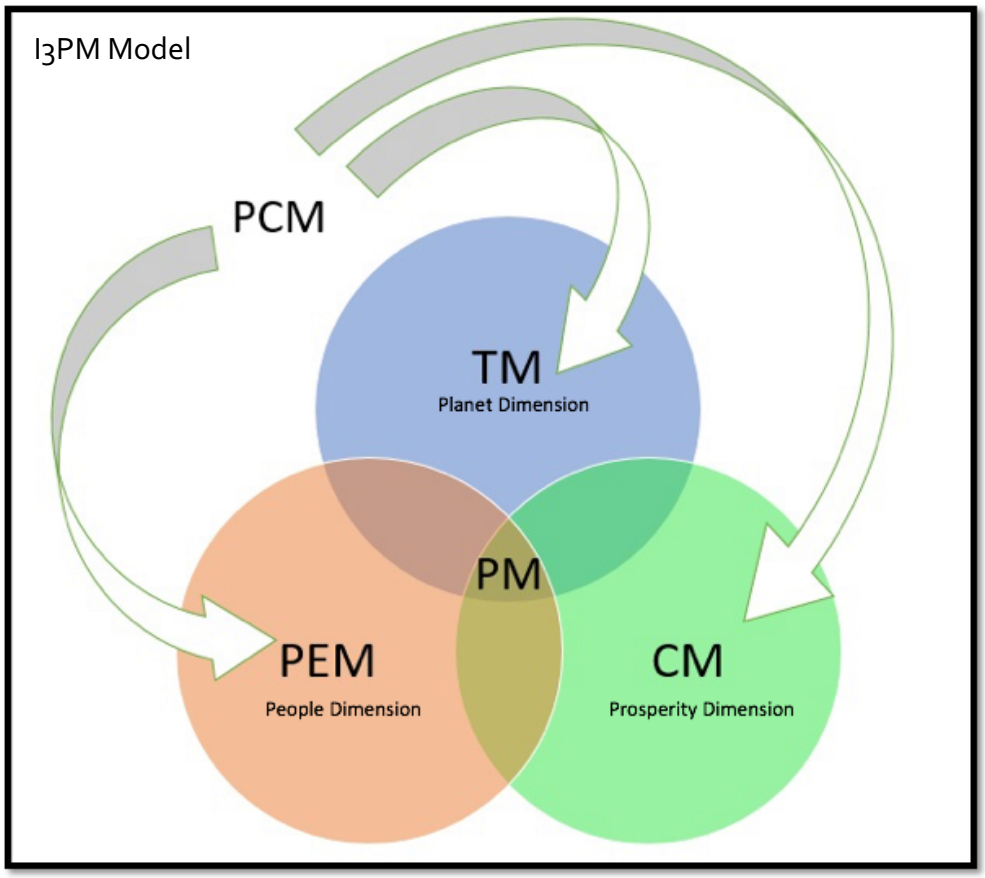
TU Delft
Delft University of Technology

Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

2017

ROBIN TAMAK

MASTER THESIS REPORT



PROJECT MANAGEMENT FOR SUSTAINABILITY

USE OF CRITICAL SUCCESS FACTORS IN AN INTEGRATED PROJECT MANAGEMENT MODEL TO IMPROVE THE CHANCES OF PROJECT SUCCESS OF A SUSTAINABILITY ORIENTED HIGHWAY PROJECT DURING THE EXPLORATION AND PLANNING PHASE

DELFT UNIVERSITY OF TECHNOLOGY

Use of Critical Success Factors in an Integrated Project Management Model to Improve the Chances of Project Success of a Sustainability Oriented Highway Project during the Exploration and Planning Phase

by

Robin Tamak - 4519809

A thesis submitted in partial fulfillment for the
degree of Master of Science

in the
CONSTRUCTION, MANAGEMENT & ENGINEERING
Faculty of Civil Engineering & Geo-Sciences

November 14, 2017

This research is promoted by Rijkswaterstraat

Master Thesis

Under the supervision of

Prof. dr. ir. M. J. C. M. Hertogh (Chair of Graduation Committee & Head of Integral Design Management, CiTG Faculty)

Dr. ir. Taneha Kuzniecow Bacchin (Second Supervisor & Asst. Professor at Delta Urbanism Department, Architecture Faculty)

Ir. M. Molaei (First Supervisor & Researcher, Integral Design Management, CiTG Faculty)

Dr. ir. Wim Leendertse (Second Company Supervisor & Senior Project Manager, Rijkswaterstaat)

Niek Overgaauw (First Company Supervisor & Rijkswaterstaat Employee)

Keywords: project success, project success criterion, sustainability, people planet prosperity, highway, public project delivery organization, critical success factors

An electronic version of this master thesis is available at `http://repository.tudelft.nl/`.

Declaration of Authorship

I, Robin Tamak, declare that this master thesis titled, 'Use of Critical Success Factors in anIntegrated Project Management Modelto Improve the Chances of ProjectSuccess of a Sustainability OrientedHighway Project during the Explorationand Planning Phase' and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a Master of Science degree at Delft University of Technology.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed: _____

Date: _____

"Sustainability has become a component of business success, and project management is one of the ways to get there. If it is going to be part of the way a company operates, it has to be integrated into the ways projects are managed"

Joel Makower

Executive Summary

Sustainability within Project Management practice is a new and challenging territory. The current project management practice within the construction industry, particularly highway construction has not yet fully embraced sustainability. Transport sector is the second largest emitter of carbon dioxide emissions; this alone has tremendous influence on creating a sustainable environment. Recent global exposure and cross national agreements, such as the Paris Agreement, reflect the urgency and need of sustainable projects for the future. There is scarce literature available in sustainability and project management. However, recent research shows a relation between sustainability and project success. In order to carry out a scientific research, the following problem statement is proposed for investigation:

Need for knowledge and expertise in the field of project management for sustainability in a highway project

This research is carried out for a public project delivery organization - Rijkswaterstaat. The main objective of this research is to inspect sustainability in the current project management practice and propose a conceptual model which helps in improving project success of a sustainability oriented highway project. Based on the above mentioned problem statement and main objective of this research, the main research question is formulated as:

"How can critical success factors be applied in an integrated project management model to improve the chances of project success during the exploration and planning phase of a sustainability oriented highway project?"

To answer the main research question, three sub-research questions are formulated. This research is divided into three main phases based on the sub-research questions. Each phase provides an answer to one of the research sub questions. By answering the sub-research questions, main research question is answered and the objective of this research is fulfilled.

The first phase elaborates on literature review on project success criterion and sustainability. Elkington's People Planet Prosperity (3P) principle was selected as a sound sustainability theory. Findings from literature suggest use of sustainability as an upcoming project success criterion. In order to establish sustainability as a project success criterion, a distinct set of success sub-criteria is required. For developing a distinct sustainability success sub-criteria list, recent literature is reviewed. With the help of a theoretical framework of sustainable aspects of a tunnel, sustainability success sub-criteria of a highway were identified. Based on three expert judgments and discussions, a total of 30 sustainability success sub-criteria were validated and defined. These are categorized in People, Planet and Prosperity dimensions of sustainability. See tables 3.8, 3.9 and 3.10 for further details.

In second phase, a literature review focusing on Critical Success Factors (CSFs) in the construction industry is conducted. Based on a developed framework from literature, 28 relevant CSFs are considered for this research. Document overview and exploratory interviews were conducted as means to identify the main project management practice of public project delivery organization. Integrated Project Management (IPM) model is identified. IPM model consists of five fundamental roles, who can dominantly effect project success of any undertaken project. It is evident that IPM roles carry out CSFs through their professional role. In order to identify CSFs for sustainability success sub-criteria, cross-case methodology is selected. Three sustainability oriented highways are chosen and IPM roles form the main respondents for cross-case method. Twelve semi-structured interviews (four interviews per case study) were conducted. ATLAS.ti is used for data analysis. Based on cross-case analysis, sixteen CSFs are identified. These CSFs are deemed as Sustainability Success Factors or SSFs, which are means to achieve and improve chances of majority of sustainability success sub-criteria of a sustainability oriented highway project. These SSFs are defined in table 5.3. Among these SSFs, *affinity for sustainability* is a new CSF added to project management literature. Out of the sixteen SSFs, recurring and most mentioned SSFs are noted, which are *sustainability policy; clear goals; active involvement of stakeholders; client involvement; collaboration between project parties; proper selection of contracting strategy/tender process* and *flexible scope*.

In third phase, findings from cross-case analysis, sustainability theory from the literature review and IPM model of public project delivery organization were used to conceptualize a project management model for sustainability. Findings from cross-case analysis suggest different inclination of IPM roles towards sustainability dimensions. Based on these observations, studied theory and discussion with a project management expert, a conceptual model is proposed (see 1). Integrated People Planet Prosperity Management or I3PM model consists of five fundamental roles, namely, Project Manager (PM), Project Control Manager (PCM), Project Environment Manager (PEM), Technical Manager

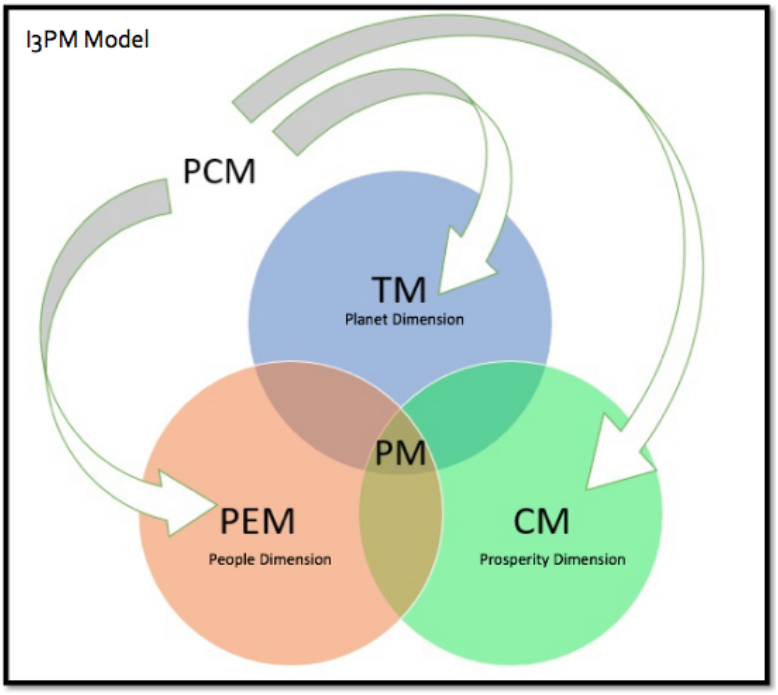


FIGURE 1: Integrated People Planet Prosperity Management Model

(TM) and Contract Manager (CM). Four of these roles, namely PM, PEM, TM and CM, work in sustainability dimensions of People, Planet and Prosperity. PM is positioned in the centre of three dimensions, reflecting his core role in a sustainable highway project. PEM is positioned in the People dimension reflecting his/her role as an intermediary between stakeholders/society and public project delivery organization. Similarly, CM is positioned in Prosperity dimension reflecting his/her role as an intermediary between market (contracting parties) and public project delivery organization. TM is positioned in the Planet dimension, based on his professional role, which significantly impacts the physical environment of a highway project. The fifth role, PCM is positioned outside the sustainability dimensions. PCM acts as a coordinator who has inter-dependency on other IPM roles to carry out his professional role and vice-versa. The defined SSFs are positioned under IPM roles based on their profession and inter-dependency to carry out a particular SSF. The I3PM model proposes SSFs, which must be carried out by a single IPM role and also proposes SSFs which are carried out by multiple IPM roles. The I3PM model is validated through discussions with nine experts. Based on the expert discussions, fifteen SSFs were confirmed and two changes were suggested. Use of I3PM model could help improve chances of project success of a sustainability oriented highway project during the exploration and planning phase.

Thus, the validated I3PM model helps in application of critical success factors to improve chances of project success during the exploration and planning phase of a sustainability oriented highway project. With this the objective of this research is fulfilled.

Recommendations:

- **For public project delivery organization**:

  SSFs such as *sustainability policy; clear goals; active involvement of stakeholders; client involvement; collaboration between project parties; proper selection of contracting strategy/tender process* and *flexible scope* are crucial areas to focus. Suggestions are made for each SSF in the final chapter of this report. It is recommended to test and further develop I3PM model by inclusion of extra IPM roles or external project parties in the overlapping domains of sustainability. Use of *omgevingswijzer* and/or developed sustainability success sub-criteria framework is suggested to define practical sustainability project goals during the exploration and planning phase. It is recommended to check, compare and update the established sustainability goals/ambitions to ensure continuity at the end of each phase of a highway project.

- **For further research**:

  The identified SSFs are critical for exploration and planning phase. This does not confirm their importance in contracting or execution phase. It is recommended to use SSFs as a starting point, for research in other phases of a sustainability oriented highway project. Sustainability goals/ambitions and IPM teams change during different phases of a highway, this could most likely effect use of SSFs. Suggestion for applying I3PM model in other phases of highway projects, such as procurement and execution phase is made. Inter-relationships between SSFs were not considered in this research. A suggestion to acknowledge these relationships and identify inter-relationships among CSFs/SSFs is made. Proposed I3PM model within the public project delivery organization is predominantly based on a client's perspective. It is recommended to validate I3PM model through a consultant's or contractor's perspective. Generalization of the validated sustainability success sub-criteria framework for large infrastructure projects is proposed. Lastly, this research is conducted through a qualitative approach, it is suggested to conduct a similar research with the help of a quantitative approach.

Acknowledgements

It is an amazing feeling to sit down and look back to my journey as an engineer. I feel a sense of accomplishment as I present to you the results of my graduation research performed in order to conclude my Master of Science in Construction Management and Engineering (CME) at the Technical University of Delft. After joining TU Delft, I got an opportunity to look at global challenges that require inter-disciplinary research. One of these challenges is achieving sustainability. It is here, that I had a chance to meet Professor Marcel Hertogh. When I first met him, I was captivated by his enthusiasm towards sustainability in construction industry. My passion for developing a project management approach for sustainability was well understood by him, and it is due to his assistance that I met Wim Leendertse, my company supervisor at Rijkswaterstaat.

I have spent last six months working on this research and without the guidance and support of some individuals this would not have been possible. I would like to thank my graduation committee members: Marcel, for helping me formulate my research topic and for all the neccessary feedbacks and inputs, Wim for taking out time from his busy schedule and helping me during important phases of my research, Maedeh my go-to supervisor, for providing me sufficient time, support and guidance whenever I needed, Taneha for always providing me a different perspective on the problem by opening new windows of opportunity and lastly, Niek for giving me the freedom and guidance to define and execute my research as I wanted.

I would also like to thank all the people who contributed to this research in more ways than one. Without them, this thesis would not have been possible. My special thanks to experts and managers in Rijkswaterstaat who took out time for interviews. Special thanks to Freek Wermer and Jos Arts for long and valuable discussions. Lastly, to TU Delft and CME faculty for helping me acknowledge my strengths and supporting me to evolve as an independent researcher. A special mention to Jules Verlaan and Sandra Schuchmann, for providing support in the CME administration work.

There are many more who contributed by either going through my research document, helping me analyze the problems or by just having an informal discussion over my research topic. This includes my colleagues from innovA58: Stan, Simone, Rob, Jasper, Marco and Tom. A special thanks to my friends: Deepak, Shruthi, Arjun, Kshiteej, Amantrita, Krishti, Rahul Sai and Prajakta who provided unconditional support.

Lastly, I take this opportunity to thank my parents and sister for providing me unconditional love and support in every walk of life.

Robin Tamak
Delft, November 2017

Contents

List of Figures

List of Tables

Abbreviations

3P	**P**eople **P**lanet **P**rosperity
CO2	**C**arbon **D**ioxide
CM	**C**ontract **M**anager
CSF	**C**ritical **S**uccess **F**actor
EIA	**E**nvironmental **I**mpact **A**ssessment
IPM	**I**ntegrated **P**roject **M**anagement
I3PM	**I**ntegrated **P**eople **P**lanet **P**rosperity **M**anagement
LCC	**L**ife **C**ycle **C**ost
NGO	**N**on **G**overnmental **O**rganization
PCM	**P**roject **C**ontrol **M**anager
PEM	**P**roject **E**nvironment **M**anager
PM	**P**roject **M**anager
QDA	**Q**ualitative **D**ata **A**nalysis
RWS	**R**ijks**W**ater**S**taat
SMART	**S**mart **M**easurable **A**chievable **R**elevant **T**ime-related
SRQ	**S**ub **R**esearch **Q**uestion
SSF	**S**ustainability **S**uccess **F**actor
TM	**T**echnical **M**anager
UN	**U**nited **N**ations

Dedicated to my father and mentor - Dr. Jagdish Chand Tamak

Chapter 1

Research Context

This chapter provides an overview of the conducted research. It is divided in seven sections. The first section discusses the importance of sustainability. The second section describes the key concept areas in this research, which are sustainability in highways, project management for sustainability and role of a public project delivery organization. Based on these key concept areas, a problem statement is formulated (see 1.2.4). The third section elaborates on the main research objective, formulated sub-goals and formulated research questions in the context of this research (see 1.3). The fourth section describes the scope of this research. The fifth section describes about the used methodology. The sixth section states data gathering and analysis in the context of this research. The last section, based on inputs from previous sections, proposes a research framework to be carried out for this research (see 1.5).

1.1 Importance of Sustainability

Sustainability has received increasing importance since (Brundtland, 1987) on environment preservation and sustainable development. It is defined as *"meeting the needs of present without compromising the ability of future generations to meet their own needs"*. Ever since there has been increasing concerns regarding sustainability from both public as well as private sector. A recent example is the Paris Agreement which is further elaborated in (Rogelj et al., 2016). Sustainability has thus become a need for various organizations, this can be seen in their mission and vision statements respectively. These statements are translated from policy level to project level. In doing so, the policy of an organization is reflected in objective(s) of an undertaken construction project. Ambitious sustainability goals of recent, current and future construction projects are not a surprise anymore. Kuhlman & Farrington (2010) conclude a need for clarifying the concept of sustainability, even though there is a large body of literature available on the concept. Sustainability and its implementation in project management practice is relatively a new phenomenon, which would be further discussed in the problem area section.

1.2 Key Concept Areas

This section elaborates three key concept areas, sustainability in highways, project management for sustainability and public project delivery organization in the context of this research.

1.2.1 Sustainability in Highways

Highway is a public construction project, significantly large enough to affect the ecosystem and society around it. The main purpose of a highway is to provide transportation service to the society. Simmons (2012) state that the sustainability implications of urban transport projects are manifold, and include effects on accessibility/congestion, safety and the environment. Karlson et al. (2014) conclude that transport infrastructure has direct and indirect impacts on ecological processes, including habitat loss, fragmentation and degradation, increased mortality and creation of new habitat. Stocker (2014) claims that transport sector is the second largest emitter of carbon dioxide (CO2) emissions, the main anthropogenic greenhouse gas. Mainly driven by fast development of emerging economies, transport sector might double its emissions by 2050 - International Energy Agency, mentioned by Jochem et al. (2016). Shiau & Liu (2013) state reducing energy consumption and emissions in the transportation sector is proving to be extraordinarily difficult despite some success in urban areas. Sustainability is thus one of the most challenging goals for a highway construction project.

Highway projects play a significant role in bringing about a change to the society. This change can be both negative or positive; in the latter case, sustainability oriented highway project could help in establishing a better, long-lasting position in the society.

1.2.2 Project Management for Sustainability - Knowledge Gap

A majority of research on project management and sustainability is mostly interpretive and less prescriptive. This is explained by Silviusab et al. (2013), which states that researches attempt to interpret the concepts of sustainability in project management context and do not prescribe how sustainability should be practically integrated into project management. Gareis et al. (2013) state that sustainable development has traditionally received less attention at project management level compared to program/portfolio management level.

A bibliographic research conducted by Martens & De Carvalho (2014) reported that almost half of the publications had been published within the past five years. Another literature review done by Silvius & Schipper (2014) shows that 76% of the total literature about sustainability and project management has been produced in the past five years. An increasing number of publications on the subject of sustainability and project management in recent years speaks for itself. Due to the recent nature of these studies (which are mostly conceptual), there is ambiguity with respect to sustainability and its effect on current project management practices.

Agarwal & Kalmár (2015) show the overlap of eight principles of sustainability and project management. They explain how sustainability is multidimensional and shares common principles with project management, which are short-term & long-term orientation, values & ethics consideration, transparency & accountability, local regional global orientation, risk reduction, stakeholder participation, harmonizing social, environmental economic interests and consumption of income & not capital. A recent study by Silvius & Schipper (2016) explored the relationship between sustainability in projects and project

success. They concluded that this relationship is not a simple one, empirical testing is recommended for further research. Ogunlanaet al. (2010) stated that strategic issues and socioeconomic issues of large development projects in the public sector require further research for improving the project performance. In the context of improving strategies of major public projects, experts are not able to be specific in their advice for sustainability (Jonny Klakegg, 2009). Important success criteria for a public client such as sustainability is left unmentioned in literature (Koops et al., 2016). In the above mentioned research, it is clear that sustainability is recommended to be used as a project evaluation criterion.

Project management literature incorporating sustainability is relatively new and demands attention. Literature also suggests project success & sustainability have a conceptual relationship. There are recommendations and possibilities to conduct further scientific research within these concepts.

1.2.3 Role of a Public Project Delivery Organization

A project delivery organization is a separate entity within a public domain, responsible for delivering the project and in essence functioning as client towards contractors, as mentioned by Hertogh et al. (2008). Rijkswaterstraat (RWS) is a public project delivery organization which was founded in 1798 in the Netherlands. It is an agency of the Ministry for Infrastructure and Environment. Until 1980, the organization used to mainly focus on technical aspects and finance. From 1980, there has been more emphasis on environment and participation of other governments, organizations and public in their project decision making processes. From 2000, there has been increasing influence of private sector in the design on infrastructure projects. Project Management within RWS until 2005 focused primarily on technical management but due to increasing influence of private sector in infrastructure projects, project management practices within RWS have also changed according to Wermer (2014). Currently, RWS follows an Integral Project Management (IPM) model, which will be further elaborated in 3.1. Briefly, the IPM model consists of five different managers or roles, which will be the focus area in this study. Koops et al. (2016) mentioned public-project managers as actors acting at the interface of their public organization and the private partner and are concerned that the project/asset should:

- Possess the desired features
- Performs to solve the problem (or) exploit the opportunity identified by the client
- Maintains the reputation of client and public organization

Sustainability challenges (climate change, depletion of natural resources, etc.) are linked to major drivers such as economic growth and consumption patterns. Addressing these challenges requires integration into the political process (Sonigo et al., 2012). Formulation of sustainability policy is not new. European Commission (2014) has set ambitious climate and energy goals for a competitive, secure and low-carbon economy, to be achieved by the year 2030. Such a policy is made to cater to the need of sustainability at both local and national level. Both EU and the government play a vital role in the formulation of sustainability goals. This policy is then adopted by a public client and translated into the goals of a public construction project. These goals are crucial for ensuring success of a project.

A public project delivery organization is responsible for project success on behalf of the public client. The public project managers explore, plan, monitor and assess the performance of the asset to provide the predicted benefits, justify the support for the project and maintain reputation of the public client. Sustainability has become a policy and is gradually integrating in the construction projects. Managers strive for successful projects but there is ambiguity and concern regarding sustainability and its effect on project management practice within a public project delivery organization.

1.2.4 Problem Statement

Based on the above mentioned problem areas, this section would discuss a problem statement, to be tackled by the outcome of this research. Aiming for sustainability is considered important for a public entity which logically strives for a successful infrastructure project. Recent literature suggests that sustainability has an influence on project management practice, specifically on project success. Both project success and sustainability are multidimensional concepts. Considering the knowledge gap, there is a possibility of conducting a scientific research. This research is focused on studying the project management practice within a public project delivery organization with respect to sustainability and help the organization to improve the chances of project success of their highway projects. This research is aimed to prepare current IPM managers of a public project delivery organization for future highway projects, which are undoubtedly becoming more sustainability oriented. Summarizing the above discussion,the problem statement is formulated as follows:

Need for knowledge and expertise in the field of project management for sustainability in a highway project

1.3 Objective, Sub-Goals and Research Question

1.3.1 Objective

The main objective of this research is to inspect sustainability in the current project management practice and to propose a model which helps in improving project success of a sustainability oriented highway project. This can be better illustrated by the figure which is based on the conceptual model presented

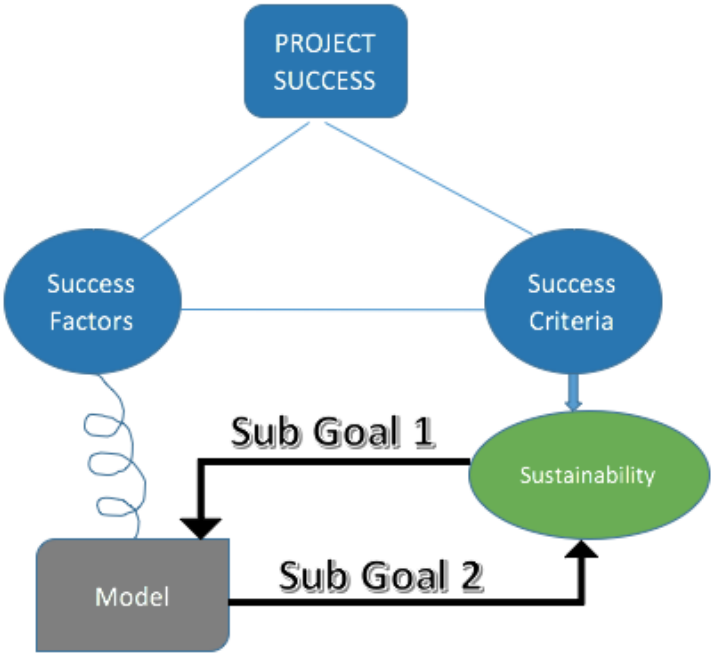


FIGURE 1.1: Research Objective

by (Hertogh et al., 2008). Briefly, project success can be divided into two categories, project success criterion and project success factors. Project success criterion, is the basis of judgment for project success. In this research, sustainability will be considered as a project success criterion. Project success factors are processes, activities and skills required to meet the project success criteria. This research aims to identify project success factors which are critical for achieving sustainability. The identified critical success factors (CSFs) help in development of the model. The sub-goals section would shed some light on this process.

1.3.2 Sub-Goals

In order to realize the main objective of this research, project management and project success in the context of a public project delivery organization were studied. The first goal of this research is to establish sustainability as a project success criterion. Second goal of this study is to review recent literature on critical success factors in the construction industry and identify critical success factors for the established criteria in highway projects. Refer 1.2 for a chronological two-step approach used for this research. The two sub-goals are elaborated as follows:

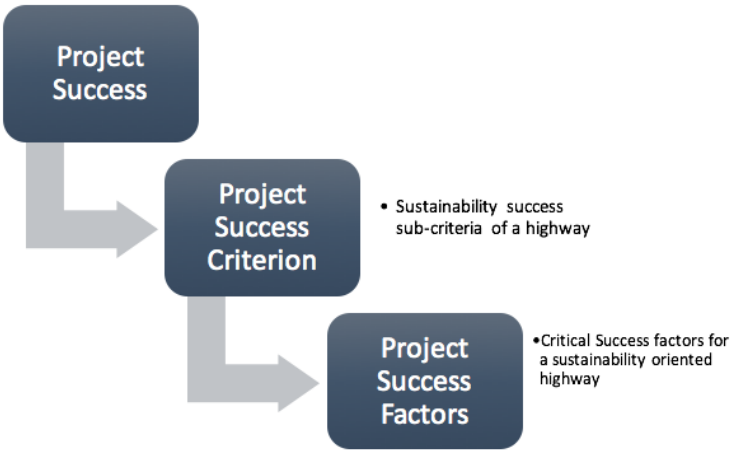


FIGURE 1.2: Research Sub-Goals

1.3.2.1 Sub-Goal 1

The first goal of this research is to establish sustainability as a project success criterion. This goal helps author in selecting a sound theory for sustainability to be used in this research. Based on the theory, various sustainability success sub-criteria of a highway were reviewed through recent literature. This provided a detailed view of a sustainability oriented highway project. An initial list of sustainability success sub-criteria is discussed with experts to make modifications in the context of this research wherever necessary. The validated list of sustainability success sub-criteria of a highway is used as the project success criteria, which also serves as an input for the second goal of this research.

