITTEE RECOMMENDS PRE-QUALIFICATION
SUB-COMMITTEE RECOMMENDS A TRIAL USE
SUB-COMMITTEE REQUESTS ADDITIONAL INFO
SUB-COMMITTEE HAS NO INTEREST IN THE PRODUCT
INFORMATION REQUEST SENT TO VENDOR
ADD TO QPL IF THERE IS A CATEGORY
YES
SUCCESSFUL TRIAL USE?
REQUESTED INFORMATION RECEIVED?
NO
NO
YES
PRODUCT INFO RETURNED TO SUB-COMMITTEE
PRODUCT REJECTED
UPDATE PRODUCT DATABASE & WRITE LETTER TO VENDOR/MANUFACTURER WITH SUB-COMMITTEE'S DECISION
PRODUCT EXPERIENCE SHARED WITH APEL IF APPLICIBLE

EXHIBIT D – ALABAMA DOT

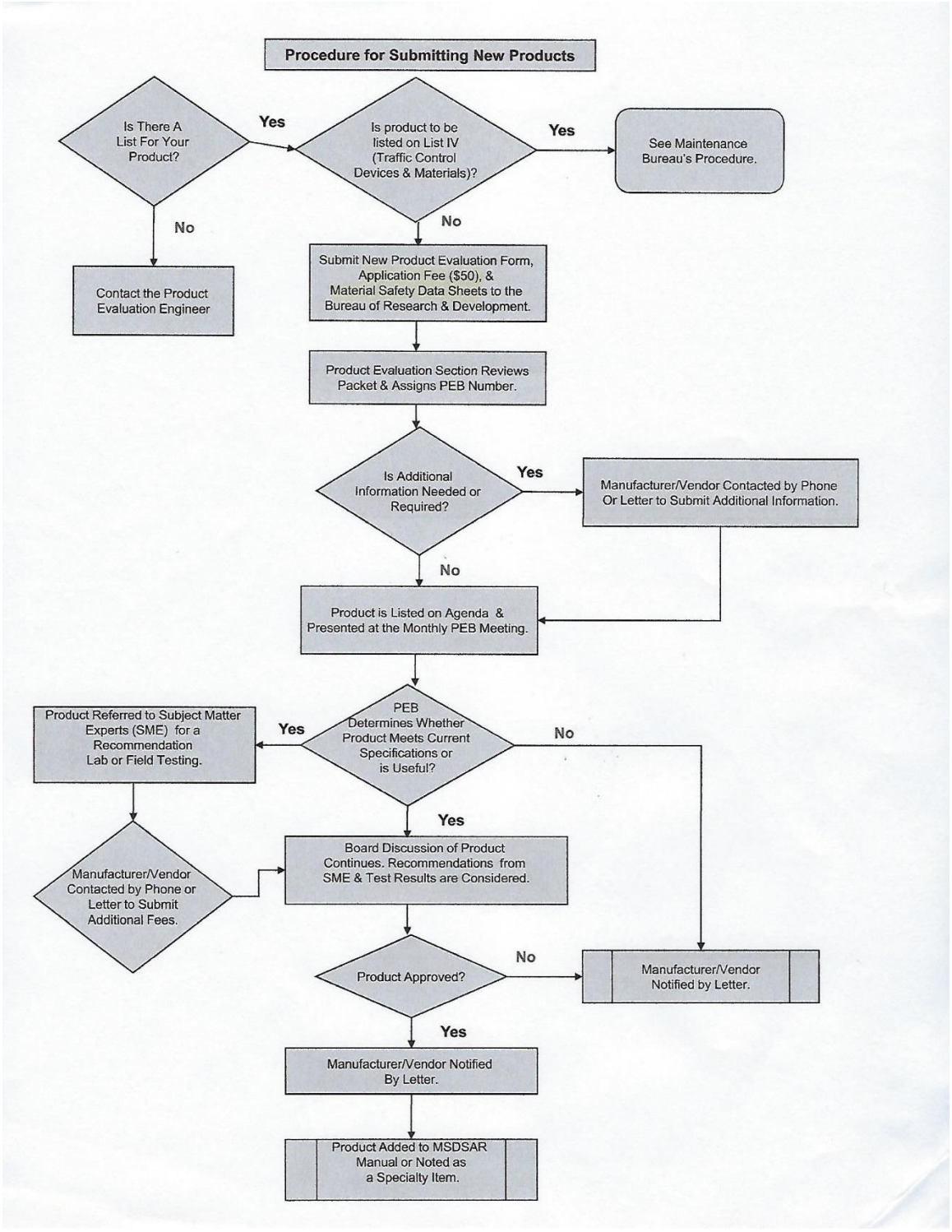
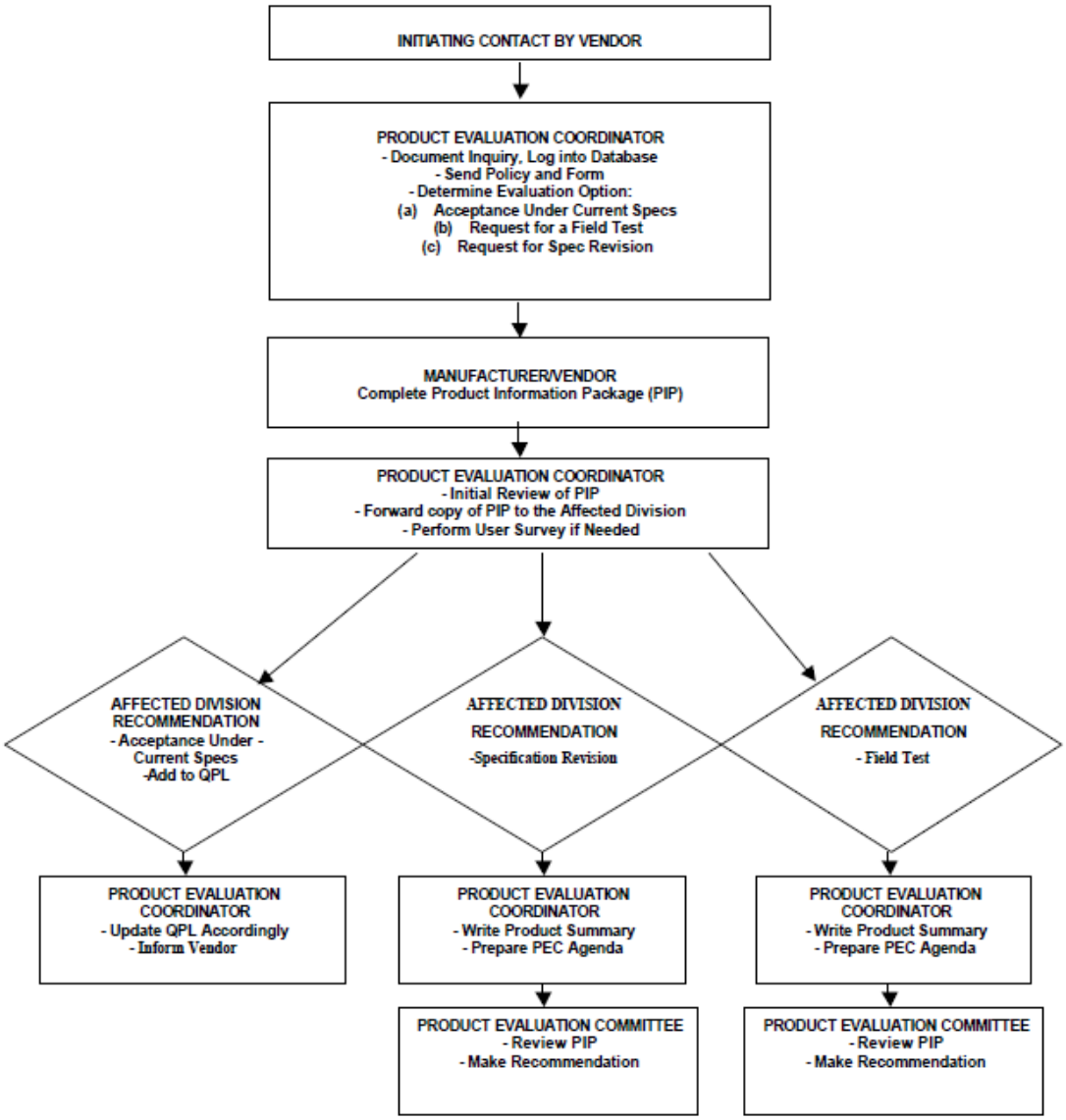