1.3.2.2 Sub-Goal 2

The second goal of this research is to identify and apply critical success factors for the validated sustainability success sub-criteria (obtained in sub-goal 1). In order to achieve this, critical success factors in the field of construction industry are reviewed by studying recent literature. These critical success factors are used to form the basis of a semi-structured interview protocol for the IPM roles within the public project delivery organization. Cross-case analysis is used to identify sustainability success factors which are critical for ensuring project success of a sustainability oriented highway project.

After achievement of the above mentioned sub-goals, a conceptual model is suggested, to apply critical success factors for sustainability in an IPM team for a highway project.

1.3.3 Research Question

In order to realize the above mentioned objective and sub-goals for this research, the following research question is formulated:

Main Research Question: *"How can critical success factors be applied in an IPM model to improve the chances of project success during the exploration and planning phase of a sustainability oriented highway project?"*

In order to achieve a logical answer to the main research question, sub-research questions are formulated to provide a step wise approach for answering the main research question. The formulated sub-research questions are as follows:

1. *"What are the sustainability success sub-criteria in a highway project?"*
2. *"What are the critical success factors during exploration/planning phase of a sustainability oriented highway project?"*
3. *"How can the critical success factors be applied in an IPM model of a public project delivery organization?"*

1.4 Scope

In order to achieve the objective of this study, it is important to define the boundaries and constraints of this research. This section would elaborate on such and help in acknowledging the scope for this research.

1.4.1 Recent Literature (2010 - 2016)

Literature research regarding project success would be limited to recent literature,that is, published only after year 2010. The reason behind this year choice is that majority of literature published in sustainability and project management is in the past five years, therefore in order to have a common ground for literature review, the time frame of 2010 to 2016 (the year in which the study was performed) is selected.

1.4.2 Available Resources

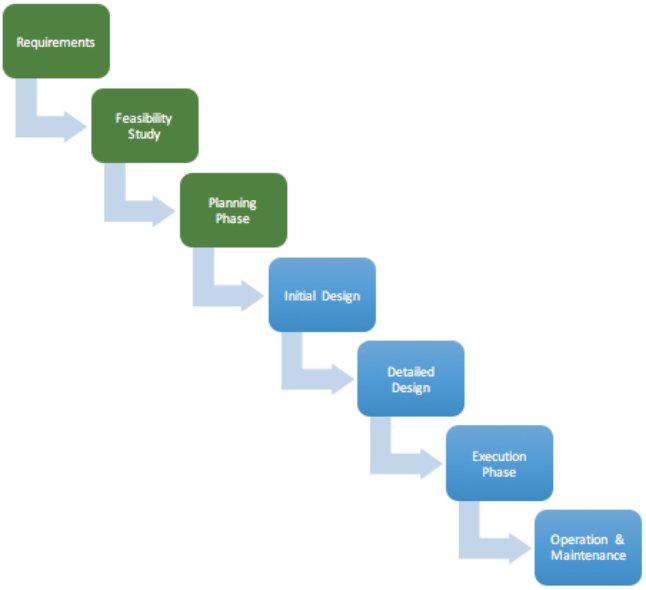


FIGURE 1.3: Project Life Cycles (adapted from Rose (2013))

Depending on the available resources from the public project delivery organization and the definite time frame of this study, three highway projects which have completed their initiation and planning phase are selected for this research. There are seven project life cycles (see 1.3). In this research, first three life cycles are focused. Experts within the public project delivery organization are consulted provide a better idea about sustainability and project management practice within the highway projects. The highway projects to be studied in this research have sustainability goals/ambitions in the deliverable of the project. To help achieve the objective of this research, the following list of requirements is expected from the public project delivery organization:

1. Available documents of the chosen projects with respect to project management and sustainability
2. Discussions with experts in sustainability, project management and highway projects
3. Discussions with IPM roles of highway projects

This research is carried out in the domain of sustainability and project management of infrastructure projects, specifically of highway projects in a public project delivery organization. This would limit the use of this research only for project delivery organizations which undertake sustainability oriented highway projects.

1.5 Methodology

In order to answer the research question, it is important to pursue a sound methodology. This section elaborates on the chosen methodology. The integration of sustainability and project management is new; hence the nature of this research is dominantly exploratory.

FIGURE 1.4: Literature Review Framework

1.5.1 Literature Review

A literature review is an explicit and reproducible method for identifying, evaluating, and interpreting the existing body of recorded work produced by researchers, scholars, and practitioners ((Fink, 1998)). In literature, sustainability in project management practice is a relatively new domain, hence it is important to gather as much relevant information as possible. There is ample literature available for sustainability (for example theories stated by (Elkington, 2004) and (Van Bueren et al., 2012)). A sound theory is selected. Literature available for project success is reviewed focusing only in the construction industry.

A two step approach is used for the literature review (see 1.4). First, literature on project success is reviewed to give an overview of project success and more importantly help to differentiate between project success criterion and critical success factors. Second, sustainability is established as a project success criterion using a sound theory. As a starting point, sustainability aspects framework developed by (Gijzel, 2014) is used to review in recent literature. The sustainability success sub-criteria are verified in literature and modified based on expert discussions. Lastly, critical success factors are reviewed in recent literature, focusing on the construction industry. This also helped in formulating the interview protocol to identify critical success factors for sustainability oriented highway projects.

1.5.2 Cross Case Methodology

As the name suggests, cross-case methodology is a research approach which focuses on comparison of different cases. Multiple case studies help in providing deeper understanding to the researcher. Knowledge obtained from different cases can be used to generalize across similar cases Eisenhardt (1989). Three sustainability oriented highway projects are selected for case studies.

Qualitative interviews are one of the means to collect in-depth information about different cases Weiss (1995). Based on the exploratory nature of this research and aim to identify critical success factors for sustainability oriented highway projects, qualitative interview approach is chosen to conduct cross-case

methodology. A total of twelve respondents (four per case study) are selected for interviewing. Further details about cross case methodology can be found in chapter 4.

1.6 Data Gathering and Analysis

This section gives an overview on data gathering and data analysis in the context of this research.

1.6.1 Data Gathering

Considering the scientific nature of this study, relevant information must be gathered from scientific sources such as journals, websites etc. *Google Scholar* and *Science Direct* are used to search scientific journals, books and reports. This is done by using a set of main search terms (or) keywords. These keywords in the context of project management in construction industry are *Project Success Success Factors* and *Critical Success Factors*. Keywords in the context of sustainability oriented highways are *Sustainability Indicators*, *Sustainability Aspects*, *Sustainability Goals*, *Sustainability Objectives*, *Sustainable Urban Development*, *Sustainable Transportation* and *Sustainable Highway*. Advance search option is used to get more valid results.

The use of keywords helped in identification of scientific journals relevant for this research, these are stated in table 1.1 and table 1.2

TABLE 1.1: Journals considered for Project Success literature review

Journals for Project Success
International Journal of Project Management
Journal of Management in Engineering
International Journal of Managing Projects in Business
Engineering, Construction and Architectural Management
International Journal of Project Organization and Management
Journal of Construction Engineering and Management
Construction Management and Economics
Project Management Journal
International Journal of Sustainable Built Environment
Journal of Environmental Management
Research in Transportation Business & Management

TABLE 1.2: Journals considered for Sustainability literature review

Journals for Sustainability Oriented Highway
Journal of Cleaner Production
International Journal of Sustainability in Higher Education
International Journal of Sustainable Built Environment
International Journal of Sustainable Development & World Ecology
Journal of Infrastructure Systems
Ecological Indicators
Journal of Transport Geography
Current Opinion in Environmental Sustainability
Transport Policy
Journal of Environmental Management
Journal of Cleaner Production

1.6.1.1 Criteria for Data Filtration

A set of criteria is followed in order to filter the data collected from above mentioned scientific journals and help the author to find relevant literature. The decision for inclusion (or) exclusion of literature is done when the following criteria is acknowledged:

1. Literature published between the years 2010 - 2016 is considered
2. Literature is about Infrastructure project (or) Construction project (excluding building construction)
3. Literature is about Sustainable Urban Development (or) Sustainable Transportation (or) Sustainable Highway (or) Sustainable Road
4. Literature consists of research done for the Public sector (or) Public client
5. Literature consists of case studies conducted in Developed Countries only (Based on Human Development Index, 2016).

1.6.2 Cross-Case Analysis

The analysis of the data acquired from qualitative studies depends significantly on summarizing, interpreting and integrating. There are two different ways of analyzing the interviews: issue-focused analysis and case-focused analysis (Weiss, 1995). A sound and holistic generation of the insights of the interviewees is possible by means of a cross-case analysis. This would be further elaborated in chapter 5.

Data analysis is the central theme of an interview. Based on the response received from the interviewees, the investigator analyses the presented data. The first step into the data analysis is that of transcribing the interviews. Once the interviews are taped and recorded, they are subject to transcription. Transcribing is done for facilitating proper flow of information from the interviews. The second step is to use

a powerful Qualitative Data Analysis (QDA) software. ATLAS.ti is a widely used QDA software which provides some useful tools for academic research (Hwang, 2008). ATLAS.ti is selected for this research.

1.7 Research Framework

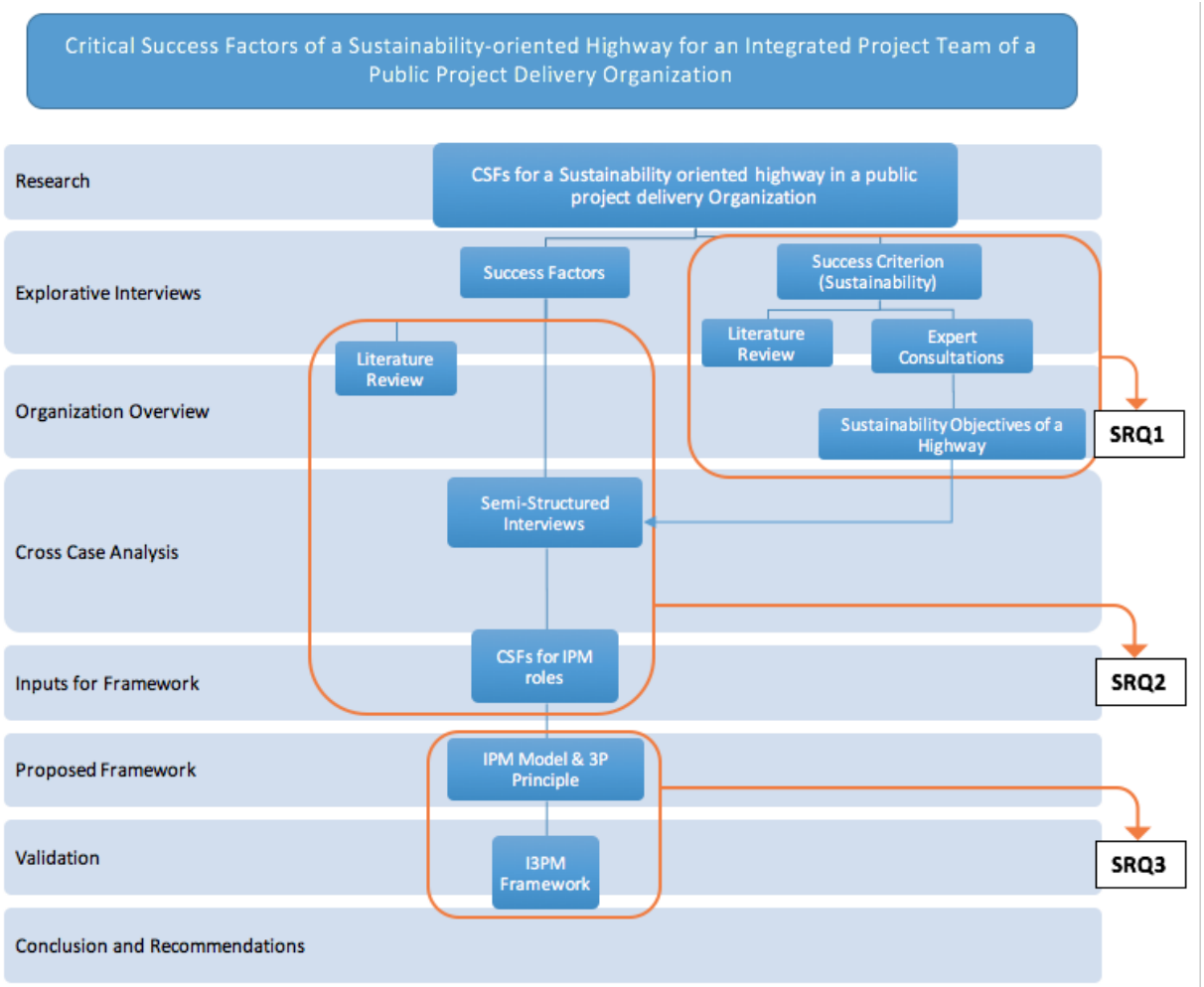


FIGURE 1.5: Research Framework

Summarizing the above sections, this section provides an overview of the research framework (Fig 1.5). To answer the main research question stated in 1.3.3, this research is divided into three sections. Each section provides answer to one of the research sub questions.

In order to answer the first sub-research question (SRQ 1), literature review on sustainability as a project success criterion is carried out. With the help of recent literature, sustainability success sub-criteria are identified. Three experts are selected for validation of identified sustainability success sub-criteria.

Answer to the second sub research question (SRQ 2) is achieved by conducting a literature review on critical success factors in construction industry. This is followed by used of findings from SRQ 1 and identified CSFs to formulate an interview protocol. The formulated interview protocol is used to identify CSFs through cross-case analysis.

Answer to the third sub research question (SRQ 3) is achieved by using the inputs from cross-case analysis. A conceptual model is proposed based on selected sustainability concept and project management model used in the organization. The findings of SRQ 2 are also used in the conceptual model. A validation procedure is carried out with a group of experts.

The next chapter would focus on the literature review conducted in the context of this research.

Chapter 2

Literature Review

This chapter is divided into three sections. First section introduces the concept of project success in 2.1.1 and distinguishes project success factors and project success criteria in 2.1.2. Second section acknowledges sustainability in project management literature and establishes sustainability as a project success criterion in 2.2.2.2. A list of 29 sustainability success sub-criteria of a highway is presented in 2.2.3. Third section reviews project success factors in construction industry, which ends with a list of 28 relevant critical success factors in 2.3.2, to be further used in this research.

2.1 Project Success

Before jumping into literature about critical success factors and project success criteria, it would be helpful for the reader to understand what is meant by *project success*. A clear differentiation between critical success factors and project success criteria is necessary to understand the proceedings of this research. This section would elaborate on these areas.

2.1.1 Introduction to Project Success

Before talking about project success, one must have an understanding of what is meant by a project. A project is a temporary endeavour undertaken to create a unique product, service or result (Rose, 2013)(Portny, 2010). Project success in simpler terms is the success of a project. The follow up questions that could arise are, Can you measure success? What makes a project successful? How to improve the chances of project success? etc. Such type of questions would be discussed in this section and efforts are made to answer them in the context of this research.

Early works in project management literature (Avots, 1969)(Gaddis, 1959) emphasized project success to be bound by the triple constraint of time, budget and scope or famously referred to as the **iron triangle** (Atkinson, 1999). The three sides of the triangle represent time, budget and scope. This supposed iron triangle consists of various combinations of time, budget and project performance (scope). By far, it is one of the most famous phrases used in project management books (Rose, 2013) (Kerzner, 2013). For a project to be completely successful (theoretically) the iron triangle must be met in all sides. As theory is far from practice, the iron triangle is never fixed throughout the project and there are possible trade-offs

among the three sides based on the project environment and context. A generic example to support this is the construction of a new Olympic stadium for conducting games. In such a project, irrespective of scope or budget changes, the time duration of the project is the main driver behind the project. The project cannot be delivered after it has passed the deadline since that would affect the primary objective of the project, which is, conducting Olympic games.

Kerzner (2013) describes project success as not a point in three-dimensional space of budget, time and scope but rather a cube in which there are possibilities of trade-offs between budget, time and performance. Rose (2013) states the success of a project should be measured in terms of completing the project within the constraints of scope, time, cost, quality, resources, and risk as approved between the project managers and senior management. Tabish & Jha (2011) mention in their research that lack of a universally accepted definition of project success and the fact that the concept of success remains vague among stakeholders makes assessing project success difficult. Erdem & Ozorhon (2013) restated that definition of project success depends on the characteristics of the project, external conditions and stakeholder expectation. No single indicator is sufficient to define and measure project success; a set of indicators and a systematic approach is necessary for accurate project performance measurement and project assessment. Various authors have agreed that **project success can no longer be seen within the iron triangle** (Ralf Müller et al., 2014); (Rashvand & Zaimi Abd Majid, 2013); (Lehtiranta et al., 2012); (Turner & Zolin, 2012); (Hertogh et al., 2008); (Jugdev & Müller, 2005); (Westerveld, 2003); (Cooke-Davies, 2002); (Lim & Mohamed, 1999) and (Pinto & Slevin, 1988).

In spite of advancement in project management processes, tools and systems, project success has not significantly improved (Mir & Pinnington, 2014). Construction projects are becoming increasingly complex and difficult to manage (Gustavsson, 2015). Rashvand & Zaimi Abd Majid (2013) state success criteria that determine a project's success for each stakeholder are different. Project success is a multidimensional and networked construct, which is impacted through interactions of personnel, project and team (Söderland et al., 2012). Söderland et al. (2012) also identified the relationship between the perception of project success and the specifics of the role and relationship to the project of the individual as an important issue to be further understood.

Project success is rarely assessed from a client's point of view (Davis, 2014); (Rashvand & Zaimi Abd Majid, 2013); (Turner & Zolin, 2012); (Hermano et al., 2013). Ralf Müller et al. (2014) express the need for a project governance body for client. Koops et al. (2016) show particular interest in project success from the viewpoint of the public project manager. Koops et al. (2016) also state that number of studies on key success criteria rarely relate to the public sector.

Summarizing, project success cannot be viewed only within the iron triangle. There is added complexity in construction projects, which makes assessment of project success difficult. Project success is a multidimensional and networked concept highly dependent on interaction of project managers. Project managers logically strive for a successful project by meeting the project objectives. The above statements provides grounds for the researcher,to further look into the concept of project success. However, it is important to clarify the difference between critical success factors and project success criterion, to continue any further in this report. The next section would elaborate on this distinction.

2.1.2 Distinguishing Project Success Criteria and Critical Success Factors

After a brief discussion about project success, few questions that might arise are: How do we know if a project is successful? Are there guiding principles for a successful project? How to ensure project success? Are there prerequisites or best practices for project success? In order to answer such questions, one must clearly distinguish between project success criteria and critical success factors (CSFs). This section would shed light on this ambiguous topic.

De Wit (1988) suggest the most important criteria for project success are the project objectives and argued that without a clear identification and understanding of a primary objective for a project, it is impossible to determine project success. Project success comprises of internal as well as external criteria/factors (Pinto & Slevin, 1988). Internal factors are controlled by project managers, which are cost, time and performance. External criterion are on the client side which are the use of the project, satisfaction of client and the effectiveness by which the project is used for its intended users. The below definition could help the reader to understand project success criterion and is deemed worthy of showcase:
Criteria of project success are the set of principles or standards by which project success is or can be judged. These (success criteria) are the conditions on which judgment can be made - Lim & Mohamed (1999).

There is vast literature available for critical success factors and project success criterion. However, one of the first research in project management literature to establish a link between critical success factors and project success criterion was carried out by Westerveld (2003). This research distinguished Project Success Criteria (Result Areas) and Critical Success Factors (Organization Areas) by adapting the EFQM-model to make the project excellence model (see fig 2.1).

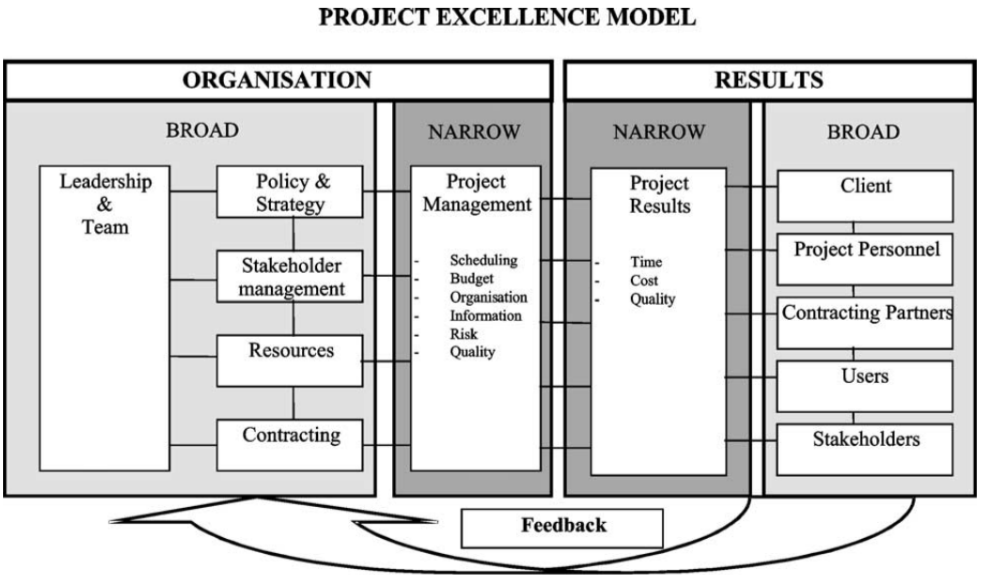


FIGURE 2.1: Project Excellence Model (Westerveld, 2003)

In this model, the six result areas cover the concept of project success in the broadest sense and each result area represents a clear and distinctive set of goals or interests. These result areas consist of narrow

as well as broad areas. Narrow result areas contain the goals of iron triangle, whereas broad result areas contain goals defined by the client, project personnel, contracting partners, users and stakeholders. The various goals present within the narrow and broad result areas together make the project success criteria.

Similarly for critical success factors, one must focus on the organization area of project excellence model (see fig 2.1). The organization area also consists of narrow and broad organization areas. Narrow organization area comprises of project management processes such as scheduling, budgeting, information management, risk management and quality control. Broad organization area consists of Leadership & Team, Policy & Strategy, Stakeholder Management, Resources and Contracting. It is evident that these two organization areas will have impact on project organization and subsequently effect project success. These areas consist of critical success factors, which will be discussed in 2.3.2 in detail. Some of these critical success factors are in direct control of project manager such as leadership and team, scheduling, risk management, quality control etc and other critical success factors indirectly influence project manager such as policy & strategy.

To help distinguish between critical success factors and project success criteria, project excellence model is selected, which distinguishes the two concepts while acknowledging the link between the two. Thus, **project success criterion are basis for judgment of project success which lie in the results area of Project Excellence Model and critical success factors are necessary means (activities and processes) to achieve project success which lie in the organization area of Project Excellence Model**. This research is based on the assumption that sustainability is an upcoming project success criterion. The next subsection focuses on identification of a clear and distinctive set of success sub-criteria for a sustainability oriented highway. This helps in establishment of sustainability as a project success criterion (for further details see 2.2.3).

Sustainability could possibly be a new independent result area in Project Excellence Model or a dormant underlying criterion of result ares of Project Excellence Model, unfortunately this discussion is beyond the scope of this research.

2.2 Project Success Criterion - Sustainability

The aim of this section is to establish sustainability as a success criterion of a highway project. This section is divided into three sub-sections. The first sub-section elaborates on sustainability through selection of a sound theoretical concept (see 2.2.1.1) to be used in this research. The second sub-section describes literature in sustainability and project success. Recent literature supporting sustainability as a prospective project success criterion is reviewed (see 2.2.2.2). The third sub-section digs into the concept of sustainability as a project success criterion of a highway project and identifies a clear and distinct set of success sub-criteria from literature. These sustainability success sub-criteria (2.5) are used as project success criterion of a sustainability oriented highway.

2.2.1 Introduction to Sustainability

Even after so many years since Brundtland (1987), sustainability has been an ever growing concept, constantly receiving attention. There are various reasons behind this, be it growing awareness among the society (Pomerance, 1986), complicated political agendas (Hecht & Tirpak, 1995) or innovations in the field of technology. In this subsection, sustainability and few theories which surround it are introduced.

John Elkington coined the triple bottom line, People Planet Profit in his book Cannibals with Forks (Elkington, 1997). Elkington (2004) reflects on the term and acknowledges the revolution it caused, both in literature and industry, thus making it as one of the most famous and widely used term for describing sustainability. Brundtland (1987) defined sustainability as *meeting the needs of present without compromising the ability of future generations to meet their own needs*. Ecosystems approach is a recent concept to define sustainability (Van Bueren et al., 2012). In this approach boundaries of a system effects the problem identification and diagnosis of different solutions within the system. As a consequence of this approach, there is no single definition of sustainability. One can define sustainability only after defining the system/subsystem boundaries and by knowledge of system properties. For a better understanding, consider the example of urban areas. Urban areas are located in a specific climate, with specific geo-morphological conditions and with specific opportunities and constraints, such as availability of natural resources and of connections (roads, railways, harbour etc.). In this way, an urban area can be considered as a ecosystem with boundaries and relations. More details on ecosystems approach can be found in A.1. In the context of transportation, Zheng et al. (2013) describe sustainability as not just a simple act of sustaining a transportation system but also about understanding of the broader impacts of the transportation system.

The triple bottom line is an old concept which has its limitations but at the same time, is widely acknowledged in practice. Ecosystems approach is new and complex in nature, which is not yet fully embraced by practice. Considering the ease of understanding and acknowledgement of the sustainability theory within practice, the author selects triple bottom line (People, Planet, Profit) as a sustainability theory to be used in this research. People and Planet dimensions within the triple bottom line have remained the same over time, however Profit dimension has been changed to Prosperity to accommodate a wider horizon of this dimension. The following subsection would elaborate on this and the chosen sustainability concept.

2.2.1.1 Triple Bottom Line - People Planet Prosperity

John Elkington coined the term and developed the 3P concept "people planet profit" (Elkington, 1997) and reviewed on it (Elkington, 2004). This concept received attention in both literature and industry. An example for latter is Shell, an Oil and Gas corporate giant, which adopted the 3P concept in its first Shell Report in 2001. The definition of sustainability adopted by United Nations is as follows:

Development is a multidimensional undertaking to achieve a higher quality of life for all people. Economic development, social development and environmental protection are interdependent and mutually reinforcing components of sustainable development - UN (1997)

From 1960 to 2001, three great waves of public pressure have shaped the sustainability agenda. The roles and responsibilities of governments and the public sector have mutated in response to each of these three waves and will continue to do so. These waves are briefly described in A.2. This research assumes that the third wave has resulted in placement of sustainability issues to the forefront of various organizations. Elkington (2004) asserted in order to achieve sustainability, governments and agencies will need to move through the various stages shown in the learning flywheel 2.2. For definitions of these stages refer A.3.

The recent Paris climate change agreement (Commission, 2014)(Rogelj et al., 2016)(Obergassel et al., 2016) is an example of Stage 1 (Invasion) and Stage 2 (Internalization) of the learning flywheel. The

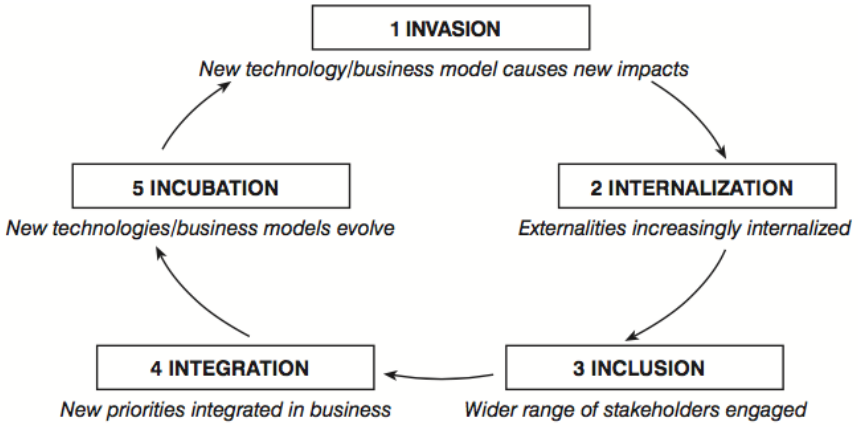


FIGURE 2.2: The learning flywheel (Elkington, 2004)

author believes this research is an indirect outcome of Stage 1 and Stage 2 and is focused on Stage 3 (Inclusion) and Stage 4 (Integration).

People and Planet dimensions of sustainability have remained unchanged in recent literature. The third pillar of sustainability represents economic development, according to Elkington (1997) and Elkington (2004). However, recent literature suggests "Prosperity" as a concept that goes beyond economic development. Examples can be found in literature (Zimmerman, 2005); (Hammond, 2006); (Jackson, 2009); (Ashby, 2015). Based on the above mentioned literature the three pillars of sustainability are described as follows:

Social Development (or) People Dimension
"People" dimension pertains to fair and beneficial business practices towards the community and in the region in which an organization starts its project.

Environmental Protection (or) Planet Dimension
The organization endeavours to benefit the natural capital as much as possible (adhering to legal standards) while ensuring least harm and minimization of environmental impact on the ecosystem surrounding the project.

Equitable Economic Development (or) Prosperity Dimension
Prosperity is a condition that includes obligations and responsibilities to others (society) for an equitable long term economic development.

Kuhlman & Farrington (2010) interprets 3P as needs versus resources or as the short versus the long term. 3P concept focuses organizations not just on the short term profit that they make, but also on the environmental and social value that they add or destroy. Elkington (1997) mentions the seven sustainability revolutions concept to further establish the 3P principle. Reader can refer A.4 for a clear and brief description of the seven sustainability revolutions concept. Elkington (1997) also referred to so called share-zones, where inter dependencies between social, environmental and prosperity aspects are explained by conveying a system view on the complex problem of sustainability. These inter dependencies (see fig 2.3) were explained by Rogers & Hudson (2011). The 3P concept apart from helping one focus attention on specific criteria for progress in each of the three domains, it also highlights the relationships among the three main elements. Ideally, the intersection of this Venn diagram, where all three goals are satisfied, would result in sustainability. However in practice, one can notice some tensions and trade-offs among competing goals, where choices have to be made at a higher level of systems thinking,

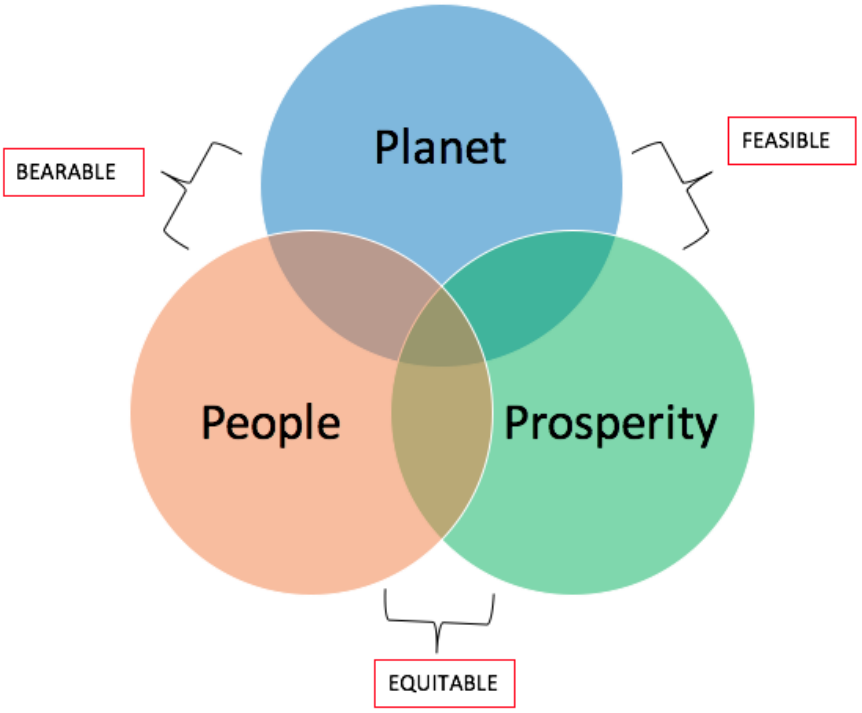


FIGURE 2.3: Inter dependencies in People, Planet, Profit dimensions of Sustainability (Adapted from Rogers & Hudson (2011))

with business decisions taken in a broader context—as broad as the concept of civilization itself (Rogers & Hudson, 2011). Hansmann et al. (2012) investigated professionals (sustainability experts) with the aim to investigate synergies between the three pillars of sustainability. An interesting finding is that synergies often coincided with occurrence of conflicts. The findings suggest resolving conflicts is often an essential part of integrating and balance between the three dimensions. There are many arguments for harmony or balance.The harmonies between different dimensions of sustainability as presented by Rogers & Hudson (2011) are described as follows:

1. Feasible - This domain reflects the harmony between Planet and Prosperity dimensions of sustainability. In this domain, environmental protection must be done considering the prosperity aspects which deem it feasible.
2. Bearable - This domain reflects the harmony between Planet and People dimensions of sustainability. In this domain, the environmental protection is viewed through consideration of involved stakeholders to check the bearing capacity of society and environment, thus called bearable.
3. Equitable - This domain reflects the harmony between People and Prosperity dimensions of sustainability. In this domain, the economic value generated must be fair and long-term oriented for the involved stakeholders. This domain is called equitable.

The harmonies can be better understood with a recent example of climate change phenomenon (Commission, 2014) (Stocker, 2014). The growing concern about climate has created new business opportunities with respect to environmental protection (this is an example of feasible domain). Many stakeholders such as concerned environmental groups and NGOs have come in the limelight to discuss what is acceptable and what is not acceptable to mitigate climate change phenomenon (this is an example of bearable domain). United Nations and European Union have formulated various laws and policies over the last

decade to maintain a fair and just system in the society regarding climate change phenomenon (this is an example of equitable domain).

Elkington's people planet prosperity is a widely used and sound theory regarding sustainability. It not only distinguishes sustainability in three different dimensions but also acknowledges the relationships between the dimensions. This theory is selected to define a sustainable highway, which will be discussed in the below section.

2.2.1.2 Definition of a Sustainable Highway

This subsection elaborates on a sustainable highway based on Elkington's people planet prosperity theory.

Transportation is not a closed, self-contained system; rather a tightly intertwined system with other systems. Human activity systems (including systems of human settlement) in which transportation occurs must be taken into account. There have been efforts to develop and operationalize the notion of "sustainable transport" into useful policy guidance, however two broad categories are interested to note: thinking of sustainable transport as a pathway and sustainable transport as an end-state (Goldman & Gorham, 2006). The author considers sustainable transport as a pathway to sustainability, in this research.The Council of Transport Ministers of the European Union Kerwer & Teutsch (2001) adopted a more expansive definition of sustainable transport as a system. The author proposes the below definition of a sustainable highway, based on the definition of the Council of Transport Ministers and Elkington's people planet prosperity theory. Thus, a sustainable highway:

- **For People** - allows the basic access and development needs of individuals, stakeholders and societies involved in the surroundings to be met equitably and in a manner consistent with the ecosystem
- **For Planet** - ensures environmental protection or limits the impact on the ecosystem while consideration of economic feasibility and the society (stakeholders) involved
- **For Prosperity** - is affordable, operates fairly and offers added value to support a competitive and balanced economy in the long term

After selection of a sound theory for sustainability and providing definition of a sustainable highway based on the selected theory, this research moves further. In the upcoming sub-section, overlap between the concepts of sustainability and project success is acknowledged through available literature.

2.2.2 Sustainability and Project Success

This subsection acknowledges the overlap between sustainability and project success through recent project management literature. At the end of this section, relationship between project success and sustainability is established.

2.2.2.1 Introduction

In the past five years, project management literature has opened its doors for inclusiveness of sustainability concept. There are many authors who acknowledge the need and urgency of sustainability concept

within project management. Authors also believe sustainability could affect project success. Increasing awareness and rapidly emerging literature within this field represents the importance of sustainability in projects.

Kirchhof & Brandtweiner (2011) point out from a theoretical project management point of view, that three pillars model could be a potential way to integrate sustainability in project management process. They also identified, a not very high level of awareness of sustainability tools in project management practice. Martens & De Carvalho (2014) did an extensive literature review and suggest validation and organization of constructs and variables of sustainability with triple-bottom line focus in project management and success in projects. They also propose a conceptual framework where sustainability is a project success criterion. Silvius & Schipper (2012) conclude sustainability as a business case could be achieved by integrating sustainability indicators by a multi-criteria approach, including sustainability assessment by expanding scope, by continuous assessment and institutional capacity & by implying openness and broad participation. Silvius & Schipper (2014) and Martens et al. (2016) state that the literature on the subjects of sustainability and project management is still emerging, where it is interesting to note that almost three-fourth of the total literature was published in past five years. This shows the growing interest to carry out research on sustainability in project management domain. Martens et al. (2016) present evidence of the relationship between the issues concerning Sustainability in Project Management and Project Success. Martens & Carvalho (2016) based on the results of multiple-case studies point out the use of sustainability in project management results in slight increase in project success. However, it states that there is a gap between the perception of importance and the actual use of sustainability in project management in practice.

From the above findings, it is evident that there are potential ways to integrate sustainability in project management practice, particularly for project success. Sustainability can effect success of a project. There is a proven relationship between sustainability and project success. The literature in this domain is new and still emerging, therefore there is a possibility for further research. The next sub-section focuses on establishing sustainability as a project success criterion.

2.2.2.2 Sustainability as a Project Success Criterion

After establishing a relationship between project success and sustainability concept, this section throws light on sustainability as a possible success criterion with the help of literature.

Söderland et al. (2012) state that success of future projects would be increasingly measured on the criteria of strategy, sustainability and safety. They also assert future buildings and infrastructure would be evaluated on their operational flexibility, maintainability, energy efficiency, sustainability and contribution to the overall well being of their end users. Silvius & Schipper (2016) hypothesize different dimensions of sustainability may affect the individual criteria of project success. Their research showed that positive relationships are expected for the relationship between sustainability and the project success criteria (see fig 2.4). Their research presents a conceptual model which uses a broad definition of sustainability. The model certainly lacks depth.

Talbot & Venkataraman (2011) conclude **high-level sustainability indicators are required to track a project's achievement of sustainability**. These can be identified by collecting information on the stakeholder requirements. It is important to identify sustainability indicator's owner to have accountability and know where in the project's life cycle the indicator should be addressed.

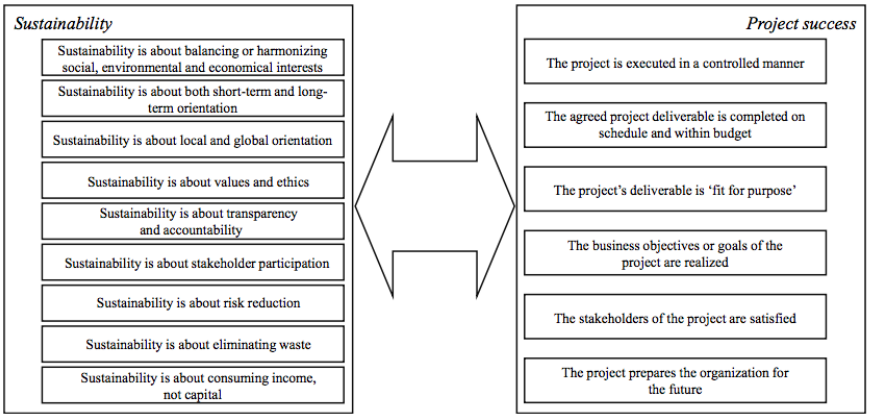


FIGURE 2.4: Conceptual model linking Sustainability and Project Success (Silvius & Schipper, 2016))

Modern needs, future demands, expectations of stakeholders, and regulations must also be incorporated into an inclusive index that could explain if the project is a successful public facility or just another mass of concrete and steel - Ogunlanaet al. (2010)

Summarizing the above two subsections, based on recent literature, there is a definite relationship between project success and sustainability. Literature also suggests sustainability can be a project success criterion. As stated in 2.1.2, in order to establish sustainability concept as a success criterion, one must identify a distinct set of success sub-criteria, which would serve as standards for judgment. The following sub-section elaborates on the identified sustainability success sub-criteria with the help of recent literature.

2.2.3 Sustainability Success Sub-Criteria of a Highway

Aim of this subsection is to identify and develop a project success criteria framework in the context of this research through recent literature. First, a well developed sustainability framework of a tunnel (developed by Gijzel (2014)) is used as a starting point, which is followed by verification through recent literature. The subsection ends with the identified sustainability success sub-criteria of a highway placed in the 3P sustainability concept (fig 2.5).

Gijzel (2014) focuses on sustainability in a tunnel project for a public client in the Netherlands. The outcome of this graduation research is a framework consisting of thirty three (33) sustainable aspects which could be used by the client to have a clearer definition of a sustainable tunnel project before tendering it out for contractors. The identified objectives followed the SMART principle, that is, the identified sustainability objectives are Smart, Measurable, Achievable, Relevant and Time-related objectives. The graduation research used building and built environment tools such as *BREEAM-NL 2012*, *CASBEE 2013*, *LEED neighbourhood 2013* and *GPR Urbanism 2011* and infrastructure assessment tools such as *Green roads 2014*, *Greenlites 2012*, *Envision 2012*, *BE2ST-in-Highways 2012*, *I-LAST- 2010* and *INVEST - 2012*. It is evident from the research that, the researcher used popular assessment tools in practice, not focusing entirely on tunnel projects, but also tools which are used to assess infrastructure projects in general.

Ogunlanaet al. (2010) express the need for identification of a set of common indicators to be used by construction executives and project managers in measuring construction performance at the project

level. Clevenger et al. (2013) recommend adaptation and improvement of identified sustainability aspects over time by experts and experience. Combining the above two rationales, this research identifies and verifies sustainability aspects of a highway through recent literature. The literature review is focused on transport sector (highway or road projects). This ensures the considered list (developed by Gijzel (2014)) is still valid. For more details on the conducted literature review, the checklist formulated in A.1 can be referred. There are few exclusions and modifications from the previous list, these will be elaborated below.

A total of seven aspects could not be identified in the literature review. These are: visual & experiential sustainability, coordination & collaboration in supply chain, operations & maintenance optimization, knowledge exchange, sustainable soil management, sustainable leadership and sustainable business operations. Visual and experiential sustainability is identified through expert consultations as stated by Gijzel (2014). An expert explicitly stated that sustainability must also be visual and experiential in nature, this means, the tunnel should have elements which represent and communicate sustainability to the user. The conducted literature review could not help this research to verify this aspect, however it would be considered to be verified by experts to ensure the inclusion or exclusion of this sustainability success sub-criteria.

Sustainability success sub-criteria such as sustainable soil management, sustainable leadership and sustainable business operations are considered as ways to achieve sustainability which lie in the hands of the organization, rather than success criteria. As explained in 2.1.2, these are success factors and not success criteria. Thus, they will not be considered as project success criteria in this research.

Local stakeholder involvement, coordination & collaboration in supply chain and operations & maintenance optimization are sustainability aspects in the framework which can also be a success factor. In literature (Talbot & Venkataraman, 2011); (Fernández-Sánchez & Rodríguez-López, 2010); (Marshall, 2013); (Zheng et al., 2013); (Haghshenas & Vaziri, 2012) these sustainability aspects are considered important. Local stakeholder involvement, coordination & collaboration in supply chain and operations & maintenance optimization are considered crucial because sustainability is a concept that is dependent on the People dimension. The involved stakeholders, required coordination and collaboration, optimization of operations and maintenance requires substantial effort from society. By this rationale, this research considers the above stated sustainability success sub-criteria and based on expert judgment, these sub-criteria can be included or excluded from this research. Therefor even though the literature does not verify these sustainability success sub-criteria, they are considered in this research to be reviewed critically by experts.

Knowledge exchange and sustainable business operations are too broad and not specific enough to be found in literature. One can acknowledge this from the definitions formulated by Gijzel (2014) for the same. Sustainable business operations could also involve stakeholders but to a lower degree of involvement as compared to coordination and collaboration, where involvement is more direct and mutual. Also, sustainable business operations can be means to achieve sustainability rather than a principle to be followed to measure project success. This research considers sustainable business operations to be part of operations and maintenance optimization, with or without involvement of stakeholders. On the other hand, knowledge exchange has a more direct involvement of stakeholders. Value generation as mentioned by Miller et al. (2016) involves stakeholders. This research thus combines these two success sub-criteria as one sustainability success sub-criterion - *Knowledge exchange and Value generation*. Experts are consulted to validate this choice and final decision to retain or use them separately is based on their comments.

Environmental Impact Assessment (EIA) and Life Cycle Cost (LCC) approach are evident in literature (Hansmann et al., 2012);(Fernández-Sánchez & Rodríguez-López, 2010);(Tsai & Chang, 2012);(Marshall, 2013);(Zheng et al., 2013);(Alonso et al., 2015);(Zhou et al., 2015). EIA and LCC are proven techniques which help to achieve sustainability, but in the end, these are approaches or ways to ensure sustainability and not a success criteria in itself. In the current era, these are famous and one of most reliable approaches but one cannot ignore the possibility of newer and improved ways to achieve sustainability in the future. By this rationale, this research does not include them in the sustainability success sub-criteria framework. Carbon dioxide emissions is one of the most important sustainability aspect of a

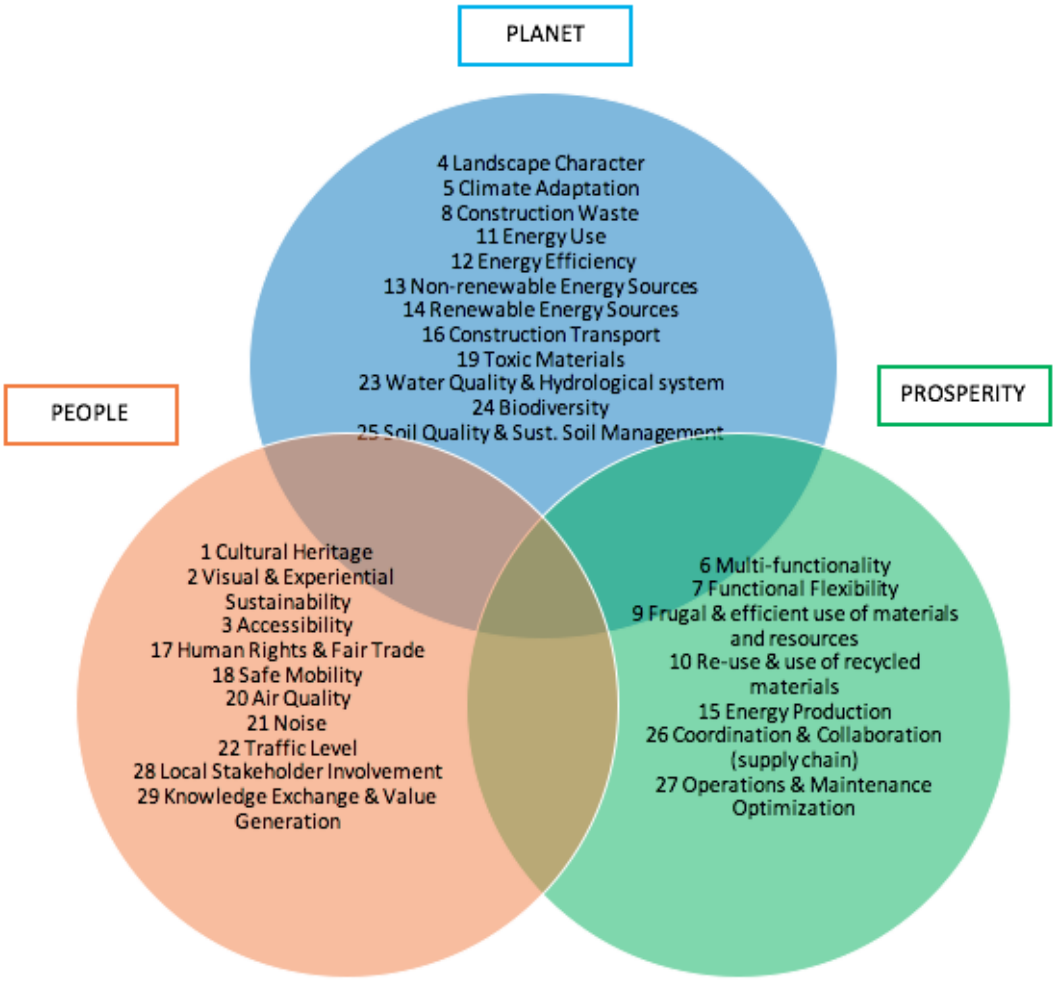


FIGURE 2.5: Sustainability Success Sub-Criteria Framework, modified from Gijzel (2014)

highway, which is evident from various citations in the literature (Hansmann et al., 2012); (Talbot & Venkataraman, 2011); (Toth-Szabo & Várhelyi, 2012); (Marshall, 2013); (Miller et al., 2013); (Zheng et al., 2013); (Santos & Ribeiro, 2013); (Smith et al., 2013); (Jullien et al., 2014); (Alonso et al., 2015); (Zhou et al., 2015); (Inyim et al., 2016); (Zhang, 2016); (Haghshenas & Vaziri, 2012); (Shiau & Liu, 2013); (Miller et al., 2016). However, it is interesting to note that the same literature also states air quality as an important sustainability aspect. There is an overlap in minimizing carbon dioxide emissions and maintaining air quality, which is also observed in the above mentioned literature. By definition, ensuring air quality consists of maintaining the levels of harmful gases and fine particulate matter. Thus

carbon dioxide emissions, by definition, is part of air quality, just like nitrogen oxide and particulate matter.

Summarizing the above subsection , a modified list of 29 sustainability success sub-criteria is used to develop sustainability success criterion framework of a highway. These success sub-criteria are grouped based on the People Planet Prosperity dimensions (see fig 2.5).

The next section focuses on critical success factors for construction industry.

2.3 Critical Success Factors

This section discusses and identifies critical success factors (CSFs) in the context of construction industry. Molaei et al. (2017) developed a critical success factor framework which is used as a starting point. The CSFs are further adapted to be used in the context of this research.

2.3.1 Introduction

As mentioned in 2.1.2, critical success factors are different from project success criterion. Müller & Jugdev (2012) state critical success factors as the elements of a project which, when influenced, increase the likelihood of success. Critical success factors are independent activities, processes or best practices. Lam et al. (2008) conclude that it is necessary to quantify project success so that project participants can compare their project performance levels for bench-marking purpose. Hertogh et al. (2008) state highest level of project maturity to be a fine balance in hard and soft factors that would help in evaluations, bench-marking (measurements) and guidelines to improve project organization of large infrastructure projects. Thus, project success is attributed to a number of factors which are large in number and project participants can only focus on the few most important ones. These few most important ones are "critical success factors", which when influenced would increase chances of project success.

Researchers have attempted to identify the common characteristic features of construction projects in order to help classify critical success factors in broad categories, however no general agreement can be made regarding one uniform categorization (Ngacho & Das, 2015). In previous sections of this chapter, critical success factors were assumed to be present in the project organization areas of Project Excellence Model (Westerveld, 2003). To ensure continuity and help in understanding, the next subsection would focus on critical success factors present in Westerveld's organization areas. An important assumption is that these selected organization areas serve as broad categories where majority of critical success factors are present.

2.3.2 Critical Success Factors

This subsection leads to identification of critical success factors in construction industry. Critical Success Factors or CSFs are categorized in seven different categories based on organization areas of Project Excellence Model (Westerveld, 2003) and CSF framework developed by Molaei et al. (2017). A total of 28 critical success factors are identified in seven categories. These are elaborated in the following paragraphs.

Critical Success Factors related to Project Characteristics

This category consists of critical success factors which are outside the control of a project manager but their awareness could impact project success.

TABLE 2.1: Critical Success Factors (Project Characteristics)

Critical Success Factors related to Project Characteristics	Literature
1. Awareness of project nature	Inayat et al (2015); Ngacho & Das (2015) ; Tabish & Jha (2011); Chen et al (2011); Yong & Mustaffa (2012); Yong & Mustaffa (2013); Hwang and Lim (2013); Wang (2015); Bayiley (2016)
2. Awareness of project external factors	Inayat et al (2015); Ngacho & Das (2015) ; Tabish & Jha (2011); Chen et al (2011); Yong & Mustaffa (2012); Yong & Mustaffa (2013); Hwang and Lim (2013); Wang (2015); Bayiley (2016); Chou and Pramudawardhani (2015); Osei & Chan (2015); Dulaimi et al (2010); Hermano et al (2013)
3. Clearly defined scope	Hwang and Lim (2013); Yong & Mustaffa (2013); Lehtiranta et al (2012); Turner & Zolin (2012); Tabish & Jha (2011)

Ngacho & Das (2015) state such external environment-related success factors which deal with the economic, social, political, technological and ecological environment of a construction project. Osei-Kyei & Chan (2015) and Dulaimi et al. (2010) conclude political support and community/public support as a CSF. Inayat et al. (2014) mention political risks, economics risks, technical approval, public opinion, project size, site access limitation and latent site conditions as potential success factors for construction projects. In context of projects in United Kingdom, Chou & Pramudawardhani (2015) state sound economic policy and stable macroeconomic condition as CSFs. Tabish & Jha (2011) state clearly articulated scope of work as a CSF. There is evidence in literature which support such type of success factors (see tab 2.1). Based on findings of Molaei et al. (2017) and the reviewed literature, chosen CSFs under this category are *awareness of project nature, awareness of project external factors & clearly defined scope.*

Critical Success Factors related to Project Management Processes

This category consists of critical success factors which are traditional aspects of project management practice. Tabish & Jha (2011) and Inayat et al. (2014) state regular quality control & quality assurance activities and adequate communication among all project participants as CSFs for construction projects. Lehtiranta et al. (2012) and Rolstadås et al. (2014) state well carried out reporting & documenting, information sharing and discussions, conscious selection of a systematic & methodical project management and systematic & extensive risk management as CSFs for a construction project. Jefferies et al. (2014) state implementation of bench marking technique and performance monitoring to measure success and identify areas for improvement. Chou & Pramudawardhani (2015) conclude well-organized public agency as a CSF for PPP projects in United Kingdom. Osei-Kyei & Chan (2015) also states clarity of roles and responsibilities among parties as important for project success. Literature that supports such factors is summarized in table 2.2.