EXHIBIT E – NEVADA DOT



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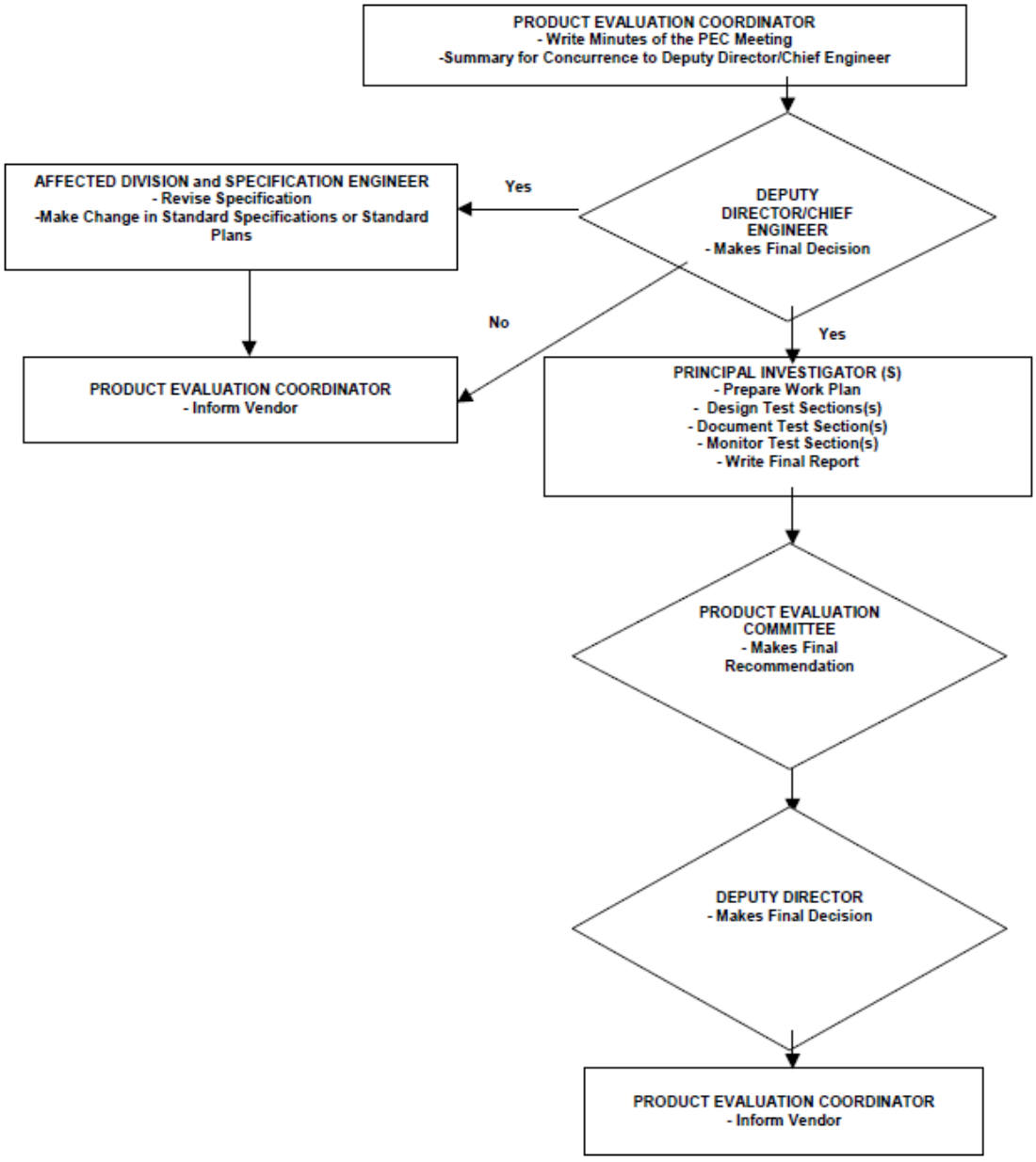
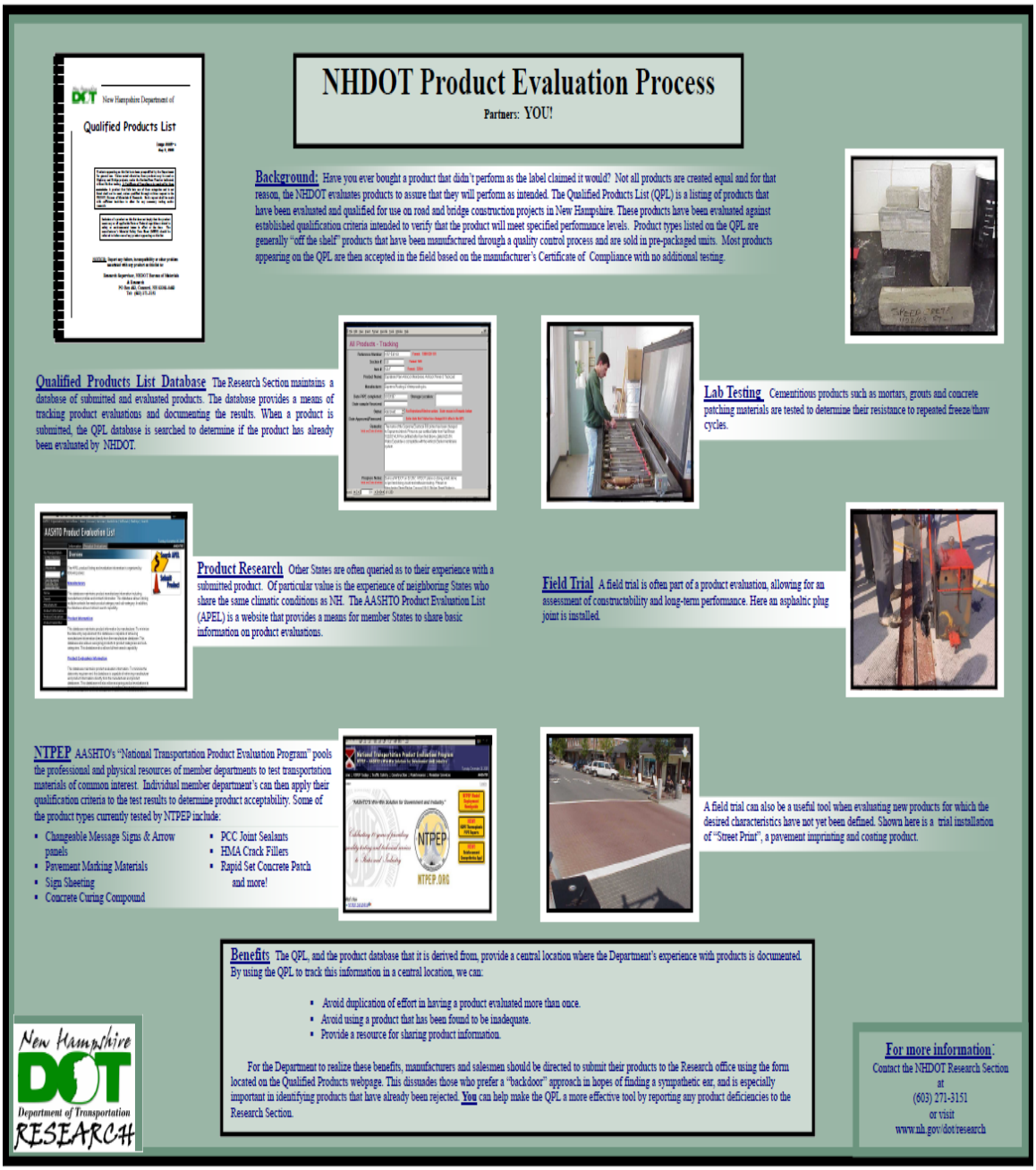
(Fig. 2.1)


PRODUCT EVALUATION COORDINATOR
- Write Minutes of the PEC Meeting
-Summary for Concurrence to Deputy Director/Chief Engineer
DEPUTY DIRECTOR/CHIEF ENGINEER
- Makes Final Decision
Yes
AFFECTED DIVISION and SPECIFICATION ENGINEER
- Revise Specification
-Make Change in Standard Specifications or Standard Plans
No
PRODUCT EVALUATION COORDINATOR
- Inform Vendor
Yes
PRINCIPAL INVESTIGATOR (S)
- Prepare Work Plan
- Design Test Sections(s)
- Document Test Section(s)
- Monitor Test Section(s)
- Write Final Report
PRODUCT EVALUATION COMMITTEE
- Makes Final Recommendation
DEPUTY DIRECTOR
- Makes Final Decision
PRODUCT EVALUATION COORDINATOR
- Inform Vendor

APPENDIX 6: PEP POSTER



APPENDIX 7: PEP PRODUCT APPLICATIONS OF DOTs

EXHIBIT A – ALABAMA DOT

ALABAMA DEPARTMENT OF TRANSPORTATION
PRODUCT EVALUATION BOARD

New Product Evaluation Application Form

PEB # _____
Official Use Only

One product (model) per submittal form. Instructions for completion on page 4
Please contact the Product Evaluation Engineer aldotpeb@dot.state.al.us (334) 353-6940, if this product is covered by an ALDOT specification(s) and is not covered under an approved products list or for general questions about this form.
NOTE: You must have legal right to submit the product for evaluation.