Among the identified CSFs, "Environmental and sustainability considerations" is part framework developed by Molaei et al. (2017). However it is not considered in this research. The reason is the research context, which is identification of critical success factors for sustainability as a project success criterion. This particular CSF already answers the second sub-research question in a direct and to an extent vague

TABLE 2.2: Critical Success Factors (Project Management Processes)

Critical Success Factors related to Project Management Process	Literature
4. Project management methodology	Rolsta et al (2014); Yu & Kwon (2011); Lehtiranta et al (2012)
5. Level of emphasis on quality	Ngacho & Das (2015) ; Tabish & Jha (2011); Liu (2014); Yong & Mustaffa (2012); Wang (2015)
6. Monitoring and control	Jefferies et al (2014); Inayat et al (2015); Yalegama et al (2016); Ngacho & Das (2015); Tabish & Jha (2011); Turner & Zolin (2012); Osei & Chan (2015); Yu & Kwon (2011); Lehtiranta et al (2012); Kog & Loh (2012); Yong & Mustaffa (2012); Hwang and Lim (2013); Wang (2015)
7. Information sharing within the project team	Rolsta et al (2014); Tabish & Jha (2011); Turner & Zolin (2012); Yu & Kwon (2011); Lehtiranta et al (2012)
8. Risk management	Hwang and Lim (2013); Yong & Mustaffa (2013); Liu (2014); Lehtiranta et al (2012)
9. Environmental and sustainability considerations	Osei & Chan (2015)
10. Learning from current and past experiences	Ngacho & Das (2015) ; Chen et al (2011); Yong & Mustaffa (2013); Hermano et al (2013);
11. Health and safety considerations	Ngacho & Das (2015) ; Chen et al (2011); Liu (2014); Yong & Mustaffa (2012); Yong & Mustaffa (2013); Wang(2015)
12. Clear organizational structure	Chou and Pramudawardhani (2015); Ngacho & Das (2015); Osei & Chan (2015);Dulaimi et al (2010); Yu & Kwon (2011); Liu (2014); Hwang et al (2013)

manner. To conduct scientific research on the chosen topic, the CSF "Environmental and sustainability considerations" is **excluded**.

Critical Success Factors related to Contracting

TABLE 2.3: Critical Success Factors (Contracting)

Critical Success Factors related to Contracting	Literature
13. Proper selection of contracting strategy and tender process	Rolsta et al (2014); Chou and Pramudawardhani (2015); Inayat et al (2015); Ngacho & Das (2015); Chen et al (2011); Yong & Mustaffa (2012); Yong & Mustaffa (2013); Hwang et al (2013); Hagen & Park (2013); Wang (2015); Osei & Chan (2015); Dulaimi et al (2010); Liu (2014); Kog & Loh (2012)
14. Contract management	Hwang et al (2013); Kog & Loh (2012);Dulaimi et al (2010); Ngacho & Das (2015)
15. Proper selection of project execution resources	Ngacho & Das (2015) ; Osei & Chan (2015); Chen et al (2011); Wang (2015); Bayiley (2016)

This category consists of the choices of contracts, contracting parties/partners involved in the construction project and the competencies of contracting parties (Westerveld, 2003). Ngacho & Das (2015) state contractor-related factors which are responsible for contractor's technical expertise, site management and supervision skills, quality management practices etc. Rolstadås et al. (2014) state contract strategy

is tailored to maximize the benefits from a competitive market. Osei-Kyei & Chan (2015) and Chou & Pramudawardhani (2015) conclude appropriate risk allocation & sharing and transparent procurement as CSFs.

Proper selection of contracting strategy and tender process, Contract management & Proper selection of project execution resources are CSFs stated by Molaei et al. (2017), which fall under this category (see table 2.3 for cited literature).

Critical Success Factors related to Leadership and Team

TABLE 2.4: Critical Success Factors (Leadership & Team)

Critical Success Factors related to Leadership & Team	Literature
16. Top management support	Berssaneti and Carvalho (2015); Tabish & Jha (2011); Yong & Mustaffa (2012); Yong & Mustaffa (2013);
17. Competent project manager	Berssaneti and Carvalho (2015); Inayat et al (2015); Yalegama et al (2016); Williams (2016); Kog & Loh (2012); Yong & Mustaffa (2012); Yong & Mustaffa (2013); Hwang and Lim (2013); Bayiley (2016)
18. Project manager early involvement and continuity	Yong & Mustaffa (2012)
19. Competent/ multidisciplinary project team	Rolsta et al (2014); Jefferies et al (2014); Yalegama et al (2016); Dulaimi et al (2010); Chen et al (2011); Lehtiranta et al (2012); Yong & Mustaffa (2013); Hwang and Lim (2013); Bayiley (2016); Hermano et al (2013)
20. Collaboration between project parties	Rolsta et al (2014); Jefferies et al (2014); Ngacho & Das (2015) ;Tabish & Jha (2011); Osei & Chan (2015); Dulaimi et al (2010); Williams (2016; Chen et al (2011); Lehtiranta et al (2012); Yong & Mustaffa (2012); Hwang and Lim (2013)
21. Training provision	Rolsta et al (2014); Inayat et al (2015; Yalegama et al (2016))
22. Integrated project team	Rolsta et al (2014); Jefferies et al (2014); Williams (2016)

This category, as the name suggests, consists of critical success factors related to leadership and team qualities required for ensuring the success of a construction project. Berssaneti & Carvalho (2015), Inayat et al. (2014) and Kog & Loh (2011) state presence of a dedicated project manager or project manager comptency as a CSF for overall project performance. Tabish & Jha (2011) state thorough understanding of scope as a responsibility of project manager. Berssaneti & Carvalho (2015) conclude top management support as a CSF. Jefferies et al. (2014) and Lehtiranta et al. (2012) state careful team selection, project specific team alignment, open minded team and creative team players as important for project success. Formation of a single entity, strong private consortium, collaborative working and integrated form of agreement is important for project success (Jefferies et al., 2014) (Osei-Kyei & Chan, 2015) (Lehtiranta et al., 2012) (Rolstadås et al., 2014). Rolstadås et al. (2014) conclude personnel training creates strong commitment toward the project objectives. Inayat et al. (2014) also mention recruitment and training as a potential CSF for construction projects.

The above stated factors are in fact related to leadership and team. As mentioned by Molaei et al. (2017), these factors are grouped as *Top management support, Competent project manager, Project*

manager early involvement and continuity, Competent/multidisciplinary project team, Collaboration between project parties, Training provision & Integrated project team (see table 2.4 for cited literature).

Critical Success Factors related to Stakeholder Engagement

This category focuses on critical success factors in relation to stakeholder engagement. Tabish & Jha (2011) state understanding of ownerneed & defined regular monitoring and feedback by owner as important success attributes. Chen et al. (2011) considered owner's expectation and owner's preference as two separate categories for CSFs. In this research, owner or *client involvement* is considered as a single CSF, which considers both aspects of client expectation and preference. Literature which states stakeholder involvement is crucial for project success is described in table 2.5. Two CSFs stated by (Molaei et al., 2017) fall in this category which are *Client involvement* and *Early involvement of stakeholders (project parties and end users).*

TABLE 2.5: Critical Success Factors (Stakeholder Engagement)

Critical Success Factors related to Stakeholder Engagement	Literature
23. Early involvement of stakeholders (project parties and end users)	Rolsta et al (2014); Jefferies et al (2014); Yalegama et al (2016); Osei & Chan (2015); Yu & Kwon (2011); Williams (2016); Yong & Mustaffa (2012); Yong & Mustaffa (2013); Hermano et al (2013); Bayiley (2016)
24. Client involvement	Jefferies et al (2014); Tabish & Jha (2011); Williams (2016); Chen et al (2011); Yong & Mustaffa (2013); Hwang and Lim (2013); Bayiley (2016)

Critical Success Factors related to Policy & Strategy

This category consists of critical success factors related to policy and strategy. Hjelmbrekke et al. (2014) state owner or the project governance body on behalf of the project owner, has responsibility to clearly communicate what value the project is to provide. Jefferies et al. (2014) state awareness of project aim, objectives and charter as a CSF. Realistic obligations or clear goals/objectives is a CSF for overall project performance (Inayat et al., 2014), (Osei-Kyei & Chan, 2015) (Kog & Loh, 2011). Ngacho & Das (2015), Osei-Kyei & Chan (2015) and Kog & Loh (2011) state detailed project planning or adequacy of project plans as a CSF. Inayat et al. (2014) and Osei-Kyei & Chan (2015) state formal dispute resolution process and favorable legal framework as CSF respectively.

Clear goals, Systematic planning and Legal & administrative processes are the CSFs under this category as stated by Molaei et al. (2017) (see table

Critical Success Factors related to Resources

This category consists of critical success factors in relation to resources of the project. Osei-Kyei & Chan (2015) and Chen et al. (2011) state innovative technology as a CSF. Adequacy of funding and efficient use of resources is considered as a CSF by various authors (see table 2.7. The CSFs stated by (Molaei et al., 2017), which are *Adequacy and efficiency of resources & Use of technology* fall under this category.

TABLE 2.6: Critical Success Factors (Policy & Strategy)

Critical Success Factors related to Policy & Strategy	Literature
25. Clear goals	Hjelmbrekke et al (2014) Jefferies et al (2014); Ngacho & Das (2015) ; Tabish & Jha (2011); Turner & Zolin (2012); Osei & Chan (2015); Dulaimi et al (2010); Yong & Mustaffa (2012); Yong & Mustaffa (2013); Hwang and Lim (2013); Bayiley (2016); Hermano et al (2013)
26. Systematic planning	Inayat et al (2015); Ngacho & Das (2015) ; Turner & Zolin (2012); Osei & Chan (2015); Yu & Kwon (2011); Kog & Loh (2012); Yong & Mustaffa (2013); Hwang and Lim (2013); Wang (2015)
27. Legal and administrative processes	Inayat et al (2015); Osei & Chan (2015); Dulaimi et al (2010); Yu & Kwon (2011); Hwang et al (2013)

TABLE 2.7: Critical Success Factors (Resources)

Critical Success Factors related to Resources	Literature
28. Adequacy and efficiency of resources	Inayat et al (2015); Tabish & Jha (2011); Osei & Chan (2015); Dulaimi et al (2010); Chen et al (2011); Liu (2014); Yong & Mustaffa (2012); Yong & Mustaffa (2013); Hermano et al (2013); Hwang et al (2013); Hwang and Lim (2013); Wang (2015); Bayiley (2016)
29. Use of technology	Osei & Chan (2015); Chen et al (2011)

2.3.3 Discussion

In this chapter, a literature review was conducted covering aspects of project success criterion and critical success factors in the context of this research. The first section provided an understanding of project success. Project success cannot be viewed only within the iron triangle. Project success is a multidimensional and networked concept highly dependent on interaction of project managers. An explicit distinction between project success criterion and critical success factors is made with the help of project excellence model. This distinction helps to better understand critical success factors and their link to project success criterion.

The second section of this chapter presented sustainability as an upcoming project success criterion. Elkington's 3P principle is selected as a sound theory for sustainability. Overlaps between the concepts of sustainability and project success through available literature are acknowledged. There is a definite relationship between project success and sustainability. Literature also suggests sustainability can become a project success criterion. In order to establish sustainability as a project success criterion, a distinct set of success criteria must be established, which would serve as basis of judgment of a sustainability oriented highway project. Based on this rationale, a sustainability framework of a tunnel was considered and reviewed against recent literature to identify sustainability success sub-criteria of a highway. A modified list of 29 sustainability success sub-criteria is developed to broadly cover the definition of a sustainable highway project. These success sub-criteria are grouped based on the chosen sustainability concept.

The third section of this chapter focused on critical success factors of construction projects. CSFs are independent activities of a project which, when influenced, increase the likelihood of project success. By

studying CSFs, various authors have compared project performance levels and provided suggestions to improve project success of future projects. There is no general agreement in literature with respect to categorization of critical success factors. A recently developed framework of CSFs is selected. Identified critical success factors are categorized based on the framework. The framework consists of 29 CSFs in total, among which the CSF *environmental and sustainability considerations* is excluded. The remaining 28 CSFs are deemed critical for construction industry from a theoretical perspective. These CSFs are used to identify success factors which are "critical" for achieving sustainability success sub-criteria of a highway project, this list is also used to formulate questions for interview protocol(see D). This will be elaborated in Chapter 5. Importantly, CSFs are multiple interacting factors (as stated by Williams (2016); Chen et al. (2011) and Liu et al. (2014).

2.3.4 Conclusion

The literature review provides a link between concepts of project success and sustainability. Elkington's 3P concept is selected and a list of 29 sustainability success sub-criteria is developed, to serve as basis of judgment of a sustainable highway project. Critical success factors are reviewed in the context of construction industry and a modified list of 28 critical success factors is selected. The above two findings are used to identify critical success factors of a sustainability oriented highway project, by means of an interview protocol. This will be elaborated in chapters 4 and 5. The next chapter of this research provides an overview of the public project delivery organization and helps in validation of identified sustainability success sub-criteria. Outcome of exploratory interviews and document review is elaborated in the same chapter.

Chapter 3

Organization Overview and Exploratory Interviews

This chapter focuses on the overview of the public project delivery organization and exploratory interviews conducted in the context of this research. The chapter is divided into two sections. The first section elaborates on the IPM model and IPM roles. Specific focus area of each IPM role and their interdependence is discussed from a theoretical point of view. The second section focuses on exploratory interviews, the outcome of exploratory interviews with project managers of highway projects and sustainability experts within the public project delivery organization is addressed, followed by identification of sustainability experts within the organization and subsequent validation of sustainability success subcriteria.

3.1 Integrated Project Management (IPM) Model

This section elaborates on the Integrated Project Management (IPM) model used within the public project delivery organization for their highway projects. The following discussions are entirely dependent on the report "Rolprofielen IPM" (Wermer, 2016). Depending on the specific nature and scope of the undertaken highway project, the public organization is staffed by employees who, on a part-time basis, based on their expertise make a substantive contribution to the project. There are five IPM roles, which work as an integrated team and also have their share of individual responsibilities. More commonly referred to as the IPM model, it is used since 2005 in the organization for their projects. It is a horizontal hierarchical model consisting of five distinct roles (see fig 3.1). The five roles have a shared responsibility for overall success of the project. All roles overlook for opportunities, risks and consequences in both short and long term. These roles discuss among themselves in order to take the right decisions for the project. Each role leads a separate team. These roles are further elaborated below.

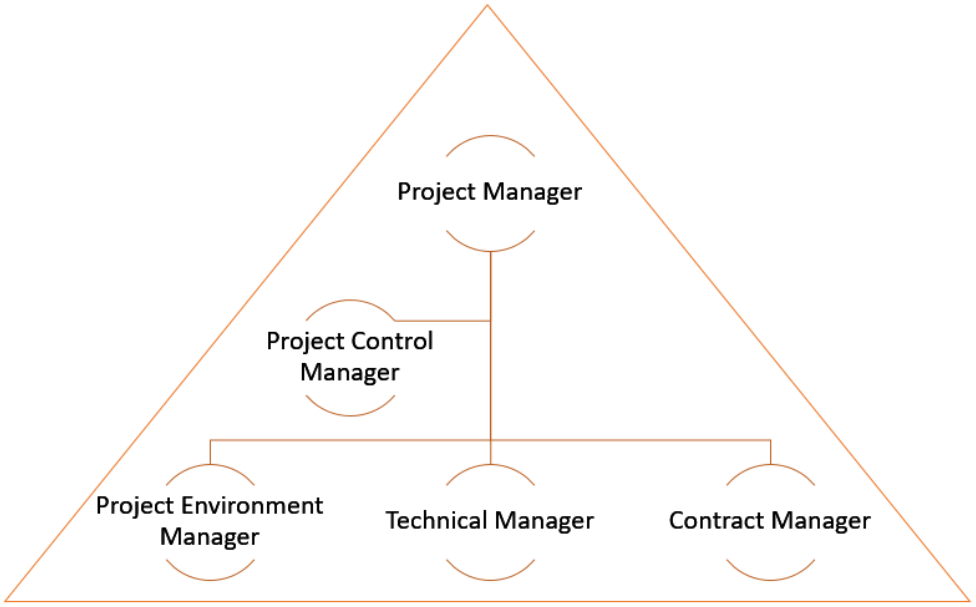


FIGURE 3.1: Integrated Project Management Model (Wermer, 2014)

3.1.1 Project Manager (PM)

The Project Manager or PM is primarily responsible for achieving the project successfully within the predetermined constraints of time, money and scope. The PM is responsible for his/her project team, monitors the mutual common ground within the team and provides the unifying leadership that binds the different professionals. PM is the spider in the web, using targeted control as means to ensure project success. PM is the natural sparring partner for other IPM roles and the intermediary between the client,

TABLE 3.1: Focus Areas of Project Manager (PM)

Team Leadership	**Targeted Control**	**Customer Oriented**	**Management Sensitivity**
Resolve contradictions between IPM roles	Establish SMART objectives to be realized	Recognize needs and interests of the customer/client	Has "antenna" for events that could affect current policies
Knowledge about individuals creating a separate group	Push other roles to get behind objectives	Keep in mind the needs and interests of the customer/client	Provide timely political detrimental risks to the governing body/Minister
Knowledge about parties to make permanent/long term efforts for cooperation	Indicate how objectives are to be achieved	Put efforts to investigate customer needs and interests	Estimate the potential effects of own policy and/or proposals on other organizations
Create a "we" feeling by strenthening team spirit	Be consistent in his/her actions	Formulate proposals based on critical analysis	
		Show respect for the wishes of the customer	

line management and project. PM contributes to project success by carrying out tasks or processes, which are well defined and explicitly stated in IPM model. (see table 3.1)

3.1.2 Project Control Manager (PCM)

The Project Control Manager or PCM is responsible for controlling risks, managing scope, handling costs, distributing information (documents) and planning regarding the project constraints of time, money and quality. According to IPM model, integrated project control is made up of: *Scope Management* - the control of scope including the changes to the project; *Financial Management* - the control on expenditure and income/revenue generated as well as income and expenses in present, past and future; *Cost Management* - control by means of figures and various forms of estimates; *Planning Management* - the management of the aspect of time during the life cycle of a system, *Risk Management* - identification and management of risks of a project, on the aspects quality, money and time; *Quality Management* - the control of quality within the project; *Information Management* - the timely delivery of accurate and reliable information for the management cycle; *Document Management* - Accessible and traceable record documents

TABLE 3.2: Focus Areas of Project Control Manager (PCM)

Control Operations	**Information Analysis**	**Planning \& Organization**	**Handling Cost Consciously**
Set priorities in planned activities within the project team	Retrieve the core (important information) from the supplied information	Set priorities and actions for self and other roles	Think economically about the deployment of people and resources
Share time, people and resources to planned activities within the project team	Organize complex information and make it accessible to others	Specify time frame, people and resources needed to achieve the objectives	Weigh costs and return well against each other
Monitors the progress of project activities	Recognize and point out important information in an information rich environment	Create preconditions needed to achieve objectives	Think about financial consequences of plans and actions
	Explain connection between data		Strive to reduce costs and efficient expenditure of available resources
	Realize possible causes of problems		

PCM is also responsible for project wide progress reports and document management/control. PCM is a sparring partner for other roles, testing the functioning of the system and internal processes of the project. PCM contributes to project success by carrying out tasks or processes, which are well defined and explicitly stated in IPM model. (see table 3.2)

3.1.3 Project Environment Manager (PEM)

The Project Environment Manager or PEM is responsible for the social integration of the project and is the interface between the organization and project environment (surroundings such as municipalities, legal bodies, stakeholders etc). The PEM interacts with stakeholders to identify requirements and achieve agreements, which is later translated to technical management. The PEM is responsible for the interaction with the project environment to get project realized within the public and private law framework conditions. In this context, PEM with his team goes through various planning procedures, obtain permits, compile (board) agreements, the (long term) laying of relationships, real estate affairs, handling claims and environmental, archaeological and explosives investigations. The PEM carries out public-oriented network management; tries to grow understanding and confidence in the project area and to achieve effective cooperation with local project environment. PEM carries out intensive contact and consultation on ministerial and administrative level; depending on the nature and context of these

TABLE 3.3: Focus Areas of Project Environment Manager (PEM)

Project Environmental Consciousness	Networking Skills	Customer Oriented	Management Sensitivity
Familiarity with (international) political and/or social developments	Explain and maintain contacts with key personnel and organizations for their specific function	Recognize needs and interests of the customer/client	Has "antenna" for events that could affect current policies
Awareness about relevant external developments in the field of work	Know the right people to find support and to obtain cooperation	Keep in mind the needs and interests of the customer/client	Provides timely political risks for the Member of Government
Integrate political and/or social developments into daily project work	Form alliances and coalitions to achieve goals, if necessary	Put efforts to investigate customer needs and interests	Estimate the potential effects of own policy and/or proposals on other organizations
Awareness of trends and developments in the market and their significance for the organization		Formulate proposals based on critical analysis	
		Show respect for the wishes of the customer	

consultations, the PEM is assisted by PM and/or project director. The PEM has a clear signal function in the project team for the proactive identification of topics from the project environment and external impact on the quality of a project. Specific areas of focus for PEM are tabulated in table 3.3.

3.1.4 Technical Manager (TM)

The Technical Manager or TM is focused on achieving the desired technical result for the client. For this goal, project requirements are drawn up leading to realization and use of a system. TM designs a system (through systems engineering) to respond to the demand of the client. TM need not have deep technical knowledge, but discipline-specific process knowledge is a must. TM provides a substantive contribution in the form of technical input, testing process and product of market participants (contractors, private consortium etc) during the realization phase. This is part of the SCB (System-based Contract Management). In doing so, the TM makes a contribution in the form of risk management, jointly establishing a test plan and contributes to the implementation of the system, process and product test(s). All this under the responsibility of the Contract Manager.

TABLE 3.4: Focus Areas of Technical Manager (TM)

Persuasion	Innovation Management	Judgment	Conceptual Flexibility
Use appealing arguments/opinions	Open to ways to improve business and practice	Assess the problem from different angles	Capability to think of different scenarios based on same data
Know to put forward arguments/opinions at the right time	Seek and consider opportunities for new products or services	Differentiate core from extra additions	Understanding of complex situations arising with different solutions
Know others (personnel/-parties) for ideas to win/-succeed	Apply ideas for improvement of business (directly if possible)	Weigh data and possible practices against each other	Can act outside their own frame of mind
Bring proposals with great enthusiasm	Motivated to try new insights about existing methods	Come to realistic reviews	Ability to comprehend new scenarios when data and/or conditions change
Have an appealing style to convince others			

The TM works in close cooperation with Project Environment Manager (wishes, demands and restrictions from surroundings) and Contract Manager (translation to contract terms and in a later stage technical input into the contract management). The TM is responsible for technical contribution to

the processes falling under the responsibility of Contract Manager, Project Environment Manager and Project Control Manager. In order to ensure overall project success, TM must on specific areas and carry out certain tasks. These are elaborated in table 3.4.

3.1.5 Contract Manager (CM)

The Contract Manager or CM is responsible for the process control of the establishment of procurement, drawing up of procurement plan, contract preparation, tendering and contract management within the constraints of time, money, quality and consideration of risks. In the planning phase, (research) contracts could be required by MER/EIA (e.g. noise, air) and OEI (economic effects). Before Rijkswaterstaat can finalize a contract with a contractor, the risks from the project environment and the technical system must be adequately controlled. The agreements with the project environment and the client apply as a prerequisite for a contract.

TABLE 3.5: Focus Areas of Contract Manager (CM)

Prediction	**Stress Resistance**	**Judgment**	**Progress Control**
Realize critical situations in time	Continue to perform, even under time pressure	Assess the problem from different angles	Monitor own activities and progress
Prevent actions by timely measures	Continue to perform effectively, even if faced by opposition	Differentiate core from extra additions	Monitor activities of others and their progress
	Does not affect the progress of project	Weigh data and possible practices against each other	Push other roles when necessary
		Come to realistic reviews	See that agreements are made
			Check if agreements are fulfilled
			Detect abnormalities and if necessary reject them

By using functional specifications, linking requirements from client and project environment, CM can optimally exploit the capabilities of the market participants while managing the risk. CM is also the one who maintains the daily contacts and, if necessary, negotiations with the market participants. In order to carry the above stated responsibilities effectively, IPM model states task which must be carried out as a CM. (see table 3.5)

The next section sheds light on the exploratory interviews carried out for this research.

3.2 Exploratory Interviews

The underlying objective to conduct exploratory interviews is to understand the current practice of project management for sustainability within the public project delivery organization. For this objective, it is important that a holistic view on the project management practice of the organization is known and documented. Interviews are means to get such a holistic view as well as provide deeper knowledge to interviewer based on examples from practice. The reasons for selection of qualitative interviews as a method for conducting scientific research is elaborated in detail in 4. Since, the nature of interviews is exploratory, it is not necessary to follow a set interviewing protocol, however it is important to select respondents based on the objective of conducting exploratory interviews.

This section is divided into two subsections, where the first subsection elaborates on profile of respondents. The second subsection discusses the outcome of exploratory interviews.

3.2.1 Profile of Respondents

The selected data-set for conducting interviews is important for the richness of the information that is obtained. Selecting the appropriate panel of respondents or interviewees plays a crucial role in the kind of information which would be made available. There are broadly two categories of interviewees: panel of knowledgeable informants and sample of representatives.

Since the interviews are exploratory in nature, a combination of two categories of interviewees is chosen, based on availability of professionals in the organization. The criteria for selection of interviews is, they must possess significant years of experience in project management (or) highway projects (or) both and significant years of experience in sustainability in projects. The table 3.6 gives an overview of exploratory interviewees profile. Their profession, years of experience in highway projects, years of experience in project management and areas of interest are shown.

TABLE 3.6: Profile of Exploratory Interviewees

Name	**Profession**	**Experience in Highways (in yrs)**	**Experience in Project Management (in yrs)**	**Area of Interest**
PM1	Project Manager	12	22	Front-End Planning
PM2	Project Manager	5	7	Use of Sustainability Tools
PM3	Project Manager	15	18	Project Environment Management
PM4	Project Director	13	20	Highway Management
CM1	Contract Manager	1	14	DBFM Contracts
E1	Senior Project Advisor	23	23	IPM Model
E2	Senior Project Advisor	9	-	Highways/Policy translation
E3	Connector/Analyzer	10	-	Innovation
E4	Senior Advisor	26	-	Circular Economy

3.2.2 Outcome of Exploratory Interviews

Interviewee PM1 described there are trust issues with stakeholders (municipalities) for sustainability solutions which slows the initiation and planning phase of a highway. PM1 and PM2 suggests there is room for improvement and lessons to be learned from new stakeholder engagement approaches used for incorporating sustainability, for example the use of sustainability tools. Interviewee E1 showed interest in knowing how sustainability could be incorporated in the project management practice of the public organization. He is dominantly responsible for the IPM (Integrated Project Management) model used within the organization. Interviewees PM1, PM2, PM3 and E1 explained the need to have a common understanding of sustainability within the public organization for improving the project management practice. E1 explicitly stated that there cannot be another additional role, of say sustainability manager, in the IPM model. The rationale behind this comment is, it would increase the amount of communication and collaboration required to carry out a project task, thus increasing complexity. He also commented that sometimes in practice, due to the size and complexity of a project, the IPM model can have extra roles if needed, to help the **fundamental five roles**. PM2 and PM3 explained the similarity between

Elkington's 3P principle and the tool *omgevingswijzer*, used in the organization. PM2 remarked *"A tool is as good as the person who uses it"*, stating sustainability must be well established in the mindset of a manager. Interviewee CM1 stated contracts can have fixed deliverable or flexible objectives, this depends on the consultants and contractors who give advice during the planning phase of the highway project. For sustainability especially, it is agreed to have some 'gaps' say a contractor has an innovative idea which he/she wants to implement.

Discussion with project managers led to an understanding of sustainability as a policy of the organization and its translation to the project level as project goals. Dynamic nature and complexity involved around such sustainability goals is acknowledged in the discussion. Almost all interviewees talked about the IPM model to represent the project management practice within the public project delivery organization. However, this IPM model is not fixed and sometimes there can be extra roles in the IPM model, depending on size and complexity of a given project.

The interviewee E2 mentioned public organization has sustainability experts but they are often scattered across various departments depending on their area of expertise. Interviewee E2 and E3 described about the sustainability tools *omgevingswijzer* and *ambitie web* which are used by the public organization in their highway projects. Apart from these tools, E4 also mentioned about "Living lab", which was described as a consortia of market, government, knowledge institutes which come together to share knowledge and answer "questions" with respect to sustainability. E3 and E4 gave insight in sustainability oriented themes within the public organization, such as circular economy. Almost all interviewees state the need for clearer goals of sustainability in their projects, they describe it to be vague and too broad sometimes. Interviewee E4 while discussing acceptance of sustainability in his profession gave examples of colleagues who told him "*what does it (sustainability) mean for me and my work?*". Interviewee E4 explained there are highly motivated employees who want to contribute towards the sustainability goals but are confused to do so because of their fixed professional role.

Experts confirm sustainability is an important theme within the public project delivery organization. It is becoming more integrated in projects and is effecting the project management practice.

Summarizing, sustainability has become a policy of the public-project delivery organization. It is evident from sustainable project goals of their highway projects. Sustainability is becoming more integrated in projects. Sustainability is complex in nature, there is confusion with respect to incorporation of sustainability in practice (profession). A valuable outcome of these exploratory interviews is the identification of experts within the organization, this would be further elaborated in the next section.

3.3 Expert Interviews

Experts are professionals who possess unique and in-depth information about a particular subject (see 4.3 for more information). In this subsection, interviews with experts in the field of sustainability in highways is explained. The sustainability success sub-criteria developed in 2.2.3 was used in the interviews. Discussion with these experts helped in validation of the sustainability success sub-criteria. Experts based on their knowledge and through constructive criticism, helped in formulating definitions of sustainability success sub-criteria of a highway.

3.3.1 Profile of selected experts

Three sustainability experts were selected for validation of proposed sustainability success sub-criteria framework developed in 2.2.3. These experts possess experience and thorough understanding of sustainability for a highway project. The profile of these experts is tabulated in tab 3.7.

TABLE 3.7: Profile of Sustainability Experts

Name	Profession	Area of Interest	Exp (Highways)
Sustainability Expert 1	Cluster Co-ordinator	Sustainability themes	18
Sustainability Expert 2	Senior Consultant	Sustainability	26
Sustainability Expert 3	Head of Dept (Urbanism)	Spatial Planning	30

Sustainability Expert 1 is responsible for development of the sustainability themes, CO2 & Energy, Circular Economy, Climate Adaptability, Health (Livability) and Sustainable Mobility, within the public project delivery organization. Discussion with the expert, led to identification of overlaps in developed framework and the five sustainability themes. Briefly, CO2 & Energy theme consists of use of materials and has a goal to become energy/climate neutral. Circular economy theme is about material consumption and aims to make the economy circular, in contrast to the traditional linear approach. Climate adaptability is a theme related to heat (increase in temperature) and water levels. This theme has a risk oriented approach to do with functioning of the road/highway. Health or Livability theme is about project surroundings and the effect of project on the project environment. Lastly, Sustainable mobility theme consists of innovations which can help mobility to become more sustainable. The above mentioned sustainability themes are still under development, these observations are entirely dependent on the views of the expert. Another critique that was made was about presence of regulations in the developed framework (such as air quality, noise, traffic level etc). Sustainability Expert 1 stated, *"laws are already well done in projects. There is no room for better project management; cant do more than this, since it is described in the law"*.

Sustainability Expert 2 is a senior consultant in the public project delivery organization and one of the top advisors for sustainability in projects. He recommended to focus on sustainability as a whole and not as parts (dimensions). He appreciated the use of Elkington's 3P as a theory for categorization of sustainability success sub-criteria, since the same theory is well known and practically used in the organization, evidence can be found in the sustainability tool *omgevingswijzer*. When asked about legal nature of few sustainability success sub-criteria in the framework, his comment was *"it entirely depends on you, how many success criteria you want to consider in your framework"*. By this comment, the expert meant inclusion of laws such as air quality and noise level in the framework. His another advise was *"you must ask critical questions to your respondents and then they have to give reasons or success factors to the choices that were made"*. He showed interest to know the choices made by IPM managers in order to achieve sustainable highway.

Sustainability Expert 3 is a highly experienced European spatial planner who has also published many scientific articles with respect to sustainability in spatial planning (urban areas, roads and highways). His comments were detailed and specific. He stated *"It is evident these* (criteria) *are products/outcomes of a highway"* Definition of each sustainability success sub-criteria in the framework was criticized and reviewed, such as cultural heritage was explained to be much larger in context and archaeology is a significant part of cultural heritage, an example street pattern in Greece which is considered cultural heritage was given.

All the three sustainability experts agreed to the proposed definitions with few minor adjustments. The three sustainability experts were unanimous on the completeness level of the list, explicitly stating, *"it* (framework)*looks complete to me"* and *"I believeit* (framework)*covers almost all sustainability aspects of a highway"*. There was no comment regarding the incompleteness of the framework and inaccuracy of definitions used in the framework. Based on their comments and constructive criticism, a modified list of sustainability success sub-criteria is presented in the next section, along with definitions.

3.4 Discussion

The IPM model and its organization structure is designed in such a way that the five role model reflects a model of cooperation. The five roles are fundamental for IPM model to function. The five IPM roles are distinct and carry responsibilities (individual/shared). There are relationships (inter-dependencies) between PEM and TM, TM and CM, TEM and CM, PCM and other roles & PM and other roles. Such inter-dependencies among the five roles are elaborated in detail in C.1. The IPM model reflects the project management practice in the public project delivery organization. The five IPM roles must carry out tasks or processes to ensure project success. As defined in 2.3, such tasks or processes are CSFs. The five IPM roles and their respective behavior can dominantly effect project success, which is also confirmed in the exploratory interviews. CSFs are thus intrinsic elements of these five IPM roles. Sustainability is becoming a new project success criterion in the organization and these five IPM roles provide the right platform to identify CSFs for achieving sustainability of a highway project. It would be interesting to note and observe CSFs carried out by these IPM roles in practice.

Sustainability Success Sub-criteria of a Highway

This paragraph discusses the sustainability success sub-criteria of a highway. Based on the above mentioned expert judgments and feedback, the definitions of sustainability success sub-criteria are formulated. Definition of a sustainable highway is used to distinguish the success sub-criteria in three dimensions of sustainability (see 2.2.1.2).

People Dimension: Sustainability success sub-criteria, which contributes to basic access and development needs of individuals, stakeholders and societies involved in the surroundings are are categorized in this dimension. See tab 3.8 for selected sustainability success sub-criteria belonging to people dimension.

Planet Dimension: The values present in sustainability success sub-criteria that portray environmental protection or limits the impact on the ecosystem are categorized in Planet dimension. See tab 3.9 for selected sustainability success sub-criteria belonging to planet dimension.

Prosperity Dimension: Sustainability success sub-criteria that offers added value to support a competitive and balanced economy are categorized in Prosperity dimension. See tab 3.10)

These validated sustainability success sub-criteria of a highway answers the first research sub-question by presenting almost all success sub-criteria for a sustainable highway project, which were found in literature and confirmed by expert judgments. These success sub-criteria also form the basis of the interview protocol, along with critical success factors. The next chapter would further elaborate on this and the methodology used in the research.

TABLE 3.8: Sustainability Success Sub-criteria of a Highway (People Dimension)

Sustainability Objectives	Definitions
1. Cultural Heritage	Preserve and safeguard cultural heritage, landmark objects and valuable historic remains (archaeology)
2. Visual & Experiential Sustainability	Communication level of a highway about sustainability from a visual and experiential perspective
3. Accessibility	Meet the basic needs of all individuals by consideration of various transport modes supported by planned roadway infrastructure, ensure a fair distribution of benefits
17. Human Rights & Fair Trade	Comply with international labour standards, respect human rights and enforce anti-corruption policy for fair trade (including procurement) as per EU guidelines
18. Safe Mobility	Ensure safe and smooth travel
20. Air Quality	Minimize emissions of air pollutants (NOx, CO2, PM10, PM2.5 etc.)
21. Noise	Minimize noise pollution in/around the areas affected by highway
22. Traffic Level	Aim for a minimum amount of traffic that would deliver/continue economic prosperity & social cohesion
28. Local Stakeholder Involvement	Create public support for the highway and activate local expertise among future users, local residents and other stakeholders
29. Knowledge Exchange & Value Generation	Exchange of information, lessons learned and added value with coordination and collaboration among stakeholders such as educational/research institutions, local community/residents, future users and local government

TABLE 3.9: Sustainability Success Sub-criteria of a Highway (Planet Dimension)

Sustainability Objectives	Definitions
4. Landscape Character	Allow maximum use of (spatial) space based on response to the landscape character in/around the highway
5. Climate Adaption	Measures and proactive strategies to mitigate and adapt to potential negative consequences of climate change
8. Construction Waste	Minimize waste due to construction activities
11. Energy Usage	Minimize energy usage over the total project life cycle
12. Energy Efficiency	Reduction of the amount of energy required for construction and use of product and services
13. Non-renewable Energy Sources	Minimize use of non renewable energy sources
14. Renewable Energy Sources	Maximize use of renewable energy sources
16. Construction related Transportation	Limit negative impact of construction related transportation through local and regional self-sufficiency
19. Toxic Materials	Minimize harmful emissions from toxic (chemical) materials
23. Water quality & Hydrological System	Prevent pollution and minimize impact of highway construction on ground/-surface water while maintaining the regular functioning of the hydro-logical system, if necessary take mitigation steps
24. Biodiversity	Enhancement (or) conservation of biodiversity and ecological connectivity
25. Soil Quality & Sustainable Soil Management	Prevent negative impact on soil quality while ensuring the capacity of soil to provide for future needs
30. Critical Natural Capital	Utmost protection of critical nature capitall e.g. Aquifers

TABLE 3.10: Sustainability Success Sub-criteria of a Highway (Prosperity Dimension)

Sustainability Objectives	Definitions
6. Multi-functionality	Practical combinations of multiple functions in the highway
7. Functional Flexibility	The ability of a highway to undergo functional adaptations in the future
9. Frugal and efficient use of materials and resources	Minimize the use of non-renewable materials and resources and maximize the use of reusable materials and resources
10. Re-use and use of recycled materials	Maximum re-use of components and use of recycled materials
15. Energy Production	Use of a highway for production of renewable energy (within project scope)
26. Co-ordination, Collaboration and Integration in the supply chain	Create easy access for coordination, collaboration and integration of key business processes from end users through original suppliers providing product, services and information that add value for client and other stakeholders
27. Operations & Maintenance Optimization	Ensure operations and maintenance personnel are part of the project planning and development process, including establishing of commissioning criteria at the onset of a highway project

3.5 Conclusion

The steps taken in this chapter, has helped in understanding the project management practice of the public project delivery organization. The IPM model and its organization structure aptly reflects the project management practice of the organization, almost all exploratory interviewees talked about the IPM model in relation to project management practice. Sometimes in practice, based on size and complexity of a project, IPM model can consist of extra roles, to help the fundamental five roles. Being an integrated model, the roles have relationships (inter-dependencies). The five IPM roles and their respective behavior can dominantly effect project success. The five IPM roles are distinct and carry responsibilities (individual/shared). The CSFs are intrinsic within each IPM role in carrying out their day-to-day project tasks. As sustainability could become a new project success criterion, these five IPM roles provide the right platform to identify CSFs for realizing a sustainable highway project. Therefore, the IPM roles form the main respondents for cross case approach.

In the exploratory interviews, managers stated sustainability as a recent policy of the organization and it's translation to the project level as project goals. Experts also confirmed sustainability as an important theme within the public project delivery organization. Dynamic nature and complexity involved around sustainability was acknowledged, with respect to integration of the concept in practice (profession).

Three sustainability experts were interviewed to provide feedback and validate the sustainability success sub-criteria framework. The experts were unanimous on the completeness level of the list. There was no comments regarding incompleteness of the framework and inaccuracy of definitions used in the framework. Based on their comments and constructive criticism, a modified framework of sustainability success sub-criteria is presented. This framework answers the first research sub-question *"What are the sustainability success sub-criteria of a highway?"* by presenting a sustainability success sub-criteria framework of a sustainable highway project. This framework also forms the basis of the interview protocol (see D), along with identified critical success factors.

The next chapter elaborates on Cross-case methodology used for this research.

Chapter 4

Cross- Case Methodology

This chapter elaborates on the selected qualitative research methodology. First section, gives an overview of cross-case qualitative approach. Second section further elaborates on qualitative nature of this study. This section provides an overview of interview protocol used for semi-structured interviews. The third section describes the type of respondents and states the profile of selected respondents. Fourth section elaborates on the different highway cases studied in this research.

4.1 Introduction to Cross-Case Approach

From a considerable amount of time, researchers have showed great interest in studying multiple individual cases. One aim of studying multiple cases is to increase generalizability, reassuring that the events and processes in one well-described setting are not wholly idiosyncratic. At a deeper level, the aim is to see processes and outcomes across many cases, to understand how they are qualified by local conditions, and thus to develop more sophisticated descriptions and powerful explanations (Miles & Huberman, 1994). In context of the cross-case examination, Eisenhardt (1989) mentions "the tactic used is to select categories or dimensions, and then to look for within-group similarities coupled with inter group differences". There are two fundamental reasons to do a cross-case analysis (Miles & Huberman, 1994) - **To deepen the understanding and explanation from the cases** and **To enhance *generalizability***. Both these fundamental reasons reflect in problem statement (see 1.2.4) and objective (see 1.3) of this research. Based on this, cross-case methodology is selected for this research. research aims to explore the recent nature of sustainability as a project success criterion and to identify CSFs with the help of in-depth information provided from sustainability oriented highway projects.

To deepen the understanding of different cases, conducting qualitative interviews can be one of the means to realize this aim. The reasons for this choice and selection of a type of qualitative interview is elaborated in the below section.

4.2 Qualitative Interviews

Qualitative interviews are aimed at achieving the complete information. This method is particularly useful as the interview questions are crafted for the interviewees so that the interviewer get depth in the

collected information. The interview is designed such that it permits the reader to be better informed about the experiences of the respondents (Weiss, 1995). This method provides better insight into practice as opposed to the quantitative approach, which would be restrictive in nature (Weiss, 1995). To provide a coherent and dense information set, as much information as possible is collected from the interviews.

There are three types of qualitative interviews: structured interviews, semi-structured interviews and open interviews. Structured interviews are used when the researcher already knows a lot about the topic. Almost all possible responses are categorized beforehand and the only goal is to count how many respondents fall into each of predefined categories (Leech, 2007). This is the journalistic approach where close-ended questions are asked. Important responses can be negated or omitted if one assumes to be over familiar in a domain and thereby ask the wrong questions in the wrong way (Leech, 2007).

On the other hand, semi-structured interviews and open interviews are like informal conversations, where the topic of conversation can also change as the interview progresses (Leech, 2007). When the interviewer has less knowledge about a particular topic and wants to further gain an insider perspective, these "soaking and poking" experiences are most appropriate (Leech, 2007). These types of unstructured interviews are like informal discussions between the interviewee and the interviewer. A downside of such interviews is that, it may wander in any direction and lose sight of the objective for which the interviews are conducted.

Based on the recent nature of the concept of sustainability in project success domain, semi-structured interview approach is chosen. The interview, though, semi-structured in nature, has to be designed such that it follows a designated path. The questions for the interview would be derived based on the findings from literature review, organization overview and outcome of exploratory interviews. Another important aspect to be considered while designing the interview questions is that the interviewee should feel comfortable while answering. There is a striking difference between posing a "why" question and a "how" question. In a "how" question, the interviewer expresses his/her views more freely and independently in comparison to a "why" question which creates defensiveness on the part of the respondent (Becker, 2008). The interview should be designed in such a way that the line of inquiry is followed (using "why" questions) and the same time posing "how" questions leading to more friendliness and openness in the interviews. The next subsection would elaborate on this by providing an overview of developed interview protocol.

4.2.1 Interview Protocol

The interview protocol is divided into three parts. The first part consists of introduction of interviewee and a short exercise to identify sustainability success sub-criteria in his/her highway project. The second part consists of semi-structured questions revolving around the critical success factors categories (see 2.3.2). The second part ends with a series of open-ended questions. Third part consists of another short exercise, where the interviewee cross verifies the stated success factors in the interview and ranks them based on his/her professional opinion. At the end of the interview, the interviewee is asked to state any success factors that he/she thinks are missing from the proposed framework.

Part 1: Introduction and Sustainability Success Sub-Criteria Exercise

The interview begins with brief introduction of the interviewer and his research. Followed by permission to record the interview, ensuring anonymity of interviewees and asking for acceptance of interview transcript. Personal information of the interviewee, such as name, educational background, professional role

within the public project delivery organization, total years of experience in projects, years of experience in highway project and years of experience as an IPM role in the organization was asked.

After the introduction, an exercise is carried out in which the interviewee is asked about the sustainability success sub-criteria or sustainability themes present in his/her highway project. First the interviewee is explicitly asked about the sustainability success sub-criteria or sustainability themes present in his/her highway project. After his/her response, the validated list of sustainability success sub-criteria (see 3.4). The overlap of interviewee's answer and the theoretical list is acknowledged, by marking sustainability success sub-criteria in the given framework. Subsequently, the interviewee is asked if any sustainability success sub-criteria is missing in the given framework. Lastly, the interviewee is asked to rank the identified sustainability success sub-criteria on a scale of 1 to 5, based on his professional opinion.

This exercise ensures the completeness of sustainability success sub-criteria framework in practice and provides the interviewee a fun way to start the interview. After the completion of this exercise, the interviewer can focus on marked sustainability success sub-criteria and gather in depth information about the CSFs used in the highway project. This list is not created in a chronological order based on sustainability dimension, this is done to **minimize the bias nature of interviewee**. This exercise also helps to **reduce the probability of confusion between sustainability success sub-criteria and critical success factor for sustainability** among the interviewees.

Part 2: Semi-Structure Interview Questions and Open-Ended Questions

The second part of the interview protocol focuses on questions formulated to identify critical success factors in the highway project. The success factor categories are used to place specific questions which revolve around specific CSFs which fall under that category. For instance, under the catory of *Project Characteristics* project external factors, main drivers behind the project and scope related questions are asked. The order of these categories/questions is described in appendix D. The order of the categories is not fixed, since it is a semi-structured interview and depends on the answers of the interviewees. A set of open-ended questions is asked at the end of this section, with the aim to identify main problems for achieving sustainability success sub-criteria and identification of CSFs which must be used to tackle such problems.

Part 3: Critical Success Factor Exercise

Similar to the exercise carried out in part one, in final part of the interview protocol, the interviewees are asked to **verify** the success factors which he/she stated during part 2 of the interview protocol and also **clarify** the CSFs, if any were missed during the interview protocol. After identification of CSFs, the interviewee is asked if there any CSFs missing in the proposed framework (see in appendix D). Finally, the interviewee is asked to rank the identified CSFs on a scale of 1 to 5, based on his professional opinion.

The interviews were recorded by the interviewer and transcribed. While transcribing qualitative data, there can be problems of perceptions of what is said by the interviewee and (what is) perceived by the interviewer. Thus, in order to eliminate this bias, the interviewer sent the summaries of the interviews to respective interviewees to gather their feedback and correct any misinterpretations.

4.3 Type of Respondents

The selected data-set for conducting interviews is important for the richness of the information that is obtained. Selecting the appropriate panel of respondents or interviewees plays a crucial role in the kind of information which would be made available. There are broadly two categories of interviewees:

1. Panel of knowledgeable informants or experts- These professionals are knowledgeable informants or experts in a particular domain. As the name suggests, these possess unique and in-depth information about a particular area (Weiss, 1995). The actual role of the expert interviews in any research design might vary from case to case, but there are still a number of common, practical reasons for their popularity in research, one significant reason being, a a more efficient and concentrated method of gathering data than participatory observation or systematic quantitative survey (Bogner et al., 2009).
2. Sample of representatives- This type of interviewees are chosen in case of an event or a situation, where the affected set of people who (taken together) display what happens within a population (Weiss, 1995).

This research uses both type of categories, whenever required. The criteria for selection of respondents is explicitly stated in the different sections of this report, whenever a choice is made. This section focuses only on selection of respondents for cross-case methodology and analysis. IPM roles are senior managers who are not necessarily experts. These roles play a significant role in achieving success of a highway project (see **??**). From outcome of exploratory interviews, it is clear that IPM roles are getting affected by sustainability in projects. Thus, the five fundamental IPM roles provide the right platform as a sample of representative to identify CSFs which could impact sustainability success criterion of a highway project. The selection of respondents must satisfy a criterion, which is: IPM roles must be part of the studied highway project during its exploration and planning phase. For cross-case methodology,

TABLE 4.1: Selected IPM roles for Interview Protocol

IPM Role	Case C (A58)	Case B (A16)	Case A (A1/A6)
Project Manager		X	
Project Control Manager	X	X	X
Project Environment Manager		X	X
Technical Manager	X		X
Contract Manager		X	X
Plan-study Manager	X		
Innovation Manager	X		

one respondent per case is mandatory and three respondents per case are sufficient to provide an unbiased narrative of a case. Based on availability of case studies and IPM roles, four respondents per case have been selected for the semi-structured interview protocol (see table 4.1). This is considered as a "good" number of respondents per case. IPM model consists of five and sometimes more roles depending on the project size and complexity. There are at least two different respondents who represent one fundamental IPM role, except for the role of project manager. The two extra IPM roles are assumed to provide enough experience and expertise for comparison with other fundamental IPM roles.

The details of respondents such as Educational background, Professional role within organization, Experience in projects, Experience in highway projects and Experience as an IPM role for each case study is tabulated in tables 4.2, 4.3 and 4.4 respectively.

TABLE 4.2: IPM role profiles for A6 highway project

Name/IPM Role	Educational background	Professional Role within RWS	Experience in RWS projects (in yrs)	Experience in highway projects (in yrs)	Experience as an IPM role (in yrs)
IPM 1	Civil Engineering/Concrete Mechanics (TU Delft)	Contract Manager	26	25-26	10
IPM 2	Civil Engg in TU Delft	Technical Manager	16	9	9
IPM 3	Physical Geography	Project Control Manager	10	5	5 (also PM for a water project)
IPM 4	Civil Engineering (Rail, road construction and traffic - TU Delft)	Project Environment Manager	20	20	8

TABLE 4.3: IPM role profiles of A16 highway Project

Name/IPM Role	Educational background	Professional Role within RWS	Experience in RWS projects (in yrs)	Experience in highway projects (in yrs)	Experience as an IPM role (in yrs)
IPM 5	Engineer (Technical Hogeschool Delft)	Project Director	30	10 to 15	8
IPM 6	Civil Engineering and Management	Senior Advisor Project Beheersing	18	13	10 (sometimes also as CM)
IPM 7	Technische Bedrijfskunde (Civil Engineering)	Contract Manager	15	15	10 (PM -1, MPB - 4, CM -5)
IPM 8	Civil Engineering (specialized in spatial planning)	Project Environment Manager	10 to 12	10 to 12	10

TABLE 4.4: IPM role profiles of A58 highway project

Name/IPM Role	Educational background	Professional Role within RWS	Experience in RWS projects (in yrs)	Experience in highway projects (in yrs)	Experience as an IPM role (in yrs)
IPM 9	Civil Engineering and Management (University of Twente)	Works in SWECO (Smart Mobility Department); (temporary part-time employee since December 2016)	17	17	7 as Innovation manager (PEM and TM for RWS projects also)
IPM 10	Two Master degrees – Planning and Economic Geography (University of Groningen)	Project Control Manager	Around 9-10 years	2	1.5
IPM 11	HTS	Technical Manager	37	37	11
IPM 12	Spatial Planning	Plan Study Manager	25	20	15-17 (PM - 10 to 12; PEM - 5)

The next section elaborates on the cases selected for this research.

4.4 Case Studies

Case studies help researchers to compare and increase generalizability, through events and processes in one well-described setting. The aim is to see processes and outcomes across many cases, to understand how they are qualified by local conditions, and thus to develop more sophisticated descriptions and powerful explanations. Case studies provide means to verify findings from literature. For conducting a cross-case study, a minimum number of two cases are required (Miles & Huberman, 1994). Based on the availability of cases and to have a decent number of cases to conduct a cross case research, three cases were selected. These cases are three different highway projects of the public project delivery organization, which are oriented towards sustainability.

Extensive document review was conducted to identify sustainability themes (or) goals (or) ambitions of selected highway projects and subsequently look for used CSFs. It is important to note that the document review of the highway projects was done prior to conducting interviews. This was done to

verify or clarify the findings from the case studies. Through this, misinterpretation of information is minimized. The three cases are presented in the below subsection.

4.4.1 Case A - Project A1/A6 (Diemen to Almere Havendreef)

Rijkswaterstaat will expand the connection A1 / A6 between Diemen to Almere Havendreef until 2020. The work on the A1 / A6 is part of the Schiphol-Amsterdam- Almere (SAA) road expansion project. Additional lanes will improve the flow, and thus the accessibility of the northern Randstad region.The project A6 Almere is an important link in the total traffic system in the corridor SAA (see fig 4.1), being close to both the A1/A6 and the A27, and local and provincial roads such as the Waterlandseweg (N702). Additionally, the livelihood of the area has also increased. The idea is essentially to move the A1 at Muiden and build the widest aqueduct of Europe.The focus on execution involves the following primary aspects:

FIGURE 4.1: Schipol-Amsterdam-Almere (SAA) (taken from (Bezoekerscentrum-Rijkswaterstaat, 2017))

- Widening A1 by 2 x 3 to 2 x 5 lanes and 2 Exchange strips, new connection A9/A1, new bridge Amsterdam-Rhine Canal, new aqueduct, new connection, new railway bridge and Weesp/Muiden extension junction Muiderberg, construction of noise barriers
- Widening A6 to 2 x 5 lanes and 2 exchange strips, new extension node connection Almere Havendreef
- With Almere organizing the 7th Edition of the Floriade in 2022 (under the theme Growing Green City), consistency of the underlying road network is important. Floriade is not only a world-renowned exhibition but also a new green city district. Thus, it is also important that the project is properly fitted into the environment as the A6 (The location of the Floriade site is in the Natura 2000 landscape, to either side of the Highway A6)

Sustainability is an important aspect of the project and is confirmed by the fact that A6 will be operated as energy-neutral confirms. This means that the required energy for the A6 during the realization phase is generated locally by means of renewable energy sources. To elaborate this and other sustainable goals see the following (Bezoekerscentrum-Rijkswaterstaat, 2017):

1. An energy-neutral way: The solar panels in the middle of the junction of the A6 and the A27 (see fig 4.2) create on average almost 1 MW of electricity on. That is enough energy to the electrical systems for the road management, lighting, traffic control and signs. The photovoltaic field is expected to contain about 4,000 to 10,000 solar panels.