Product Information

Trade Name

Model Number

Manufacturer	Vendor (If other than manufacturer, List the local Distributor)
Contact	Contact
Company	Company
Address	Address
City	City
State Zip Phone	State Zip Phone

Applying for Qualified Product List(s) Designation	Choose List Applying for
	Choose List Applying for
	Choose List Applying for
	Choose List Applying for

Has this product previously been submitted to ALDOT for evaluation? *YES* ☐ *NO* ☐

If yes, provide previous application ID #

Product Description	
Recommended Uses—Primary	
Recommended Uses—Alternate	
Outstanding Features or Advantages	

Material Composition (attach laboratory report and Material Safety Data Sheet)

Alternate or comparable to what existing material or product(s)	

Patented? *YES* ☐ *NO* ☐ *attach copy of patent* Patent Number(s)

Proprietary Item Country of Origin

If the Product is selected for use on a project, then the Manufacturer will be required to furnish proper documentation with the shipment, confirming your company's compliance with Buy America Act (23CFR 635.410) and the current ALDOT standard specification, Section 106.

SPECIFICATION INFORMATION

AGENCY/ORGANIZATION	APPLICABLE? YES	APPLICABLE? NO	SPECIFICATION(S) DETAIL
ALDOT Standard Specifications	☐	☐	
ALDOT Special Provisions	☐	☐	
AASHTO	☐	☐	
ASTM	☐	☐	
MUTCD	☐	☐	
Federal Inspection/Opinion	☐	☐	
Other Specifications (List)	☐	☐	

TESTING INFORMATION

AGENCY/ORGANIZATION	APPLICABLE? YES	APPLICABLE? NO	TEST DATA/RESULTS
NTPEP	☐	☐	
Independent Lab Test (List)	☐	☐	
Other Tests (List)	☐	☐	

COST, AVAILABILITY and WARRANTY

Estimated cost of materials per unit? Delivery at site within days after receipt of order

	YES	NO	If yes, explain
Is product seasonal	☐	☐	
Are quantities limited	☐	☐	
Will free sample(s) be provided for laboratory or field tests	☐	☐	
Will free installation of the material in the field be provided	☐	☐	
Will onsite supervision of first installation in the field be provided	☐	☐	
Will special equipment be required to install the product	☐	☐	
Is the Material/Product guaranteed	☐	☐	Conditions

OTHER DOT(s) AGENCY CONSIDERATIONS – list products approved by other highway authorities or other agencies
Attach additional sheets if needed

Agency/Organization	Contact Name & Number	Approval List(s)

OTHER DOT(s) AGENCY CONSIDERATIONS – list products under evaluation for approval by other highway authorities / agencies
Attach additional sheets if needed

Agency/Organization	Contact Name & Number	Consideration List(s)

REQUIRED DOCUMENTATION
The following applicable information and materials are available and are required to accompany this form in order to substantiate, verify or clarify its content

Specifications	Attached	Not Applicable
Drawings, Sketches, Pictures	☐	☐
Installation Instructions	☐	☐
Material Safety Data Sheets	☐	☐
Product/Material Literature	☐	☐
Test Data/Laboratory Reports	☐	☐
Certifications	☐	☐
Warranty	☐	☐

The manufacturer/distributor is hereby notified that the ALDOT, Product Evaluation Board reserves the right to release or distribute any of the information included in this form as well as any recommendations the Board may make concerning the product. ALDOT will only consider any products for evaluation or testing when all criteria are received to the ALDOT Bureau of Research and Development. The required application fee is $50 per product from and must accompany this form. All other associated testing fees are provided in the ALDOT 355-88. A check or money order must be made payable to the Alabama Department of Transportation.

Printed Name of Submitter _____

Title _____ Contact Number _____

Company Name _____

Signature _____ Date _____

Kidada Dixon, P.E. – Assistant Research and Development Engineer
Research and Development Bureau
Alabama Department of Transportation
3700 Fairground Road
Montgomery, AL 36110

EXHIBIT B – ARIZONA DOT

Arizona Department of Transportation
Product Evaluation Program

APPLICATION FOR PRODUCT EVALUATION

Note: Applications must be submitted electronically to: apl@azdot.gov

I, _____ being an authorized
(Name of Company Representative)

agent of _____, request that
(Company Name)

the Arizona Department of Transportation (ADOT) performs a product evaluation of

_____.
(Name of Product)

Identify the ADOT Approved Products List (APL) subcategory or subcategories that this product would be listed under. A copy of the APL may be viewed or downloaded from the Product Evaluation Program web site at: http://www.azdot.gov/apl.

APL Categories applicable to the PRODUCT (list specific sub-categories):

_____

_____

_____

I have read and understood the ADOT Product Evaluation Instructions. The subject product (hereinafter PRODUCT) is submitted for evaluation under the Product Evaluation Program under existing APL subcategories.
Submit all the necessary information as described in the Application Instructions.

_____ _____
(Signature of Company Representative) (DATE)

Arizona Department of Transportation
Product Evaluation Program

Has the PRODUCT previously been submitted to the Product Evaluation Program for evaluation?

Yes ☐ No ☐

Please provide the previous Product Evaluation Program application identification number(s) and product name(s).

Is the PRODUCT a component of a system that has been previously evaluated under the Product Evaluation Program?

Yes ☐ No ☐

Explain and provide the previous Product Evaluation Program application identification number(s) and product name(s).

Is the PRODUCT a replacement for a product the *Applicant* manufactures that is presently on the APL?

Yes ☐ No ☐

Please provide the previous Product Evaluation Program application identification number(s), product name(s), and the APL Subcategory.

Does the product have a Globally Harmonized System (GHS) Safety Data Sheet (SDS)?