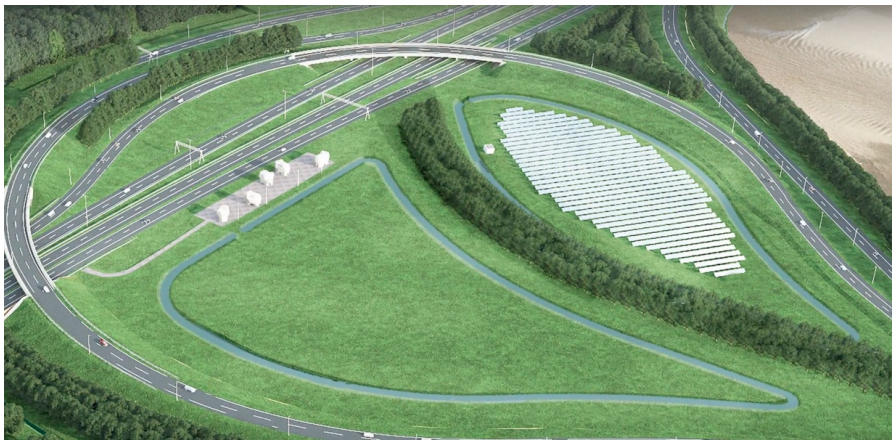


FIGURE 4.2: Location of solar panels in between A6 and A27 (Bezoekerscentrum-Rijkswaterstaat, 2017)

2. Energy savings of 15,048 (tonne of oil equivalent) in 50 years. This is equivalent to 15,355,000 litres of diesel.
3. A reduction of 52,800 tons of CO2 emissions in 50 years. This is equivalent to the emission of 6600 households in a year.
4. An innovative asphalt saving construction (39,900 tons). As a result, the number of asphalt transports is reduced by 2,660 movements.

4.4.2 Case B - A16 Rotterdam

Department of public works (Rijkswaterstaat) made a new highway between the A13 at Rotterdam The Hague Airport and the A16/A20 at the Terbregseplein. The 11 km long A16 Rotterdam ensures that the traffic on the A13, A20 and surrounding local roads can be reduced. The new connection contributes to better accessibility and livability of the region (Lansingerland and northern edge of Rotterdam). The construction is expected to start in 2019. In 2024 the road is open to traffic citepA16.

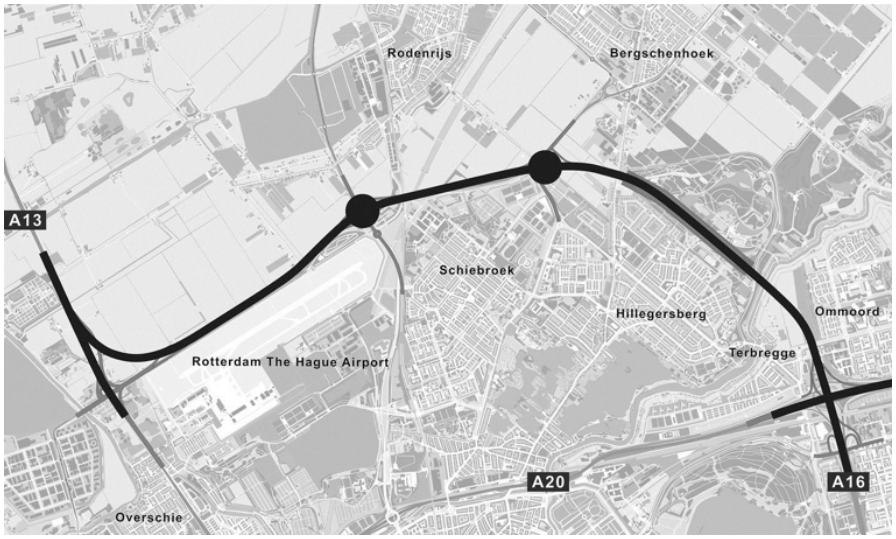


FIGURE 4.3: Location of new A16 Rotterdam (Rijkswaterstaat, 2017a)

The A16 Rotterdam is a new motorway connection towards the northern part of Rotterdam city. The A16 Rotterdam will replace the current provincial N209, where the location of the A16 Rotterdam coincides with the current N209. The A16 Rotterdam will close on the route at 4 locations on the underlying road network (see fig 4.3). At the exit of the current A13, at the current connection Berkel/Rodenrijs (at the junction with the N471) and at the Ankie Verbeek Ohrlaan (junction with the N209). In the interchange Terbregseplein connections are included with the main road. The number of lanes of the A16 Rotterdam is on almost the entire route 2 x 3; the tunnel share has 2 x 2 lanes with space reservation for a third strip. Between the N471 and the Ankie Verbeek-Ohrlaan, due to the short intersecting in and outbound roads, the number of lanes on this route is four.

What is going to happen?

- There will be a new highway along the north-eastern edge of Rotterdam. Driving speed is up to 100 km/h.
- The A13 and N209 at Rotterdam are adapted and connected to the new A16.There are connections to the N471 and Ankie Verbeek-Ohrlaan.
- The Terbregs square is also being adapted and connected to the new highway.
- In the Lage Bergse Bos, construction of a deepened tunnel, passing through the Rotte and Grindweg.
- To avoid noise pollution due to traffic, the A16 uses additional noise-suppressed asphalt (two-layer). There are also sound barriers and embankments.
- The road is optimally integrated into the landscape. Adjacent areas such as the Terbregseveld, Vlinderstrik and Lage Bergse Bos are refurbished and connected to cycling and hiking trails.

What does it deliver?

1. Better flow on the A13 and A20 highways at Rotterdam, improving road use and decreasing traffic.
2. Less traffic on local roads, which contributes to better living ability.
3. Better accessibility of the Rotterdam region, possible improvement in economy.

4.4.3 Case C - InnovA58

The A58 connects to Tilburg, Breda, Eindhoven, Hertogenbosch and Helmond and other regions such as Amsterdam (Airport Schiphol), Rotterdam (Mainport Rijnmond) and Eindhoven (Brainport South-East Brabant). In addition, the A58 is an important connecting road to the neighbouring countries. There are regular traffic jams on the A58. This results in major economic damage. Also, the traffic jams lead to inconvenience of traffic jams in village centres. In November 2015, the Minister of Infrastructure and Environment, chose to broaden parts of the A58 from two to three lanes, InnovA58 project focuses on the widening of the A58 between Sint-Annabosch and Galder and between Eindhoven and Tilburg (see fig 4.4).

The main project objectives are:

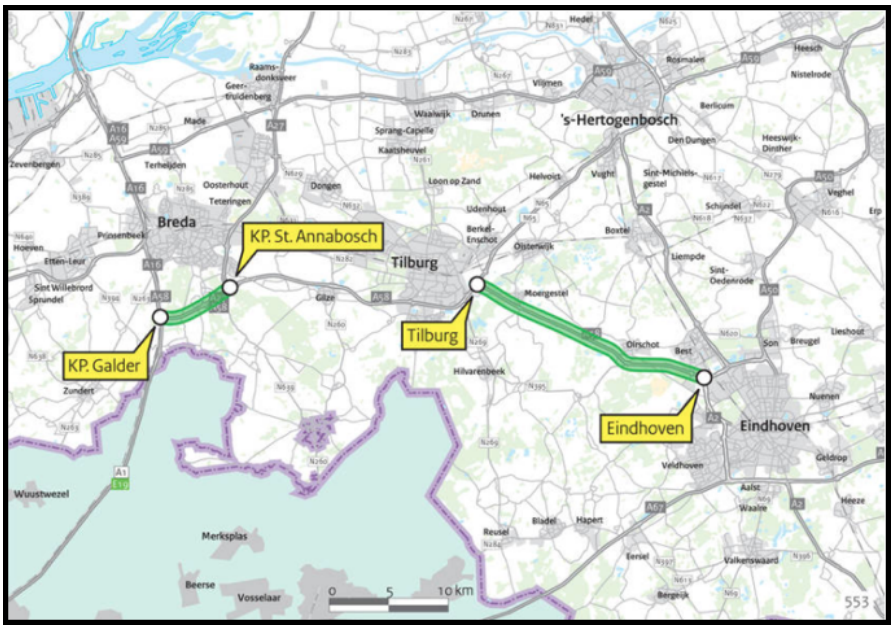


FIGURE 4.4: Widening of the A58 between Sint-Annabosch and Galder & between Eindhoven and Tilburg (Rijkswaterstaat, 2017b)

- Widening of the A58 between the Sint-Annabosch and Galder junctions and between Eindhoven and Tilburg from 2x2 to 2x3 lanes, including measures at the junctions Ekkersweijer, Batadorp, the Baars, St. Annabosch and Galder and the roads.
- The TB procedure is also established through participation of interested parties. InnovA58 looks for support of the stakeholders for location-specific assignments.
- The A58 always meets the applicable safety standards, principles and guidelines during construction, management and maintenance.
- The expansion of the A58 meets environmental impacts on all applicable laws, standards and guidelines.
- The degree of obstacle during the construction, management and maintenance period is acceptable.
- InnovA58 is given a regional and national image of 'reliable' and 'innovative' in process control.

InnovA58: A smart and sustainable highway Rijkswaterstaat makes the most use of innovation in the widening of the A58. For this innovA58 project has set a number of specific innovation goals. This makes the A58 a smart, sustainable and futuristic highway. InnovA58 focuses on four themes. These themes are in line with the national policy of the Rijkswaterstaat and with the policy of regional authorities (Rijkswaterstaat, 2017b).

In addition to the project objectives, innovA58 also pursue the following (innovation) **ambitions**:

1. The overall mobility between the Sint-Annabosch and Galder nodes and between Eindhoven and Tilburg, including connections to the A16, A27, A65 and A2, is being improved.
2. The flow of the A58 remains the same during construction, management and maintenance.
3. InnovA58 stimulates and implements innovations in life cycle costs (LCC) and total costs of ownership. This leads to a 30 percent cost reduction over current costs for regular management and maintenance.

4. InnovA58 stimulates and implements innovations in terms of sustainability and energy saving. This leads to:
    - a reduction (100 percent) in the use of fossil fuels in the construction phase;
    - fully energy-neutral management and maintenance (CO2-neutral footprint).
5. InnovA58 stimulates and implements sustainability innovations that lead to a lower CO2 footprint in the roadway exploitation phase.
6. Developing a full circular design and formulating a roadmap for further development of circular design of road projects aimed at achieving the government's goals for the circular economy.
7. Developing a "balance zero design" for human and natural critical passages without increasing the environmental impact of noise, particulate matter and NOx in relation to the current situation during the TB procedure. This is also called the balance zero approach, which means the environmental impact of project will be no more than the current situation.
8. InnovA58 stimulates and implements innovations appropriate to the development of climate change policy.
9. InnovA58 is given an international image of "example" and "innovative" in addressing the innovation task and the resulting results.

4.5 Discussion/Conclusion

This chapter described use of cross-case methodology in the context of this research. The importance and advantages of qualitative research and cross-case method are stated. Answer to first sub-research question and identified 28 CSFs from literature are used to formulate the interview protocol.The interview protocol consists of three parts, first part consists of sustainability success sub-criteria exercise, second part consists of "how" and "why" questions to identify CSFs in a sustainability oriented project and third part consists of a CSF exercise. The protocol is briefly discussed in this chapter, for more details see D.

IPM roles of three highway projects are chosen as respondents for cross-case methodology. The profile of respondents is stated in this chapter. Based on requirements of this research, three case studies are selected and elaborated. The three highways consist of sustainable themes/goals/ambitions and it is assumed that these cases could consist of developed list of sustainability success sub-criteria. Twelve semi-structured interviews are conducted with the selected respondents for cross-case analysis. The findings of cross-case analysis are elaborated in the next chapter.

Chapter 5

Cross-Case Analysis

This chapter describes cross-case analysis used in the context of this research. The chapter consists of five sections. First section gives an introduction to cross-case analysis. Second section describes the use of ATLAS.ti - a qualitative data analysis software. Third section elaborates on the first step of cross-case analysis, exploring and describing of data. This is done with formulation of a meta-matrix per case. Fourth section describes the final step of cross-case analysis, ordering and explaining. This section narrates data reduction through use of ATLAS.ti and use of a rule of thumb to identify recurring CSFs across cases. The identified CSFs are deemed Sustainability Success Factors or SSFs. Based on the interview protocol and data collected, inclination of various IPM roles towards sustainability dimensions is identified. Based on findings of cross-case analysis, sixteen Sustainability Success Factors or SSFs are defined in the last section of this chapter.

5.1 Introduction to Cross-Case Analysis

The analysis of the data acquired from qualitative studies depends significantly on summarizing, interpreting and integrating. There are two different ways of analyzing the interviews: issue-focused analysis and case-focused analysis (Weiss, 1995). The issue-based analysis focuses on analyzing and reporting issues as they are learned from the respondents themselves. On the contrary, the case-focused analysis focuses more on the interviewee and his/her specific case (Weiss, 1995). This type of case-focused analysis is useful when insights about the complete case or even parts of the case are to be obtained. The interviews in this research are based to gain insights in project management practice for sustainability by studying three cases, thus case-focused analysis is considered appropriate. Further to this, the focus would be analyzing the data generated from the three cases. In this, the recorded interviews are transcribed in detail and uploaded to a Qualitative Data Analysis (QDA) software as hermeneutic units.

A two step approach is followed for this research, in order to realize the two mentioned fundamental reasons of cross case analysis as stated in 4.1. First step is to explore and describe the individual cases. The first step at cross-case analysis is often exploratory (Miles & Huberman, 1994), the researcher chose to formulate a partially ordered meta-matrix to analyze each case separately while reducing the substantive amount of data gathered. After exploring and describing the data, the next step is to see the outline what the researcher sees as the main issue. Due to the large set of variables obtained from the literature review and semi-structured interviews, variable-by-variable matrix is selected as a way to

order and explain data gathered in the interviews. These will be further elaborated in the upcoming sections.

5.2 Qualitative Data Analysis : Use of ATLAS.ti

The familiarity of the investigator with each case plays an important role while dealing with the cross-case examination. In order to do so, each case is studied from different perspectives, with the help of data generated from interviews. Data analysis is the central theme of an interview. Based on the response received from the interviewees, the investigator analyses the presented data. There are four major components of a QDA (see fig 5.1). The first step into the data analysis is that of transcribing the

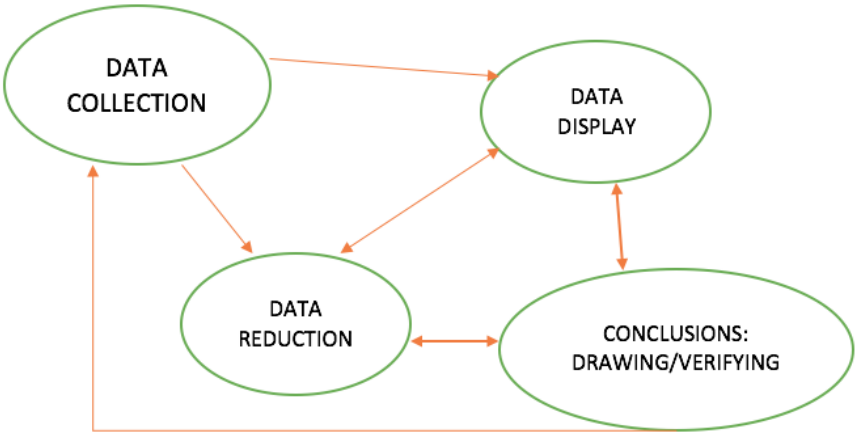


FIGURE 5.1: Components of Qualitative Data Analysis: Interactive Model (modified from Miles & Huberman (1994))

interviews. Once the interviews are taped and recorded, they are subject to transcription. Transcribing is done for facilitating proper flow of information from the interviews. As these qualitative interviews generate volumes of data, the central theme behind this transcription is to make the investigator familiar with each case as a single independent entity. The second step is to use a powerful Qualitative Data Analysis (QDA) software. As the cases are transcribed and through the use of a QDA software, patterns (codes) that are unique to each case become evident to the investigator (Eisenhardt, 1989).

ATLAS.ti is a widely used QDA software which provides some useful tools for academic research (Hwang, 2008). One of these useful tools is coding. Coding is a technique to mark "codes" in the transcript, these codes represent important information that the researcher can use for his/her analysis. Coding helps in establishing link to literature (deductive approach) and identifying raw information (inductive approach). Additionally coding helps in data reduction and enhances data display. Coding is an iterative process and it is used extensively to draw and verify conclusion(s). Concentrating specifically on such codes enables the investigator to identify the key-factors and unique patterns. Thus, this process of coding will be used in upcoming sections for **data analysis**, **data reduction** and **identification of key factors/patterns**.

5.3 Exploring and Describing

The first step at cross-case analysis is often exploratory. Since the first step is exploratory the choice of method to analyze this data does not effect the analysis significantly. There are two ways to explore data in a cross-case analysis, case oriented or variable oriented approach. The nature of this study is predominantly focused on large number of factors and criteria, hence the choice to use variable oriented approach is made. One of the ways to explore data is through formulation of meta-matrices. Meta-matrices are master charts assembling descriptive data from each case in a standard format (Miles & Huberman, 1994). Therefore, formulation of three partially ordered meta-matrices is chosen. These matrices will help to analyze each case separately while reducing the substantive amount of data gathered during each case study. The formulated meta-matrices for this research can be found in appendix G .

The below section provides an extensive example of exploring and describing through findings of a meta-matrix. Based on chronology of this report, case A is chosen.

5.3.1 Case A - Project A1/A6 (Diemen to Almere Havendreef)

Case findings which provide a deeper insight of project A1/A6 (Diemen to Almere Havendreef) are discussed in the upcoming paragraphs. First, the identified sustainability success sub-criteria are described. Subsequently, identified CSFs in each project success category are listed. Finally, main problems, suggestions and key CSFs are discussed.

Majority of sustainability success sub-criteria of case A fall under the theme of **energy neutral highway**, which are visual & experiential sustainability; landscape character; multi-functional; energy efficiency; energy use; energy production; use of non-renewable energy sources, local stakeholder involvement; knowledge exchange and value generation. The solution called **ecosand** concept covers these sustainability success sub-criteria, namely, re-use and use of recycled materials and resources, coordination and collaboration in supply chain; local stakeholder involvement; landscape character, knowledge exchange and value generation. Use of **DBFM** contract and **EMAT** criteria led to identification of frugal and efficient use of materials and resources, construction transport, construction waste & operations and maintenance optimization sub criteria. There is a statue of elephants located close to the highway, which was taken into account while planning the highway, this confirms cultural heritage (archaeology) sub-criteria. Other than these, air quality, soil quality, biodiversity, water quality & hydrological system, toxic materials, human rights & fair trade, noise and critical natural capital were also present, although not as important to other sustainability success sub-criteria. These were considered up to the standards (laws) present in the Netherlands. Traffic level and accessibility were also identified, these are entirely based on calculations done by the organization and/or consultants. Safe mobility is the most important sustainability success sub-criteria for the organization in their highway projects. This makes a total of 28 sustainability success sub-criteria present in case A.

Feelings of the respondents: Case A is a successful highway project considering exploration/planning phase. This reflects in the contracting phase of project, where Case A became the first energy neutral highway of the Netherlands. This corresponds to the high level of accomplishment, ambitiousness and sense of pride among the respondents. Phrases such as *"we are proud we did it"; "we made a system step to our new policy"; "ours is a special project"; "we recently were awarded the PROCURA award"; "our minister liked it"; "the project started three years ago and by then our wishes were not very high, in the end we did it".*

CSFs related to Project Characteristics : All the respondents talked about *"Koers 2020"*, which is a recent Rijkswaterstaat policy aimed at sustainable goals for the next decade, this is explained in the phrase *"our minister promised all RWS works (roads, locks, bridges, everything) to be energy neutral in 2030"*. This policy reflects the aim of Dutch government to contribute to sustainability goals of European Union (*"because of recent climate change agreement"*). Municipality of Almere is another external factor which was stated many times by respondents. TM, CM and PEM confirm this in their statements *"the local government wants it", "Almere wants it", "Floriade is also there"*. The municipality of Almere wants to have a *"green city image"* and this has helped the highway project in getting major support from muncipality of Almere. CM and PEM respectively state *"We had discussions on table, with contractors and municipality"; "they came forward in our discussions and sat with us on table""*. With regard to scoping, CM explicitly stated *"we defined it based on formats based on mother company GPO"*. These examples confirm the presence of awareness of project external factors, awareness of project nature and clearly defined scope as CSFs used in case A. Three respondents, namely CM, PEM and PCM ranked these factors are most important in the CSF exercise.

CSFs related to Project Management Processes: PCM stated *"I have a team, who does WBS, Risk Management, Quality control etc"; "I am responsible for information management, not coming up with information, this other roles have to do; I help in distribution of information"*. Other roles also stated *"We had a strong MPB"; "MPB monitors us"; "she checks on the risks and our progress"*. This confirms use of CSFs, namely, risk management, monitoring and control, information sharing within the project team. For CM, risk management is carried out in the form of EMAT procedure, this will be elaborated in upcoming paragraphs. In context of information sharing CM stated *"land use plans are needed before planning for a solution on land, we need to check with law, to use solar panels or a wind mill"*, by this he also explained the importance of PEM in arranging the necessary information for him and other IPM roles to do their job. TM said in context of quality assurance & health and safety considerations, *"I have two main goals: ensure quality and ensure safety (safety of drivers,people"*. In context of learning from current and past experiences, PEM stated *"we tell about, how we did it, what worked and what not worked"*, he also stated *"I am not sure if other IPM teams would come"; "we could do that more actively but we are not sure that other IPM teams would come"; "we do that not very frequently within RWS, can be a lot better"*. There was no evidence of a clear organization structure for sustainability, respondents state *"we do it together; not one mans job; sustainability is very broad"*. It is important to note, CSFs such as information sharing within project team, risk management and quality control are responsibilities of PCM, but these are done in co-ordination with other IPM roles, through weekly or bi-weekly meetings with PCM or one of his/her team members.

CSFs related to Contracting: CM stated *"DBFM and EMVI criterion"; "the specification of a energy neutral road"*. When asked about other contractual agreements, he responded *"There are no others, for sustainability. Because of legislation, when you say this is the legislation, they (contractors) would meet the minimum level. They will not do anything extra. But when there is an EMVI criterion, they will deliver some extra"*. All respondents state DBFM being advantageous for sustainability as well as the client, statements which support this are *"DBFM helps in sustainability"; "he (contractor) does it for long time; the contract is for 20 years"*. CM stated risk management is carried out with the help of EMAT criteria, *"EMVI consists of 30 percent of total value, we give 10 percent of that to sustainability"*. These statements confirm importance of choice of selecting a proper contracting strategy and tender process. With respect to proper selection of contractor, CM stated *"that is no problem, they all can do it"*. It is important to note that CM had the most knowledge about contracts and the contracting process, other respondents also confirmed this by stating *"talk to CM for more details"*.

CSFs related to Leadership and Team: In context of top management support, CM and PEM stated *"That was very high, because our minister wants to have the first road which is energy neutral"; "4 years ago they were not very supportive in my opinion but later on, the policy of the ministry changed"*. In the same context, TM stated *"on a higher level, if people say we have to do that (sustainability), there are more possibilities for us"*. For collaboration with project parties, CM stated *"I do not have all the answers I need to ask others (experts within or outside RWS)"; "partner nature of Municipality of Almere"; "have an OPEN approach than a closed approach"; "dont say NO too early"*. PEM also stated about collaboration with statements like *"who (municipality of Almere) later become our partners"; "we hired an architect to give us some advice about solar panels"*. In context of project team competency, TM stated *"we have OM and CM who also have a technical background - easier to communicate"*; PCM stated *"I coordinate the weekly meetings"; "I prepare the agenda"; "when a role is not on track I tell him LOOK you are running late"*. Each respondent stated that the IPM team was a *"good team"*. In context of competent project manager, TM and PEM stated *"The fact that our PM stated the idea of sustainability way earlier helped us"; "she is a strong woman with a wide network"*. There were no statements supporting early manager involvement, training provisions and integrated project team between client and contractor.

CSFs related to Stakeholder Engagement: CM stated *"early involvement of Municipality of Almere"*. TM stated *"we need to check with stakeholders (about land use plans) before you think about a solution (wind mills or solar panels)"*. PEM stated *"We had support from local government; Our PM was in talks with the minister, she did a lot of advertising and that helped in more involvement of our minister"*. All roles stated the municipality of Almere as an *"important stakeholder"* for inclusion of sustainability in the project. It is important to note that involvement of stakeholders was considered the responsibility of PEM, the statements *"OM talks to them in early phases"; "OM is regularly involved"; "he gets the support for the project"* confirm this.

CSFs related to Policy and Strategy In context of clear goals, TM stated *"saying to contractor we need energy neutral highway was too broad, we had to establish the energy demand first"*. PCM stated *"I need clear goals to carry out my tasks"*. CM stated *"when you know upfront the contractor can make the design"*. PEM stated *"It should always be part of the OPDRACHT, that is very important"*. It is important to note that clear goals are important to all respondents based on their profession. In context of planning, PEM stated *"We started it early in the discussion, planning was smooth"*. However CM stated *"there are strict regulations of RWS for innovations, lot of checks are required"*. The three respondents stated PCM carries out planning and ensure that they work within time and budget. PCM explicitly stated *"my team carries does planning; I monitor progress, we ask the IPM roles how much time and money they need; after discussions with TM/OM I discuss with PM if we can have the resources on time/within budget"*. This shows that PCM was responsible for planning. TM, CM amd PEM stated about rules and regulations of Rijkswaterstaat and its effect on choices of solutions for the sustainability. TM gave example of *"ecosand solution"*, in which the proposed solution could not be implemented on land owned by Rijkswaterstaat due to certain laws. However after discussions with municipality of Almere, this solution was decided to be implemented on land owned by municipality, since they had more flexible laws. As stated above, CM talked about various "checks" that are needed for sustainability. PEM stated *"there is a RWS internal website, lot of best practices and rules that we have to follow, unless we have good arguments"*. He further explained when something is not done before, the organization tends to be conservative about it and that causes a lot of discussions. This confirms the importance of legal and administrative processes for sustainability.

CSFs related to Resources: In context of use of innovations, TM stated *"mostly innovation has its risks and the risk we (RWS) don't want to take"*. PEM stated the use of DuboCalc and CO2 ladder

as new tools used in this project. CM stated *"invest more in the beginning, it is possible to achieve a energy neutral highway, we proved it"*. PEM also stated the importance of budget *"despite sustainability demands, the budget was still very important"*. The above statements confirm the importance of adequacy and efficiency of resources as a CSF.

Main problems and suggestions:

CM stated no problem for sustainability, he thinks of it as a challenge. He suggested to have an "open approach" to it and an ambitious nature. He stated *"be open, work together not against"; "have ambitions don't think it terms of risks but chances"; "not saying NO too early"*.

TM stated *"new things are difficult"; "I have ideas but I don't know how much it costs beforehand"; "because we have a big organization, someone wants to know everything. We have to talk, about permits, rules, regulations. So we check, check and check, until the contractor can use that idea"; "if it is extra (more than law) then he (minister) says well I don't want extra things, just do the things we have to do and not more than that"*. He suggested *"have discussions with client"; "convince him/her that it will be cheaper in the long run"; "when there is someone on a higher, at the government who says we want this goal, we want to do it better, there are more possibilities for me"*. The above statements suggest TM has interest in designing practical sustainable solutions for the highway project.