Yes ☐ No ☐

If yes, please send an SDS by email to apl@azdot.gov.

Does the product have supporting National Transportation Product Evaluation Program (NTPEP) data?

Yes ☐ No ☐

Please comment.

Is the PRODUCT approved on other state DOT APLs or Qualified Products List (QPLs)?

Please list the state DOTs.

Arizona Department of Transportation
Product Evaluation Program

MANUFACTURER:
ADDRESS:
WEBSITE:
CONTACT:
PHONE:
E-MAIL:

DISTRIBUTOR:
ADDRESS:
WEBSITE:
CONTACT:
PHONE:
E-MAIL:

PRODUCT:
Trade Name:
Description:
Primary Use:
Secondary Use:
Guarantee:

Arizona Department of Transportation
Product Evaluation Program

LIST APPLICABLE SPECIFICATIONS AND TEST PROCEDURES:

ADOT: _____

ASTM: _____

AASHTO: _____

OTHER: _____

PRODUCT is proposed for the following specific uses: _____

_____

_____

_____

_____

GENERAL:

Attach available literature pertaining to the product, including, but not limited to, instructions and limitations for use, laboratory analyses, handling precautions, health hazards, an up to date Safety Data Sheet, specifications, installation and maintenance manuals or pamphlets, independent 3rd party test results, and cost. Information regarding product composition, formulation, or design may also be requested. If this is the case, written proprietary information should be underlined or, in the case of drawings or plans, labeled, so that information may be redacted if there is a public information request. The application itself and non-proprietary supporting literature will not be redacted from a public information request; nor will proprietary information that is not underlined or labeled. In the future, if a public information request is received, the vendor/manufacturer may be contacted for clarification regarding proprietary information.

The Arizona Department of Transportation reserves the right to refuse to test any material that cannot be safely tested with the laboratory equipment available to ADOT. If unused product portions would be considered hazardous waste (as defined by 40 CFR 261 *et seq*.) then the *Applicant* must accept the financial responsibility for proper return or disposal of this material.

By submitting this application, the applicant and/or their representative grant ADOT permission to reproduce, in full or in part, any information supplied by the Applicant for the purposes of this evaluation. This permission also will apply to material with copyrights held by applicant.

PLEASE DO NOT SEND ANY PRODUCT SAMPLES
UNLESS REQUESTED BY ADOT.

NO applications will be accepted by postal mail or hard copy. All applications must be submitted electronically to: apl@azdot.gov.

Thank you for your cooperation.

EXHIBIT C – CALIFORNIA DOT

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

NEW PRODUCT EVALUATION SUBMITTAL FORM

TL-9501 (REV 10/2017)

For Caltrans Internal Use Only	
Tracking Number:	
Date Received:	

Do not use this form if your product meets current AML criteria or current Caltrans specifications. Refer to the Product Evaluation Program website for instructions.

Use this form only for a product:

1. that would meet the intended use of a Caltrans specification, but not all of the requirements in that specification
2. not covered under current Caltrans specifications or Authorized Material List (AML) criteria and would enhance the State's transportation system

Submit this form for each product to be evaluated. Do not include samples or specimens. You will be notified if samples are required. An incomplete submittal will not be considered and will be discarded after 30 days.

Please answer all questions thoroughly and fill in all fields. If not applicable, write N/A.

E-mail your submittal to the following address: New.Products@dot.ca.gov

VENDOR INFORMATION

Company Name:

Contact Person:

Telephone No.:

Address:

City/State/Zip Code:

Email Address:

Web Site:

PRODUCT INFORMATION

Only fully developed products that are commercially available are eligible for evaluation.

Product Name:

Product Manufacturer:

If your product includes several components, list the manufacturer of each component:

List the intended use of your product:

Are you proposing a new specification for adoption by Caltrans or a revision to an existing Caltrans specification or AML criteria? ☐ Yes ☐ No

If no, STOP. No evaluation is required. You may market your product to Contractors who bid on Caltrans projects.
If yes, list the section the new or revised specification applies to and attach proposed new or revised specification.

If a revision to an existing Caltrans specification is required, list the requirements that your product already complies with:

General composition of product:

Is the product made with recycled materials? and/or sustainable production practices? Explain:

Product limitations:

NEW PRODUCT EVALUATION SUBMITTAL FORM

TL-9501 (REV 10/2017)

Alternate use for what existing product(s)?

Advantages over currently used product(s)?

What is the estimated product performance life and basis of estimate?

How does the use of this product aid Caltrans in complying with any safety or environmental regulations?

What year was product introduced into the market?

Approximate cost per unit:

Approximate cost per unit in place:

Is special equipment needed to install or place new product? Is this equipment proprietary?

ADDITIONAL INFORMATION

Has this product been evaluated previously by Caltrans? When and under what product name? What has changed?

Has your product been evaluated by NTPEP? If so, what date was your product evaluated and was your product included in the APEL?

List references of other state DOTs or agencies where your product has been used?

PRODUCT MEETS THE FOLLOWING SPECIFICATIONS

	Agency	* Specification Number
☐	AASHTO	
☐	ASTM	
☐	FHWA	
☐	Other DOT's (specify DOT)	
☐	Other Nationally Recognized Agency (specify Agency)	

LIST NATIONAL STANDARD TEST METHODS USED AND INCLUDE TEST DATA

ASTM	
AASHTO	
Other Nationally Recognized Agency (specify Agency)	

NEW PRODUCT EVALUATION SUBMITTAL FORM

TL-9501 (REV 10/2017)

NEW PRODUCT SUBMITTAL PACKAGE CHECKLIST	
☐	1. New Product Evaluation Submittal Form
☐	2. Product literature (brochures, cut sheets, specifications, etc.)
☐	3. Test data
☐	4. Safety Data Sheet (SDS), if required
☐	5. Quality control plan
☐	6. Contact or reference list, if applicable, identifying other entities that have used the product
☐	7. Other pertinent information
☐	8. Include suggested specification language
☐	9. Product warranty, if applicable
☐	10. Life cycle cost analysis