PCM stated*"no problems for my role"* and suggested *"more communication"* of other IPM roles with him/her and among each other to better achieve sustainability. PCM also stated involvement of stakeholders and collaboration with project parties as important factors for project success.

PEM stated *"Ah, the cooperation of the stakeholders is very important and luckily they did cooperate, even stimulate in the case of Almere"; "what also influenced the process was the standards within RWS"; "there was a strict budget about energy neutrality and we had to prove that and as I told you, we could prove that with business case and the fact that we had a DBFM contract, that helped"*. PEM suggested *"rules we have to follow, unless we have good arguments; It should always be part of the OPDRACHT, that is very important"; "more communication and lesson learned, we do that not very frequently within RWS, can be a lot better"*. For exploration and planning phase PEM suggested *"at this moment in time, you need some budget to investigate things, lot of sustainability themes are developing very fast"; "we need some budget to make it practical in our projects"*.

New CSFs: Through inductive coding and answers to the final exercise of interview protocol, new CSFs emerged. The CSF **affinity towards sustainability** was noted in respondents CM, TM and PEM. These three roles show ambitious nature, interest in sustainability and a personal driver for achieving sustainability. This can also be noted in their statements above. CM explicitly stated *"Be ambitious, don't think in terms of risks but chances; open & ambitious team; presence of extroverts"* for achieving sustainability in highway projects. Apart from this, TM stated *"Generating value"* as a CSF, this suggestion was made in context of generating a sustainable value for stakeholders.

The above case shows presence of 28 sustainability success sub-criteria. The above findings confirm use of CSFs from developed framework of 28 CSFs. Importantly, it is interesting to note inter-relationships among CSFs and use of CSFs by particular IPM role(s). CM, TM and PEM agreed to consider sustainability in their professional role and PCM disagreed to any effect of sustainability on his/her professional role. All roles implied achieving sustainability as a team effort and not a responsibility of a single IPM role. In a similar way, data from meta matrices of case B and case C are used to identify sustainability success sub-criteria and provide in depth case knowledge to identify CSFs. Close attention is paid to

CSFs and their use by IPM roles. The next section elaborates on ordering and explaining such findings across the three cases.

5.4 Ordering and Explaining

After exploring and describing the data through means of meta-matrices, the next step is to see the outline of the data to interpret the main issue(s). As defined by Miles & Huberman (1994), a series of important working principles must be followed: Understand the case; Avoid aggregation; Preserve case configuration; Combine variable-oriented and case-oriented strategies; Inquire into deviant cases; Look for typologies,case families; Avoid forcing. This is done to enhance generalization without changing the original and distinct context of a studied case.

5.4.1 Data Reduction

Miles & Huberman (1994) also state counting as an effective technique to draw conclusions from qualitative research. The supporting reasons behind use of this approach is: to identify patterns quickly in a large data set; to verify hypothesis and protection against bias (being analytically honest). Qualitative research generates a substantial amount of data, to be interpreted and analyzed. Thus one of the major component of QDA is to reduce data, as stated in fig 5.1. Based on above mentioned reasons, identified CSFs in partially ordered meta-matrices are first analyzed by counting. This will help in reduction of data and make a clearer data display.

Use of Coding Technique: The identified CSFs were coded by a combination of inductive and deductive approaches. In deductive coding, existing theoretical framework of CSFs was used for identification of CSFs in the case studies. The third review of transcripts focused on inductive coding, to identify new CSFs from raw information. Based on three reviews of each transcript, the frequency of occurrence of identified CSFs through deductive coding is illustrated in fig 5.2. Use of ATLAS.ti and three reviews of each transcript helped to **minimize repetition** of CSFs identified in the same project success factor category per case study. The new CSFs identified through inductive coding are as follows: affinity for sustainability (10); expectations management (5); timely involvement of stakeholders (6); presence of ambitions (4); appreciation of success (4); project team early involvement(3); showcase of technology (2); awareness of legal and administrative processes (1); delivering/creating value for stakeholders (1) and extrovert nature (1). The number in parenthesis represents the number of respondents who stated these CSFs.

After formulation of meta-matrices, the amount of information is still large and needs further reduction for generalization across the three cases. To focus on the most important and recurring CSFs across the three cases, a rule of thumb is followed.

Rule of Thumb: For identification of a CSF which is present in all three cases, a rule of thumb must be developed apart from observations from frequency of occurrence of codes. This rule of thumb rule will act as means to filter and reduce data. Keeping the above stated principles in mind, the rule of thumb is defined as: **Majority of respondents (75 percent or more)** must state a CSF, for it to be considered in next phase of qualitative data analysis. This would ensure that a CSFs is present in all the three cases and is also considered "critical" by majority of respondents in each case. Based on these reasons, at least 9 respondents must state a CSF.

FIGURE 5.2: Frequency of Occurrence of Critical Success Factors using ATLAS.ti

With the help of above stated rule of thumb, CSFs are filtered. It is important to note that, there can be CSFs which are present across the three cases and are stated by minority of respondents. In such a situation, that would be the case of a success factor present across the three cases but not a "critical" success factor for the respondents. Therefore, the list of CSFs which satisfies the above mentioned criterion are *awareness of project external factors; clearly defined scope; information sharing within the project team; proper selection of contracting strategy and tender process; monitoring and control; risk management; collaboration between project parties; competent/multidisciplinary project team; top management support; client involvement; early involvement of stakeholders; clear goals; legal and administrative processes; systematic planning; adequacy and efficiency of resources; affinity for sustainability.* These 16 CSFs are deemed as CSFs which reoccur across the three case studies and are named the **Sustainability Success Factors** (SSFs). At the end of this chapter, based on further data analysis, the definitions of SSFs would be provided, based on examination of SSFs in terms of their meaning and intention.

5.4.2 Inclination of IPM roles to Sustainability dimensions

Exercise conducted in part one of the interview protocol (see D) is elaborated in this section. Apart from identification of sustainability success sub-criteria, the exercise also helped to rank sustainability success sub-criteria according to the importance level perceived by an IPM role. Sustainability success sub-criteria which were ranked as 4 (important) and 5 (very important) are considered only. The exercise framework consists of 30 sustainability success sub-criteria, out of which 13 belong in planet dimension, 10 belong in people dimension and 7 belong in prosperity dimension. A simple tool in excel is developed to calculate the percentage of inclination of high ranked sustainability success sub-criteria. The results

are visualized in the form of pie-charts. Beside these findings, coded data from transcripts is used to interpret the observations. These observations show the behaviour of IPM roles, based on sustainability dimensions and use of CSFs. Such observations are elaborated in detail in the following paragraphs.

5.4.2.1 Inclination of a PM

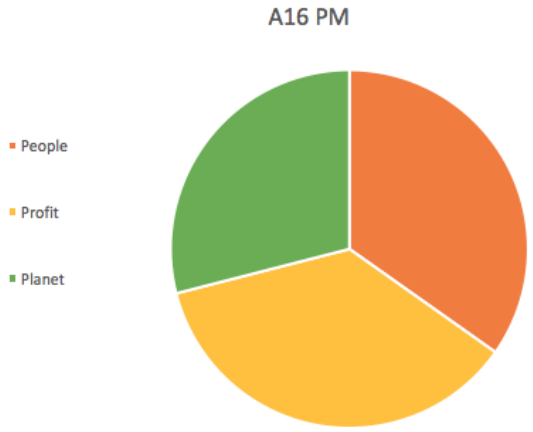


FIGURE 5.3: Inclination of a PM to sustainability dimensions

During the exercise, it was interesting to note that not all sustainability success sub-criteria were identified, but among the identified ones, almost equal number in each dimension were marked important. The fig 5.3 clearly depicts this balanced approach towards the identified sustainability success sub-criteria. According to the IPM model, a PM is the *spider in the web*, which states he is involved and connected with all IPM roles. He is responsible for the overall success of the project, thus all success criteria must be equally important for him/her to ensure project success. Respondents also said in context of PM's role, that he/she has a *helicopter view of the project; PM is responsible for everything; he cannot be biased towards a single goal; our PM made sure we had it (sustainability) in our project.* These confirm the "helicopter view" and "spider in the web" nature of a PM towards sustainability. An ideal PM will not have a biased view or a particular inclination towards a sustainability dimension. Therefore, for a PM all three dimensions of sustainability are equally important for his/her highway project.

5.4.2.2 Inclination of PEMs

Both the PEMs show comparable pie-charts (see fig 5.4), which are more inclined towards the planet and people dimensions. This corresponds to networking skills and project environment consciousness as stated in 3.1. From PEM interviews, use of phrases such as *"cooperation with stakeholders is very important for me"; "I arrange approvals/permits"; "they must be happy, remain happy"; "reduce disturbance for people living close to highway"; "strategic omgevings management is carried out by OM"* confirm a society oriented role of a PEM. "zero" inclination to prosperity dimension of PEM (A16) can be attributed to the low number of identified sustainability success sub-criteria and subsequently low rankings given during the exercise.

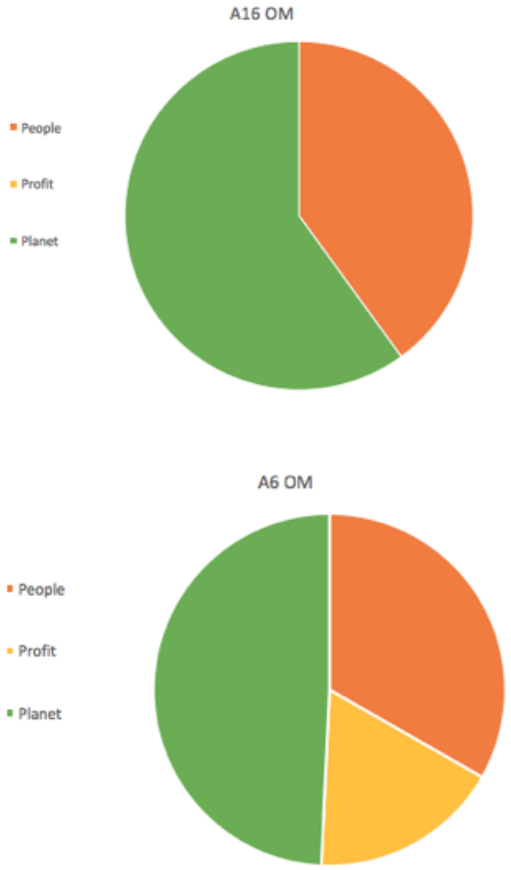


FIGURE 5.4: Comparison of inclination of PEMs to sustainability dimensions

5.4.2.3 Inclination of CMs

CMs show slightly different pie-charts (see fig 5.5). CM (A6) is more inclined towards the prosperity dimension whereas CM (A16) shows a almost balance approach. CM (A16) has professional experience of two different IPM roles (other than CM) in the past, this could be one of the reasons why the respondent shows a balanced approach towards sustainability dimensions. Based on response to the question, whether sustainability has effected your professional role, CM (case A) responded *"a little bit, because you have to have more dialogues with all the parties, also with the municipalities"*. Both CMs stated, it is more responsibility of PEM and TM (in exploration and planning phase) to ensure sustainability requirements in the TB procedure, after that it is CM's responsibility to ensure sustainability is part of the highway project. As stated in 3.1, a CM must exploit the capabilities of the market. statements from CM interviews such as *sustainability pushes the market to make innovative solutions; it (sustainability) is not impossible, but a challenge for them (contractors)* confirm that market can be exploited if sustainability is part of the project. Statements such as *"it is my responsibility to make sure (sustainability) is in the contract"; "it (energy neutral) can be done, already proved"; "for it (sustainability) to be realized, it has to be in our contract"* state that CM uses contract as means to integrate sustainability in the project. Various IPM roles talk about EMAT criteria as being responsible for successful inclusion of sustainability goals/ambitions. CMs state risk management is carried out in the form of contract, if it is a DBFM contract then the contractor is responsible for a longer duration. This reduces the risk on the client as well as the society, making it a win-win situation. Based on above statements, for improving the chances of project success for sustainability, sustainability success sub-criteria must be part of the

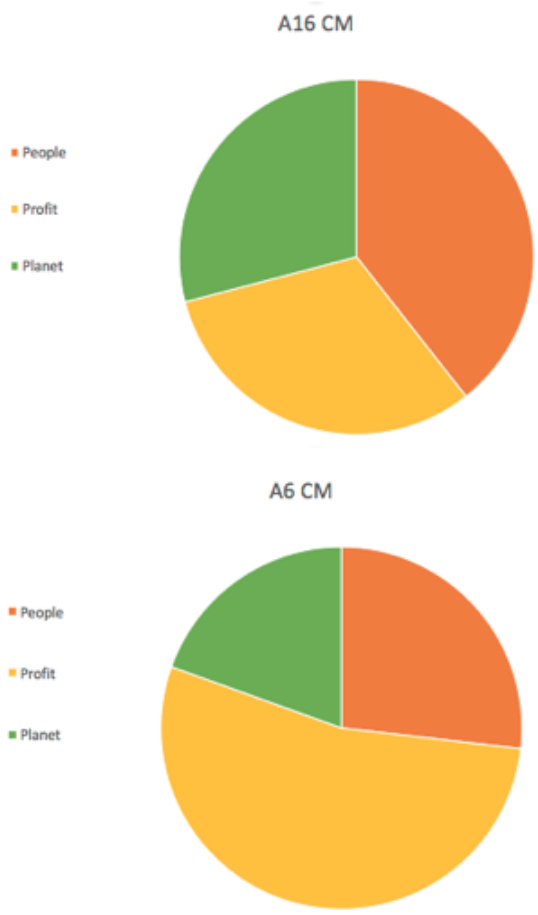


FIGURE 5.5: Comparison of inclination of CMs to sustainability dimensions

contract in the form of "requirements". This increases the chance of sustainability being an integral part of project, until realization/construction phase of highway, which is the long-term aim of a prosperity oriented highway project.

5.4.2.4 Inclination of TMs

TMs show drastically different pie-charts. TM (A6) is more prosperity dimension oriented, with planet dimension being second largest; on the other hand TM (A58) has almost balanced inclination towards planet and prosperity dimensions. Based on these pie charts, no concrete judgment can be made.

TMs state *"my mission is to bring together, technical aspects and innovation aspects"; "monitor/check the work of our consultants,match the proposed solutions of consultants with rules/regulations of RWS"; "sometimes I require documents from OM/CM"* these reflect the role of a TM. Based on IPM model, a TM is responsible for technical contribution to processes falling under other IPM roles. The TMs in their interviews confirmed effect of sustainability in their profession and talked more about *"new type of asphalt; use of low noise asphalt; construction waste; soil analysis; air quality; developing a circular design; bi functional design; multi-functional highway; energy use/efficiency"* which clearly show their involvement and expertise in the sustainability success sub-criteria of Planet dimension. In exploratory interviews, an expert explained, before the use of IPM model, the public project delivery organization consisted of only a technical department and a technical manager for each project. This is confirmed

by highly experienced profiles of few respondents (see tab 4.4). Therefor, role of a TM is fundamental and important. TM are professionally effected by sustainability. Based on above stated reasons and inclinations of other IPM roles to People and Prosperity dimensions, it is assumed that a TM is more inclined towards Planet Dimension.

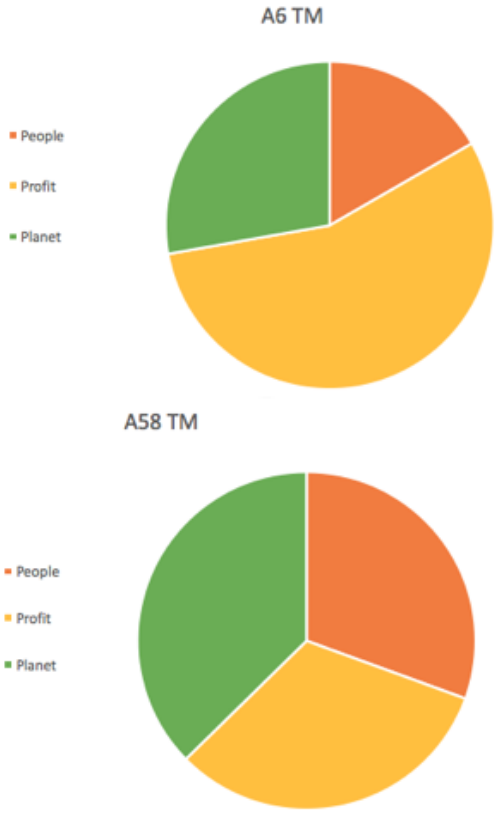


FIGURE 5.6: Comparison of inclination of TMs to sustainability dimensions

5.4.2.5 No Inclination of PCMs

All the three PCMs, unanimously disagreed to effect of sustainability on their profession. The statements *"I carry out risk management, information management same as before; my role is to coordinate; I see that we are on time/within budget; asking other roles if they need anything"; "for I am doing risk management also, and you see a lot of risks about innovation pop out. So that's a change, uhm but the process of risk management doesn't necessarily change because of it. But we do have different risks than other projects"; "I am still doing financial management, the way I normally do it"; "so I have a bag of money for innovations and sustainability. Next to the bag of money that we have for the widening of the road"* reflect that opinion. This also overlaps with IPM model theory, where PCM are coordinators of other IPM roles. From the findings of interviews and IPM model theory, it can be concluded tasks such as **information management, documentation management, risk management, cost/financial management, quality management and systematic planning** are under the responsibility of a PCM. Most importantly the process to carry out these tasks remains the same as any other highway project, however it is crucial for other IPM roles to provide the input/necessary information to a PCM, in order to carry out his professional role.

Observation

Based on results of first exercise of interview protocol and answers to questions such as *"Does sustainability affect your professional role?"*, it can inferred that not all IPM roles have equal inclination towards sustainability dimensions. PM is responsible for everything in his/her project, hence his balanced view of sustainability reflects his professional responsibility for success of entire project. All three PCMs stated their professional role is NOT effected by sustainability, hence they are considered to be working outside the dimensions of sustainability. PEM, TM and CM are directly connected and constantly involved with stakeholders, design/technical teams and contractors respectively. Based on their exercise results and views of other respondents, PEM is positioned in the People dimension, CM is positioned in the Prosperity dimension and TM is assumed in the Planet dimension.

5.4.3 Variable-by-Variable Matrix: Inter-relationships of IPM roles for use of SSFs

TABLE 5.1: Variable by Variable matrix

SSFs	**PEM (People Dimension)**	**TM (Planet Dimension)**	**CM (Prosperity Dimension)**	**PM (3P)**	**PCM (No Dimension)**
Awareness of project external factors	X	X	X	X	X
Clearly defined scope	X	X	X	X	X
Information sharing within the project team					X
Monitoring and Control					X
Risk Management					X
Proper selection of contracting strategy/tender process			X		
Collaboration between project parties	X	X	X		
Competent/multidisciplinary team				X	
Top management support				X	
Affinity for sustainability	X	X	X	X	
Client involvement				X	
Active involvement of stakeholders	X				
Clear goals & ambitions	X	X	X	X	X
Sustainability policy	X	X	X	X	
Systematic planning					X
Adequacy & efficiency of resources				X	X

After carefully analyzing the above three cases, two main variable sets can be identified. First set of variables are SSFs which are common across the three case studies. Second type of variables are the IPM roles inclined towards sustainability dimension(s). Based on these variables, a variable-by-variable matrix is selected to draw conclusions. A *variable-by-variable matrix* has two main variables in its rows and columns where the cell entries are case names. By this, rich information from each case can be used to identify patterns across cases. These patterns are based on specific type of interaction between the two variables and thus can be noted to jot down conclusions (Miles & Huberman, 1994). Based on information from identified SSFs and inclination of IPM roles to sustainability dimensions, a variable-by-variable matrix is formulated (see tab 5.1). In this table, each "X" represents evidence from at least two cases, to justify relationship between two variables.

Observation

Based on patterns of variable-by-variable matrix, it can be inferred that not all IPM roles carry all SSFs to help improve chances of project success of a sustainability oriented highway project. These patterns are listed in table 5.2, in the form of SSFs under each IPM role(s). Each of these patterns either represent a single role which focuses on specific SSFs or inter-dependent roles to carry out a particular SSF. This is similar to IPM model, which dictates different focus areas for different IPM roles and also acknowledges the inter-dependency of different IPM roles to achieve a successful project. SSFs such as awareness of external project factors, clearly defined scope, clear goals/ambitions are shared by all IPM roles. This conclusion is made from observations from the three cases, where external social, political, technological and economical factors were important for incorporating sustainable "wishes" in the highway projects. In order to use these SSFs, IPM roles relied heavily on each other. The SSF *sustainability policy* is attributed to four IPM roles, where laws, regulations and administrative processes related to sustainability effect the IPM roles in their day-to-day activities. There is not enough evidence in literature talking about importance of legal and administrative processes (see 2.3.2), however examples from the three cases, such as *use of ROK; arranging permits; check of land-use plans for sustainable solutions; need to meet the best practices of RWS; as a government body we cannot generate (legally) electricity; check check check, so many checks;* states the importance of sustainability policy SSF and its use by the four IPM roles effected professionally by sustainability. SSF *adequacy and efficiency of resources* is jointly carried out by PCM and PM, where PM negotiates need of resources from higher management and PCM accompanies PM is such meetings to give his professional opinion. SSF *collaboration between project parties* is carried out by TM, CM and PEM, based on their interactions with different project parties, independently or together. For instance, PEM and TM have meetings together with stakeholders to ensure the acceptance of proposed solutions; TM and CM have meetings with contractors/consultants to identify "good" functional requirements which can be part of contract. SSFs under PCM (such

Table 5.2: SSFs for different IPM roles

All IPM roles	Awareness of project external factors
	Clearly defined scope
	Clear goals/ambitions
PM/PEM/TM/CM	Sustainability policy
PEM/TM/CM	Collaboration between project parties
PM/PCM	Adequacy & Efficiency of resources
PM	Competent/multidisciplinary team
	Top management support
	Affinity for sustainability
	Client involvement
PCM	Information sharing within the project team
	Monitoring and Control
	Risk Management
	Systematic Planning
CM	Proper selection of contarcting strategy/tender process
PEM	Active involvement of stakeholders

as information sharing within project team, monitoring and control, risk management and systematic planning) overlaps with his responsibilities as stated in 3.1. PEM has frequent meeting with stakeholders effected by highway project (local residents, municipalities etc), these meetings are carried out to know their wishes/grievances for the project. Therefore, the SSF *active involvement of stakeholders* is carried out by PEM alone. The SSF *proper selection of contracting strategy/tender process* is carried out by CM, based on his professional role and competence. PM carries out SSFs (Competent & Multi-disciplinary team, Top management support; Client involvement; Affinity for sustainability) which involve interaction with higher management and selection of a "good" IPM team for the project. However, these findings do not taken into account the inter-related nature of CSFs (as stated by Williams (2016); Chen et al. (2011) and Liu et al. (2014)).

Other CSFs, which are crucial in literature but were not identified during the cross-case analysis are briefly discussed in this paragraph. CSFs such as *clear organization structure* was not identified during the cross-case analysis, this is attributed to absence of a clear organization structure with respect to sustainability. It was also mentioned in exploratory interviews, that sustainability experts are scattered across the organization and there is no different department of sustainability. Lack of evidence for CSF such as *learning from current and past experiences & training provisions* reflect the "recent" nature of sustainability within highway projects. There are not many examples available, as of now to use those CSFs. CSFs such as *use of technology; proper selection of project execution resources; health and safety considerations; use of technology* were also not identified. This could be based on the selection of exploration and planning phase to carry out this research. CSFs are different for different phases of a construction project (Liu et al., 2014) and this may be one of the reasons why the above stated CSFs could not be identified in the exploration and planning phases of a highway.

5.5 Discussion

Based on data of first exercise of interview protocol followed by analysis of transcripts, Sustainability Success Factors or SSFs are means to achieve and improve chances of identified sustainability success sub-criteria of a sustainability oriented highway project. It is assumed that the respondents provided answers after due consideration of identified sustainability success sub-criteria in his/her highway project. Minimum bias to a particular sustainability success sub-criteria dimension can be assumed in the responses of IPM roles, based on random order, absence of categorization and large number of identified sustainability success sub-criteria in the conducted exercise. Thus, identified SSFs contribute to majority of sustainability success sub-criteria.

Among the identified SSFs, based on frequency of occurrence and answer to open questions, important SSFs can be noted. SSF *sustainability policy* was stated by majority of respondents. Laws, regulations and administrative processes related to sustainability effect IPM roles in their day-to-day activities. On one hand, such policy provide means to have more sustainable projects in future and on another hand, laws and regulations are too rigid to incorporate innovative and sustainable solutions of a highway. SSF *clear goals* is important for IPM roles to reduce ambiguity and long discussions to formulate sustainability requirements of highway project. It was suggested to identify sustainability goals which are explicit and sustainability ambitions which are implicit. Respondents recommended to have sustainability goals/ambitions mentioned in *OPDRACHT*. The above two SSFs are not in direct control of IPM roles, since these SSFs are part of Policy and Strategy domain. SSF *active involvement of stakeholders* and *client involvement* was stated by respondents as critical for ensuring project success. Early involvement of stakeholders was suggested by respondents to establish mutual trust, improve commitment, increase

transparency and minimize conflicts with respect to sustainability goals/ambitions of a highway project. Involvement of client was stated paramount to have clear and timely decisions. Whenever necessary, client must also provide the required decision making authority for sustainability goals/ambitions. SSF *collaboration between project parties* was stated by majority of respondents as means to improve success. It was stated sustainability is complex and requires collaboration and knowledge sharing from different project parties. In one of the case studies, "living lab" is used as means to improve collaboration. SSF *proper selection of contracting strategy/tender process* such as use of EMAT criteria, use of DBFM or DBFM plus, use of Innovative partnerships etc are suggested as ways to include sustainability success sub-criteria in contract. The above stated SSFs are in direct control of IPM roles.

Inclination of various IPM roles towards sustainability dimensions is observed. The identified SSFs are carried by different IPM roles. There are SSFs which are carried out by a single IPM role, as defined by IPM model. There are also SSFs which require more than one IPM role. SSFs and their responsible role(s) are stated in table 5.2.

The identified sixteen SSFs are deemed critical for project success of a sustainability oriented highway project. Based on data collected and cross-case analysis, these SSFs are defined. The definitions are tabulated in table 5.3. These findings will be further used to develop a conceptual project management model for sustainability in Chapter 6.

5.6 Conclusion

This chapter discussed the findings of cross-case analysis. All the three case studies identified large number of sustainability success sub-criteria, an average of 22 were identified per respondent. This confirms the selection of appropriate highway projects as case studies for this research. Almost all respondents agree to the completeness of developed sustainability success sub-criteria framework. It is important to note that, no additional sub-criteria was added by respondents. Based on ordering and explaining section of this chapter, sixteen SSFs are identified, which are deemed critical for project success of a sustainability oriented highway project. The identified SSFs were defined based on findings of cross case analysis. The definitions of sixteen SSFs are tabulated in table 5.3. The identified SSFs provide answer to the second research question *"What are the critical success factors during exploration/planning phase of a sustainability oriented highway project?"*. Based on the above discussion, top SSFs among identified SSFs are *sustainability policy; clear goals; active involvement of stakeholders; client involvement; collaboration between project parties; proper selection of contracting strategy/tender process*. Data analysis also suggested two types of variables, namely SSFs and IPM roles inclined to sustainability dimensions. With the help of variable-by-variable matrix, patterns of SSFs under different IPM roles are noted. These SSFs and their positions under IPM roles will be further used to hypothesize a conceptual project management model for sustainability. The next chapter elaborates on the use of such findings from this chapter.