THE FOLLOWING CONDITIONS APPLY FOR ALL NEW PRODUCT EVALUATIONS

1. The California Department of Transportation (Caltrans) policy is to ensure the objective, impartial, and consistent evaluation of new products, or products to be considered in the AML, for use in the construction, maintenance, and operation of the State's transportation system. New products are defined as fully developed and marketable products that have not been previously evaluated by Caltrans and for which Caltrans specifications do not exist. All new products are evaluated on the basis of departmental priorities, performance, and compliance with health, safety, and environmental regulations.
2. All new products will first be subject to a "priorities assessment" by an impartial panel including ultimate users. Products that pass the initial assessment will be evaluated as described in Product Evaluation Guidelines.
3. The evaluation of a product is not a commitment by Caltrans to purchase, recommend, or specify the product, regardless of performance.
4. The manufacturer may be required to provide installation, be present for installation, and/or to lend assistance to those involved with the installation. The manufacturer may also be required to provide materials and equipment required for the installation.
5. Data resulting from evaluations is considered public information and will not be considered privileged. As authorized by the signature below, all information developed during this product evaluation may be released by Caltrans.
6. The submitter agrees to accept the return of any products or samples, for disposal, after the completion of the evaluation.

SIGNATURE

Submitted by (print name):

Title:

Signature:

Date:

If you have questions regarding the submittal of your product,
please contact the New Products Desk at:
New.Products@dot.ca.gov or (916) 227-7073.

Print

EXHIBIT D – FLORIDA DOT

Florida Statutes:
334.049(4)
688.002
812.081(1)(C)

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

PRODUCT EVALUATION APPLICATION

630-020-04
PROGRAM MANAGEMENT
06/16

1. Product Name _____ Patented: Yes _____ No _____
(Each product or material must be submitted separately, and must have a unique and identifiable name.)

2. Manufacturer _____ Phone _____

Address _____ _____ _____ _____
Street City ST Zip Code
(This will be the address used for contact in the event of a QPL approval)
Phone _____ Fax _____ Email _____

3. Distribution/Local Representative _____
Only fill the following contact information if different from above.

Address _____ _____ _____ _____
Street City ST Zip Code
Phone _____ Fax _____ Email _____

4. FDOT Specification Section (or Standard Index) number _____. You must identify a current FDOT Specification (or Standard Index) number from the Standard Specifications, Supplemental Specifications, Special Provisions or Standard Index. **Applications without reference will NOT be processed for APL inclusion**. (Note: If there is no FDOT Specification (or Standard Index) or you know that you do not meet the existing specification – **STOP** – Refer to the New Product Submittal process.)

5. Include all Test Reports or Material Certification that may be required in accordance with FDOT Specifications or Standard Index. List each individual Test Report or Material Certification in Number 9 below. The list should include the name, number (if applicable) and date of each Test Report or Material Certification.

6. Is any information, method of process, production, or manufacture included in this application a trade secret? Yes _____ No _____ (See Sections 334.049(4), 688.002, and 812.081(1)(C) Florida Statutes.) If YES, you must identify and prepare a list of any such information and include with this application package. In addition, any supplemental submissions must also be identified as such.

7. Plans, Drawings, Picture or Sketch furnished herein by manufacturer? Yes _____ No _____
Be sure to include all instructions for this product.

8. THE DEPARTMENT WILL ACCEPT NO MATERIAL OR SAMPLES UNLESS REQUESTED. ALL MATERIALS NOT REQUESTED WILL BE RETURNED COLLECT FREIGHT.

9. ALL INFORMATION PROVIDED IN THIS APPLICATION AND THE SUPPORTING DATA LISTED BELOW IS ACCURATE AND CORRECT AT THIS DATE.

This application will be returned to you if not completed, signed and notarized.

Person furnishing information (printed) _____

Title _____

Signature _____

Notary:

This application is for informational purposes only and in no way obligates the Department to use your product.

Please submit your Application and supporting data in one of the three following formats: (All Applications exceeding 20 pages must be submitted on CD.)

1) One hard copy of the Application by mail and a copy of the Application and all supporting data electronically in a *.pdf format less than 5 MB to:

product.evaluation@dot.state.fl.us

2) Mail one hard copy of the Application and CD with supporting data to:

3) Mail hard copy of this Application and all supporting data in DUPLICATE to:

PRODUCT EVALUATION SECTION
FLORIDA DEPARTMENT OF TRANSPORTATION
605 SUWANNEE STREET, MS 75
TALLAHASSEE, FLORIDA 32399-0450

EXHIBIT E – MAINE DOT

MaineDOT Tracking Number:_____

Date Received:_____

STATE OF MAINE • DEPARTMENT OF TRANSPORTATION

NEW PRODUCT SUBMITTAL FORM

Please answer all questions. Where a question is not applicable, enter "N/A". Incomplete submittals will be returned and not considered. Attach extra sheets if needed. Please do not re-format this document.

A New Product Submittal Package must be submitted for each new product and must include the following information: New Product Submittal Form, Technical Data Sheets, Safety Data Sheets (SDS), Installation Instructions, Test Data, and any other pertinent data. Please do not send any product samples at this time.

Send New Product Submittal Package by regular mail to the following address :

Attention: Product Evaluation Coordinator
Maine Department of Transportation
Transportation Research Division
16 State House Station
Augusta, ME 04333-0016
207-624-3268

PRODUCT IDENTIFICATION
Product Trade Name:
Model/ID Number:
PRODUCT MANUFACTURER
Company Name:
Address:
City, State, Zip Code:
Telephone No:
Fax No:
Email Address:
Web Page URL:
PRODUCT SUBMITTED BY
Company Name:
Contact Person/Title: (correspondence will be sent to the person listed here)
Address:
City, State, Zip Code:
Telephone No:
Fax No:
Email Address:
Web Page URL:
PRODUCT DISTRIBUTED BY
Company Name:
Address:
City, State, Zip Code:
Telephone No:
Fax No:
Email Address:
Web Page URL:

STATE OF MAINE • DEPARTMENT OF TRANSPORTATION

NEW PRODUCT SUBMITTAL FORM

MaineDOT Tracking Number _____

PRODUCT INFORMATION
Brief description of product:
Proposed use of product:
Advantages over currently used product(s):
General composition of material:
VOC Content (g/l):
Alternate for what existing or currently used product(s):
Approximate cost per unit:

PRODUCT MEETS THE FOLLOWING SPECIFICATIONS			
Yes	**No**	**Agency**	**Specification Number**
☐	☐	MaineDOT	
☐	☐	AASHTO	
☐	☐	ASTM	
☐	☐	FHWA	
☐	☐	Other DOT's (specify DOT):	
☐	☐	Other Nationally	

PRODUCT TEST DATA		
Yes	**No**	**Agency**
☐	☐	NTPEP
☐	☐	AASHTO/APEL
☐	☐	ASTM
☐	☐	FHWA
☐	☐	Other Nationally Recognized Agency (specify):
		(Please submit additional test data on separate sheets.)

NEW PRODUCT SUBMITTAL PACKAGE CHECKLIST	
☐	1. New Product Submittal Form.
☐	2. Product Literature (technical data sheets, instructions, brochures, etc.).
☐	3. Test Data.
☐	4. Safety Data Sheets (SDS).
☐	5. Contact List (other agencies).

Please see our New Product Evaluation Process: www.maine.gov/mdot/tr/docs/qpl/prodevalproc.pdf

Note: Please submit packages via regular mail. Do not email submittal packages as attachments.

EXHIBIT F – TENNESSEE DOT

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
6601 CENTENNIAL BLVD.
NASHVILLE, TENNESSEE 37243-0360

Lab Use Only
P.E. No.
Material code
P/S Code

PRODUCT, MATERIAL, EQUIPMENT OR PROCESS EVALUATION
(Product Submittal Form for Qualified Products List Evaluation)
QPL LIST # .....

Trade Name	Patented ☐ Yes ☐ No ☐ Applied For
Manufacturer	Representative
Street Adress	Street Adress
City / State / Zip	City / State / Zip
Phone	Phone
E-mail	E-mail
Will Samples Be Furnished For Evaluation ☐ Yes ☐ No	Can Demonstration Be Provided ☐ Yes ☐ No
Availability ☐ Seasonal ☐ Non-Seasonal	Delivery at Site ..... Days After .....
Are Quantities Limited ☐ Yes ☐ No	Estimated Cost Per Unit of Application ..... Per .....
Has Another Office of TDOT Been Contacted *(If Yes, Explain)* ☐ No ☐ Yes, Explain:	

Has this product been evaluated, or is it currently being evaluated, by the National Transportation Product Evaluation Program (NTPEP)?
☐ Yes ☐ No JTPEP Submittal and Report Numbe .....

Product, Materials, Equipment or Process Identification

Recommended Use and Requested QPL Designation

General Composition of Material ***(Attach Laboratory Report Where Applicable, and MSDS)***

List Applicable Specifications Which Product, Material, Equipment, or Process Meets

AASHTO	ASTM	Federal Specification(s)	TDOT

List All Highway Agencies Presently Using or Evaluating this Product ***(including personal contact and phon***

AGENCY	CONTACT	PHONE

The following applicable information and materials are available and accompany this form in order to substantiate, verify, or clarify its contents.

Specifications	☐ Attached	☐ Not Attached	☐ Not Applicable
Drawings, sketches, pictures	☐ Attached	☐ Not Attached	☐ Not Applicable
Warranty	☐ Attached	☐ Not Attached	☐ Not Applicable
Installation instructions	☐ Attached	☐ Not Attached	☐ Not Applicable
Material Safety Data Sheet (MSDS)	☐ Attached	☐ Not Attached	☐ Not Applicable
Product/material literature	☐ Attached	☐ Not Attached	☐ Not Applicable
Test data	☐ Attached	☐ Not Attached	☐ Not Applicable
Certifications	☐ Attached	☐ Not Attached	☐ Not Applicable

Typed or Printed Name of Manufacturer's Official	Title
Signature	Date

Typed or Printed Name of Representative or Supplier	Title
Signature	Date

The Tennessee Department of Transportation will not consider any product for testing or evaluation until samples are received along with this form completed in it's entirety and signed by an authorized official of the manufacturer. An authorized official of the manufacturer refers to an actual employee of the manufacturer, not a supplier of distributor. Separate Evaluation Forms are required for each product submitted for testing. All products submitted for testing shall be furnished at no cost to the Tennessee Department of Transportation. The Department reserves the right to return all unused samples to the manufacturer at no cost to the Department.

Products must meet all requirements outlined in the specific Evaluation Procedures to be added to the Department's Qualified Products List (QPL). The purpose of the QPL is to make available to Construction and Maintenance personnel a list of products which perform satisfactorily. Inclusion on the QPL must not be considered as prior approval, and in no way precludes Departmental testing and approval requirements. Products on the QPL are products which have been evaluated and found that they could be acceptable for use, provided all testing and/or certification requirements have been met and provided the products are used in accordance with the manufacturers recommendations. Since there is not a QPL covering every type of product, some products which are found to perform satisfactorily are not placed on a Qualified Products List. As the need arises, new QPL's may be developed for some of these products.

The Department reserves the right to reject any product, which does not demonstrate satisfactory performance in any of the tests outlined in the Evaluation Procedures. The Department also reserves the right to remove any product from the Qualified Products List that does not perform satisfactorily under real life conditions.

All Product Evaluation Forms, samples, and MSDS shall be submitted to the following address:

Tennessee Department of Transportation
Research and Product Evaluation Section, Materials and Tests Division
6601 Centennial Boulevard
Nashville, TN 37243

EXHIBIT G – VIRGINIA DOT

VDOT TITLE VI EVALUATION FORM

This Title VI Evaluation Form is used as a Pre-award Review and Post-award Review. VDOT is required to conduct routine assessments prior to releasing funds to ensure Title VI compliance. A pre-award review assists VDOT in determining whether applicants operate in a nondiscriminatory manner. Pre-award reviews can also be used to require applicants to take preventive measures to ensure that discrimination will not occur in their services as a condition of receiving contracts. Pre-award reviews represent a frontline approach to eliminating and preventing discrimination before it occurs.

Post-Award Reviews are generally conducted after a contractor begins the scope of work. However to minimize the burden on VDOT's contractors, VDOT has developed a form that serves as both a pre-award and post-award compliance tool.

VDOT must also conduct on-site reviews of prime contractors periodically to ensure that the contractor remains in compliance with Title VI and to verify that the contractor has preventive measures to ensure nondiscrimination by their sub-contractors.

Name of Preparer: Click here to enter text.	Preparer's Title: Click here to enter text.
Phone #: Click here to enter text.	Email Address: Click here to enter text.
Name of Organization: Click here to enter text.	Address of Organization: Click here to enter text.
Address of Virginia location where project will be done: Click here to enter text.	

Type of Contractor/Organization:

☐ Private Organization ☐ Supplier

☐ Governmental Agency ☐ Other

Workforce for Virginia Location(s)

Total	% Minority	% Female
Click here to enter text.	Click here to enter text.	Click here to enter text.

Business Ownership/Control ☐ Minority ☐ Female	☐ DBE Certified ☐ SWaM

Does your organization currently have contracts or subcontracts with VDOT?

☐ Yes ☐ No

What is your organization's most recent date of Title VI approval? Click here to enter text.

Status of Project(s): Click here to enter text.	Value of current Contract(s): Click here to enter text.

What does your organization have in place to ensure nondiscrimination in your VDOT scope of work and your programs and services?
Click here to enter text.

Virginia Workforce

CONSULTANT EQUAL EMPLOYMENT OPPORTUNITY WORKFORCE ANALYSIS

Employment at this establishment – Report all permanent full and part-time employees including apprentices and on-the job trainees unless specifically excluded as set forth in the instructions. Enter the appropriate figures on all lines and in all columns. Blank spaces will be considered zeros.

Job Categories	Number of Employees (Report employees in only one category)														
	Race/Ethnicity														
	Hispanic or Latino		Not Hispanic or Latino												
			Male						Female						
	Male	Female	White	Black or African American	Native Hawaiian Or Other Pacific Islander	Asian	American Indian or Alaska Native	Two or more races	White	Black or African American	Native Hawaiian Or Other Pacific Islander	Asian	American Indian or Alaska Native	Two or more races	Total Col A-N
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Executive/Sir. Level Officials & Managers (1.1)															
First/Mid-Level Officials & Managers (1.2)															
Professionals (2)															
Technicians (3)															
Sales Workers (4)															
Administrative Support Workers (5)															
Craft Workers (6)															
Operatives (7)															
Laborers & Helpers (8)															
Service Workers (9)															
TOTAL (10)															
PREVIOUS YEAR TOTAL (11)															

Organization, Staffing, & Training

1. What type of services will your organization provide VDOT?
   Click here to enter text.

2. Identify the person responsible for the administration of Title VI polices and procedures (a Title VI Coordinator). Provide the name, position, title, and contact information. Click here to enter text.

Title VI/Nondiscrimination

1. Is your Title VI Coordinator, project managers, and other staff made aware of Title VI compliance and regulations relative to nondiscrimination in federally-assisted programs of the Department of Transportation (hereinafter, "DOT") Title 49, Code of Federal Regulations, Part 21 and the Federal Highway Administration's 23 Code of Federal Regulations 200? Please explain how they are made aware. Click here to enter text.

2. What procurement procedures does your organization have in place to ensure nondiscrimination in the selection and retention of subcontractors including procurements of materials and leases of equipment? *** Please note N/A is not an acceptable response, please provide a complete answer**

   Click here to enter text.

3. How does your organization notify your subcontractors and suppliers of their obligations under this contract and the Regulations relative to nondiscrimination on the grounds of race, color, national origin, sex, age, disability and low income populations? *** Please note N/A is not an acceptable response, please provide a complete answer**

   Click here to enter text.

4. Are facilities and meeting areas fully accessible to persons with disabilities? Click here to enter text.

5. Does your organization have a system in place to accommodate persons with disabilities? If yes, how does your organization notify the public? If no, please explain. *** Please note N/A is not an acceptable response, please provide a complete answer**
   Click here to enter text.

6. How are limited English proficient persons made aware that they can receive translation services for access to services? *** Please note N/A is not an acceptable response, please provide a complete answer**
Click here to enter text.

7. Has your organization been reviewed by any governmental agencies for compliance with Title VI and other laws and regulations? If yes, provide a copy of the letter identifying the review findings? Click here to enter text.

8. Does your organization receive federal assistance (grants, loans, donations of property, or detail of personnel) from any Federal government entity? Click here to enter text.

9. List any discrimination complaints and/or lawsuits received in Virginia during the reporting period. Include the basis for the complaint (ethnicity, gender, etc.) and summarize the outcome or resolution. If applicable, include a copy of the investigation report. Click here to enter text.

Disadvantaged Business Enterprises (DBE)

1. Did your organization award any contracts/subcontracts related to VDOT work to DBEs during the reporting period?

   ☐ Yes ☐ No

   If yes, provide the following:

   - The DBE's name and amount awarded Click here to enter text.
   - Total # of contracts awarded to DBEs Click here to enter text.
   - Total dollar amount of contracts awarded to DBEs Click here to enter text.

I certify that the data given in this report is correct to the best of my knowledge. (Report has to be submitted with original signature, not a photocopy.)

Signature:

_____

(Authorized Officer) (Title) (Date)