TABLE 5.3: Sustainability Success Factors

No.	SSFs	Definitions
1	*Awareness of project external factors*	The awareness of project regarding sustainability goals/ambitions with respect to policy, society, technology and economic context
2	*Clearly defined scope*	A clear, well defined scope for sustainability goals/ambitions through establishment of boundaries and constraints (standards) & acknowledgement of ambitions by the client
3	*Information sharing within the project team*	Use of timely (active) distribution of necessary and valuable information regarding sustainability goals/ambitions through efficient communication channels from different project parties within the project team
4	*Monitoring & Control*	Use of standard control and monitor mechanisms for sustainability goals/ambitions through detailed plan, change management process, inspection/supervision and feedback mechanism to ensure acceptable progress on time, cost and scope.
5	*Risk Management*	Use of risk oriented warning system and risk sessions to identify, define, analyse and assess risks pertaining to sustainability goals/ambitions
6	*Proper selection of contracting strategy/-tender process*	Use of an adequate contracting strategy and competitive tender process that incorporates and promotes sustainability goals/ambitions (explicitly states sharing of risks and clarity about responsibility)
7	*Collaboration between project parties*	Required level of collaboration/cooperation among project participants for definition and implementation of sustainability goals/ambitions through an open (positive) attitude and effetive communication
8	*Competent/ multidisciplinary team*	Use of a suitably qualified project team to define and achieve sustainability goals/ambitions
9	*Top management support*	Commitment of senior management of the organization for the sustainability goals/ambitions
10	*Client involvement*	Timely consultation of client for decisions and support regarding sustainability goals/ambitions
11	*Active involvement of stakeholders*	Timely involvement of stakeholders, in various stages of project to improve commitment, provide continuous support, lay grounds for negotiations, minimize opposition, develop mutual trust and improve overall communication for the sustainability goals/ambitions
12	*Clear Goals & Ambitions*	Clear goals (obligatory) & ambitions (that have added value) regarding sustainability, linking to the requirements of the client
13	*Sustainability Policy*	Use of sustainability policy
14	*Systematic planning*	Use of a realistic and detailed project plan to achieve the sustainability goals/ambitions
15	*Adequacy & Efficiency of Resources*	Presence of available and competent resources for achieving sustainability goals/ambitions
16	*Affinity for sustainability*	Presence of ambitious nature, personal drivers and like-mindedness within the project team for sustainability goals/ambitions

Chapter 6

I3PM Model

This chapter explains the development and validation of a conceptual project management model which incorporates principles of sustainability. The chapter is divided into four sections. The first section, sheds light on the followed design procedure to come up with a conceptual model. In this section, sustainability and IPM model theory is used, followed by synthesis of SSFs within the IPM model. The findings of cross-case analysis are discussed with a project management expert to get better insights. The second section hypothesizes Integrated People Planet Prosperity Management model or I3PM model, with sixteen SSFs assigned to five fundamental roles. The third section elaborates of validation procedure. This section describes expert judgments, by selection of experts and findings from expert discussions. The final section states the validated I3PM model.

6.1 Design Procedure

This section throws light on the design procedure of I3PM model. In the first subsection, the theoretical concepts of sustainability and IPM model are discussed. The second subsection focuses on findings of cross-case analysis and synthesizes applicability of SSFs within IPM model. A project management expert from the organization is consulted to have a better understanding of these findings. Finally, I3PM model is proposed with sixteen SSFs positioned under five fundamental roles, including definition of SSFs.

6.1.1 Use of Sustainability and IPM model theory

Using the principles of sustainability stated in 2.2.1.1, sustainable highway definition provided in 2.2.1.2 and characteristic features of IPM model stated in 3.1, this section acknowledges the use of these concepts to define a conceptual project management model for a sustainability oriented highway project.

Elkington's 3P principle is used in this research to cover the concept of sustainability in the broadest sense. The three dimensions of sustainability, namely People, Planet and Prosperity are three pillars which come together to represent sustainability. There is evidence in literature for using 3P principles in proposing conceptual project management models (Martens & De Carvalho, 2014); (Martens et al., 2016); (Umer et al., 2016); (Zhang, 2016); (Fernández-Sánchez & Rodríguez-López, 2010); (Bai et al.,

2012); (Gareis et al., 2013); (Jones et al., 2013). Due to their recent nature, there is lack of evidence for applicability of such conceptual models in project management practice. However, the extensive use of 3P principles for formulating such models clearly shows the acceptance of scientific community for using principles of sustainability in making conceptual project management models for sustainability.

The IPM model is a project management model used in the public project delivery organization for more than a decade. IPM model consists of five fundamental roles that are paramount for the overall success of any project. IPM model dictates individual focus areas, tasks and responsibilities as well as inter dependency of the five fundamental roles. The findings from cross-case analysis show the usage of SSFs by the five fundamental IPM roles. The findings also conclude direct effect of sustainability on professions of four fundamental IPM roles, namely PM, PEM, TM and CM. There is evidence of usage of SSFs by PCM, who is not professionally effected by sustainability success sub-criteria but needs input from other IPM roles to carry out his professional role.

Theoretically, IPM team must be formed at the start of a new phase of a highway project. Based on observations and statements of respondents, in practice, this is not the case. In the exploration phase, IPM team consists of PM, PEM and a project secretary. Other IPM roles are added to this initial IPM team whenever necessary. In particular, CM is added towards the end of planning phase and at start of procurement phase. Few respondents referred to this phase as the overlapping phase between planning and procurement or *planuitwerking fase*. Many respondents, including a CM stated his involvement as *"way too late for sustainability"*. From the interviews, it is observed that there is added value to early involvement of IPM roles for sustainability goals/ambitions.

Based on the above stated sustainability concept, IPM model and findings from cross-case analysis. An Integrated People Planet Prosperity Management model or I3PM model, consisting of five fundamental IPM roles is proposed for the exploration and planning. The applicability of SSFs within this model is elaborated in the next section.

6.1.2 Synthesizing applicability of SSFs within IPM model

This section uses the findings of cross-case analysis. In 5.4, sixteen SSFs were identified and defined (see table **??**). IPM roles and their inclination towards sustainability dimensions was noted. Based on results/patterns of variable-by-variable matrix, SSFs for different IPM roles were tabulated (see table 5.2). These SSFs are carried out by five fundamental managers of IPM model. There are SSFs which are carried out by a single IPM role and also SSFs which are carried out by more than one IPM role. These observations are discussed with a project management expert from the organization to get a better understanding, before conceptualization of I3PM model.

Discussion with Project Management Expert: A project management expert from public project delivery organization is selected. Project management expert plays the professional role of a senior project management advisor, with 23 years of experience in projects and is involved in functioning of IPM model since its inception in 2006. Based on this information, the project management expert is deemed fit to review the positions of SSFs under each IPM role and provide valuable comments on the definitions provided for SSFs.

The expert explained about IPM model being a horizontal hierarchy model (in theory) used at project level but also stated the importance of PM role who is involved at project as well as organization level. Initially (during the exploration and planning phases) all the five fundamental roles are equal, however at later stages such as contracting (or) execution phase, a PM has higher authority as compared to other

IPM roles. Expert elaborated this by an example *"in case of a long discussion or fight, PM can say ENOUGH, we do this and they (IPM roles) have to agree"*. With respect to positioning of SSFs under IPM roles, the expert agreed to fifteen patterns, except the pattern regarding "affinity for sustainability". He compared the patterns of "competent multi-disciplinary team" and "affinity for sustainability" to explain his point of view. Both these SSFs are under the success factor category of Leadership and Team and he commented *"if you give PM the responsibility of choosing the right multi-disciplinary team for project, then he (PM) is also responsible to select a team which has affinity for sustainability"*. The expert further re-stated the leadership capabilities of a PM in IPM model (see 3.1). With respect to SSF definitions provided, the expert agreed to all the definitions except definition provided for "sustainability policy". During discussion, a more elaborated definition of "sustainability policy" was discussed, to avoid confusions about the SSFs. The modified definition is *"presence and awareness of a sustainability policy within the organization which helps in achieving sustainability goals/ambitions"*. Based on expert comments and use of findings from cross-case analysis, the I3PM model can by hypothesized. This is explained in the next section.

6.2 Hypothesis: I3PM model

Based on discussions in above sections, this section states conceptual I3PM model, consisting of five fundamental roles, out of which four roles are inclined towards sustainability dimensions. Sixteen SSFs are listed under respective IPM role(s).

6.2.1 Project Manager (PM)

The Project Manager or PM has the main responsibility for overall success of a sustainability oriented project. PM is a *spider in the green web*, who provides unifying leadership and uses targeted control to ensure project success. He possesses an unbiased nature and does what is deemed right for ensuring sustainability of the project. A PM also serves as an intermediary role between top management at organization level and his project team at project level. The below SSFs are responsibility of a PM:

1. Competent/multidisciplinary team: use of a suitably qualified project team to define and achieve sustainability goals/ambitions
2. Top management support: commitment of senior management of the organization for the sustainability goals/ambitions
3. Client involvement: timely consultation of client for decisions and support regarding sustainability goals/ambition
4. Affinity for sustainability: presence of ambitious nature, personal drivers and like-mindedness within the project team for sustainability goals/ambitions

A PM also acts as a sparring partner for other roles and pushes them to achieve mutually shared SSFs. These are *awareness of project external factors, clearly defined scope, clear goals/ambitions, adequacy & efficiency of resources and sustainability policy.*

6.2.2 Project Control Manager (PCM)

Based on findings of cros-case analysis, Project Control Manager or PCM is not professionally affected by inclusion of sustainability in his/her project. However PCM is a fundamental role of IPM model. There are interdependency between the different roles, that is the nature of IPM model. Without a PCM, the other IPM roles will fail to do their role properly. Based on this, a PCM role will act in the same way as stated in 3.1. Therefore, SSFs used by a PCM are:

1. Information sharing within the project team: Use of timely (active) distribution of necessary and valuable information regarding sustainability goals/ambitions through efficient communication channels from different project parties within the project team
2. Monitoring and control: Use of standard control and monitor mechanisms for sustainability goals/ambitions through detailed plan, change management process, inspection/super-vision and feedback mechanism to ensure acceptable progress on time, cost and scope.
3. Risk management: Use of risk oriented warning system and risk sessions to identify, define, analyze and assess risks pertaining to sustainability goals/ambitions
4. Systematic planning: Use of a realistic and detailed project plan to achieve the sustainability goals/ambitions

SSFs which are mutually shared with other IPM roles are *awareness of project external factors, clearly defined scope, clear goals/ambitions and adequacy & efficiency of resources*. These SSFs are carried out in consultation with other IPM roles, whenever necessary.

6.2.3 Project Environment Manager (PEM)

A Project Environment Manager or PEM is responsible for the social (people) integration of the project and acts as an interface between the organization and the project environment (consisting of municipalities, legal entities, local communities, concerned individuals etc). A PEM ensure that the development needs of individuals, stakeholders and societies involved in the surroundings are to be met equitably and in a manner consistent with the ecosystem. The SSF used extensively by a PEM is *Active involvement of stakeholders*, which states timely involvement of stakeholders, in various stages of project to improve commitment, provide continuous support, lay grounds for negotiations, minimize opposition, develop mutual trust and improve overall communication for the sustainability goals/ambitions of a highway project.

SSFs which are mutually shared with other IPM roles are *awareness of project external factors, clearly defined scope, clear goals/ambitions, sustainability policy and collaboration between project parties*.

6.2.4 Technical Manager (TM)

A Technical Manager or TM is focused on achieving the desired technical result for the client. The TM works in close co-operation with PEM (to acknowledge wishes/demands/restrictions from project environment) and CM (to translate technical requirements in contractual terms). Based on focus areas of a TM, which are persuasion, innovation management, technical judgment and conceptual flexibility, TM can significantly effect the impact of project on the ecosystem.

SSFs which are mutually shared with other IPM roles are *awareness of project external factors, clearly defined scope, clear goals/ambitions, sustainability policy and collaboration between project parties.*

6.2.5 Contract Manager (CM)

A Contract Manager or CM is responsible for the process of procurement, contract preparation and tendering. CM uses contract as his tool for ensuring project success of a sustainability oriented project and derives maximum benefits by exploiting market participants (contractors). CM carries out risk management by formulating legal requirements in the contract, this ensures transfers of sustainability risks to contractor and a win-win situation for the community as well as client. Based on the nature of work and mission of a CM, he/she is positioned in the Prosperity dimension. SSF *proper selection of tender strategy/tender process* is used by CM, which is defined as use of an adequate contracting strategy and competitive tender process that incorporates and promotes sustainability goals/ambitions (explicitly states sharing of risks and clarity about responsibility).

SSFs that are mutually shared with other IPM roles are *awareness of project external factors, clearly defined scope, clear goals/ambitions, sustainability policy and collaboration between project parties.*

The mutually shared SSFs are listed and defined as follows:

1. Awareness of project external factors: The awareness of project regarding sustainability goals/ambitions with respect to policy, society, technology and economic context
2. Clearly defined scope: A clear, well defined scope for sustainability goals/ambitions through establishment of boundaries and constraints (standards) acknowledgement of ambitions by the client
3. Clear Goals Ambitions: Clear goals (obligatory) & ambitions (that have added value) regarding sustainability, linking to the requirements of the client
4. Sustainability Policy: Presence and awareness of a sustainability policy within the organization which helps in achieving sustainability goals/ambitions
5. Adequacy & Efficiency of Resources: Presence of available and competent resources for achieving sustainability goals/ambitions
6. Collaboration between project parties: Required level of collaboration/cooperation among project parties for definition and implementation of sustainability goals/ambitions through an open(positive) attitude and effective communication

The above five roles are fundamental in I3PM model (see 6.1). PM acts as a *spider in the green web* and is responsible for overall success of a sustainability oriented project. PEM, TM and CM are positioned in People, Planet and Prosperity dimensions respectively. PCM is positioned outside the sustainability dimensions, however PCM acts as a coordinator and relies on other IPM roles to carry out his role and vice-versa. The sixteen SSFs are intrinsic elements of the I3PM model. These SSFs are either shared among IPM roles or accounted as an individual SSF for a particular role. For instance, the success factors *Awareness of project external factors*, *Clear Goals & Ambitions*, *Clearly defined scope* are responsibilities shared by all the five IPM roles. *Sustainability Policy* is another such factor common to all roles, except PCM. PM and PCM roles work together towards *Adequacy & Efficiency of Resources*, while PEM, CM and TM roles work together for *Collaboration between project parties.* The above listed SSFs are carried out by group discussions/meetings, which require involvement of stated IPM roles.

The next section describes the validation procedure of the proposed model.

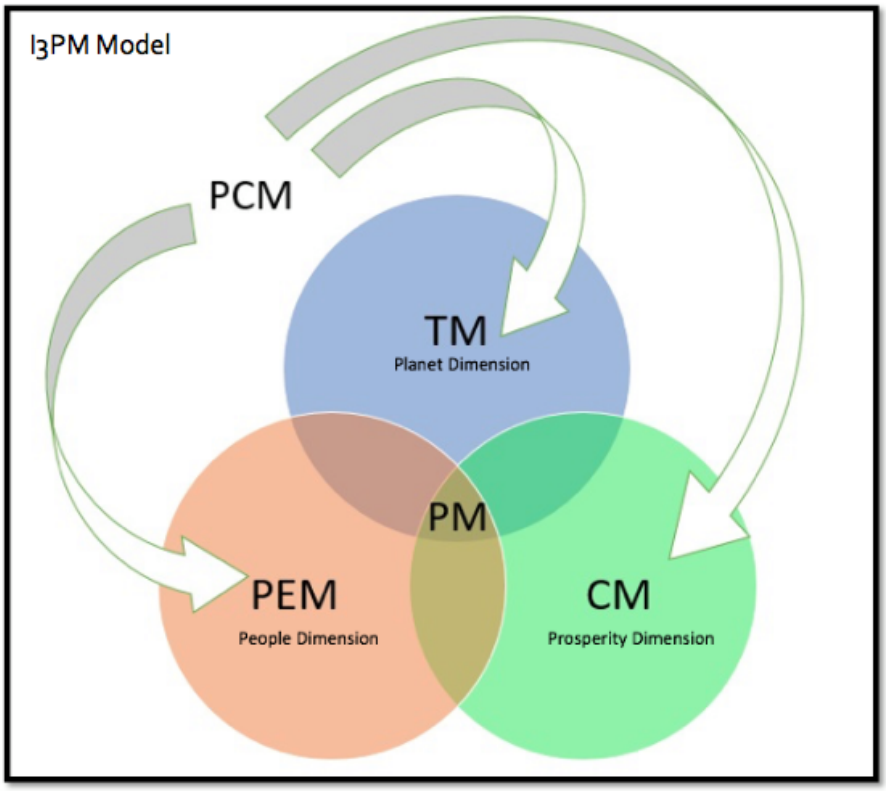


FIGURE 6.1: Conceptual I3PM Model

6.3 Validation

This section describes the validation procedure for I3PM model. It is subdivided into three sections. First section elaborates on focus group discussion. Second section describes the selection of experts and states the profile of selected experts. The third section elaborates on the findings from focus group discussion.

6.3.1 Focus group discussion

Focus group is a method of specific data collection, which involves semi-structured interviews of the members present. An effective focus group session would require a group of 6-12 individuals chosen based on their relation, relevance and contribution to the topic, the members are chosen by a facilitator who will also convene the session. Contrary to other forms of data gathering like interviewing, focus group sessions have multiple benefits; they help in setting an environment conducive to group interaction and knowledge sharing which helps in bringing to fore certain concepts and ideas which may not possible through interviews, it enables vast amount of data gathering in a very short period of time and it brings to fore the difference of opinions and experiences of the members which give deeper insights to the topic (Edmunds, 2000).

Based on above reasons, focus group discussion is selected to validate the I3PM model. A validation protocol is followed for the focus group session. This is elaborated in F.0.1. A total of nine experts are selected for focus group discussion, the choice of experts will be discussed in below section.

6.3.2 Selection of experts

To validate the above-mentioned model, a total of nine experts were selected. As stated in 4.3, experts are those professionals who possess deep knowledge about a particular topic. The criteria for selection of experts is that, each expert should possess substantive knowledge about IPM roles. This knowledge can be reflected in their profession as an IPM role (or) their interaction with IPM roles for a considerable amount of time (see table 6.1). By following this criteria, nine experts were identified, among which seven experts are IPM roles and other two experts are senior advisors who have been professionally involved with various IPM roles.

Among the nine experts, only seven were available for a joint focus group session. The remaining two experts are interviewed individually and a similar focus group protocol is followed. These two interviews were conducted after the focus group session, thus findings of focus group sessions are extensively used to derive similar discussions in individual interviews as well. The observations from focus group discussion and individual interviews are used to validate the I3PM model. The below section elaborates on such findings.

TABLE 6.1: Selection of experts for validation of I3PM model

Profile of Experts	**Professional Role**	**Substantive Knowledge about IPM roles**
Expert 1	Senior Project Manager	Yes
Expert 2	Project Control Manager	Yes
Expert 3	Project Environment Manager	Yes
Expert 4	Technical Manager	Yes
Expert 5	Contract Manager	Yes
Expert 6	Innovation Manager	Yes
Expert 7	Plan-study Manager	Yes
Expert 8	Senior Advisor	Yes
Expert 9	Senior Advisor	Yes

6.3.3 Findings from Expert Discussions

The focus group session was relaxed and almost everyone had an opportunity to interact. After giving a brief presentation based on validation protocol, the focus group session was carried out. The findings/conclusions from focus group sessions are elaborated below

Validation of roles in 3P dimensions: All the respondents agreed to positioning of roles in the respective sustainability dimensions. The CM and PCM discussed about Prosperity dimension, where CM responded *he (PCM) has the money but I am the one who spends it.* This confirms CM's position in the prosperity dimension. In the individual discussions, one expert stated *IPM roles are too small to cover the whole people, planet, prosperity dimensions in sustainability but I agree with this concept as a starting point.* Another expert stated *I fully agree with directions and these people (roles) could become more responsible for that (sustainability). But we have to challenge them to think BROADER than their professional role.* The answers to close-ended questions such as *Should something be introduced and/or changed within the boundaries of the proposed model* and *Would you re-structure the proposed model?* reflects the level of agreement of experts. Therefore, the assumed directions of sustainability

Validation of SSFs under IPM roles (including definitions):

1. **Awareness of project external factors**: All experts agreed to the definition and majority of experts agreed to proposed position of SSF. Three experts disagreed with position of SSF under role of CM. Two of them stated CM is only responsible for contracting and joins later, not involved in exploration/planning phase of project. There are instances in the organization, where there are overlapping phases in which CM is involved during the planning phase. Recently, the organization also has pilot projects (Project A6 to see early involvement of IPM roles. During cross-case analysis, few respondents also stated that IPM team is formed very late, it should be formed earlier. Based on these reasons, IPM team must be formed together, with all five roles and CM must incorporate this SSF while doing his professional role.
2. **Clearly defined scope**: Majority of experts agreed to proposed position of IPM roles but few experts showed concerns regarding use of terminology "clearly defined" for this SSF. Experts stated *"contradiction between clearly defined scope and sustainability ambitions; a clear defined scope can limit goals/ambitions; as a OM you are looking for extra space/extra profit (benefits) for stakeholders, you have to be flexible"*. Experts suggested use of "flexible scope" instead of fixed or defined. This suggestion, probably reflects the nature of considered phase in this research. During exploration and planning, there are chances to look for solutions and the "scope" of the project is not yet fixed, until contracting phase begins. During this phase, the scope is more "fixed" than compared to exploration and planning phase. Based on above comments the **name and definition of SSF "clearly defined scope" is changed**.
3. **Information sharing within the project team**: All experts agreed to the definition provided for this SSF but there were concerns with proposed position of SSF. There was discussion about "source of information". Experts stated, PCM is responsible and has access to documents but PEM also has certain documents which must be shared from the project environment. Similarly, PM has information which is outside the project environment and must be shared with other IPM roles when necessary. Few experts also stated, information regarding sustainability must be shared by everyone. One expert stated *other roles should remain proactive, for PCM to carry out this SSF*. All experts unanimously agreed to positioning of this SSF under PCM role and few experts had different opinions with respect to other roles. This SSF is focused on information management and not information generation, thus PCM is the right role for facilitating distribution of information related to sustainability goals/ambitions of project.
4. **Monitoring and control**: All experts agreed to the definition and proposed position of this SSF.
5. **Risk Management**: All experts agreed to the definition and proposed position of this SSF. Few experts stated involvement of other IPM roles to identify risks in the form of risk sessions. This SSF dictates use of risk management as a process, which is the professional role of a PCM, the other IPM roles are required to carry out this process, however it is the responsibility of a PCM to carry out this process based on his knowledge and expertise. One expert stated *opportunity management could also be done by PCM*, which is risk management for sustainability but considering risks in terms of opportunities.
6. **Proper selection of contracting strategy/tender process**: All experts agreed to the definition and proposed position of this SSF.
7. **Collaboration between project parties**: All experts agreed to the definition and proposed position of this SSF. Six experts had comments on addition of PM as a responsible role to carry out this SSF. This comment was elaborated with examples of PM being an initiator and also using his wide network (both inside and outside of project) for collaborations.

8. **Competent/Multi-disciplinary team**: All experts agreed to the definition of SSF. All experts except PCM agreed to proposed position of SSF.
9. **Top management support**: All experts agreed to definition and experts unanimously agreed to proposed position of this SSF.
10. **Client involvement**: All experts agreed with definition and experts unanimously agreed with proposed position of this SSF.
11. **Active involvement of stakeholders**: All experts unanimously agreed to definition and proposed position of this SSF. Five experts suggested involvement of a PM to connect stakeholders present at different/higher levels, which are not in the direct reach of a PEM.
12. **Clear goals and ambitions**: Majority of experts agreed to definition and proposed position of this SSF. One expert suggested *translation of policy goals into practical goals* as an addition to proposed definition.
13. **Sustainability policy**: All experts agreed to definition and majority of experts agreed to proposed position of SSF. Four experts stated PCM could contribute more if he/she also knows about this SSF.
14. **Systematic planning**: All experts agreed to definition and majority of experts agreed to proposed position of this SSF. Four experts stated PM as also responsible for planning and working along with PCM.
15. **Adequacy and efficiency of resources**: All experts agreed with definitions and majority of experts agreed with proposed position of this SSF.
16. **Affinity for sustainability**: All experts agreed to definition but had concerns regarding position of this SSF. Seven experts stated affinity for sustainability must be from within and does not depend on PM's competence. Their statements such as *all IPM roles need affinity; everyone should make their own team aware; it helps if all roles have affinity otherwise their focus will be defending their area instead of trying to help another role; must be there for all* confirm the strong opinions of experts. Based on this, the **proposed position of SSF "affinity for sustainability" is changed**.

Summarizing, there were not many changes to the proposed I3PM model. Fifteen definitions were validated and fifteen SSFs under IPM roles were also validated. The definition of SSF *clearly defined scope* and position of SSF *affinity for sustainability* were changed. These are discussed in the following section.

6.4 Discussion - Validated I3PM Model

Majority of experts appreciated the proposed I3PM model. This is reflected in their agreement of fifteen definitions of SSFs and agreement of fifteen proposed positions of SSFs under IPM roles. There are only two changes with respect to boundaries of I3PM model.

First, the definition of SSF *clearly defined scope* is modified based on expert comments to "Flexible scope" which is defined as *"a flexible scope for sustainability goals/ambitions through establishment of opportunity space by the client"*. In this definition, opportunity space depicts a more broader boundary than establishment of boundaries and constraints (as per standards) which was used in the previous definition. The opportunity space is discussed with client. Moreover, the considered phases of this research are exploration and planning, which is synonymous to front-end development phase. Rose

(2013) states a flexible nature of scope during the initial phases of a project and gradual definition of scope towards the procurement/execution phase. This overlaps with the comments made by experts.

Second, the position of SSF *affinity for sustainability* is changed. Based on expert comments, this SSF is allocated to IPM roles which are professionally effected by sustainability, namely PM, PEM, TM and CM. It was concluded that affinity for sustainability cannot be forced and must be embedded in an IPM role. It is interesting to note that, the SSF *competent/multi-disciplinary team* was almost unanimously agreed as a SSF under PM role whereas "affinity for sustainability" is strongly criticized to be part of other IPM roles as well. A PM can appoint a competent/multi-disciplinary team but to maintain the affinity of sustainability within the project team depends on personal nature and NOT on leadership/team building skills of a PM. Going by this rational, the position of SSF under IPM roles is changed. SSF *affinity for sustainability* is a new CSF, there is no literature to support it. This change is entirely made on comments of experts.

Based on the two changes mentioned above, I3PM model is validated by nine experts. The I3PM model is an integrated project management model which incorporates sustainability principles and consists of five fundamental IPM roles. The sixteen SSFs are intrinsic elements of I3PM model, as each SSF is positioned under IPM role(s). Based on expert judgments, the use of I3PM model could help improve the chances of project success of a sustainability oriented highway project during the exploration and planning phase.

6.5 Conclusion

This chapter described synthesis of SSFs in IPM model by use of sustainability principles, IPM model and findings from cross-case analysis. These findings were discussed with a project management expert to conceptualize an Integrated People Planet Prosperity Management model or I3PM model. The conceptualized model is validated using a focus group discussion with nine experts. Based on the findings from focus group discussion, two changes were made to the conceptual model. The validated I3PM model consists of five fundamental roles, namely, Project Manager (PM), Project Control Manager (PCM), Project Environment Manager (PEM), Technical Manager (TM) and Contract Manager (CM). Four of these roles, namely PM, PEM, TM and CM, work in sustainability dimensions of People, Planet and Prosperity. PM is positioned in the center of three dimensions, reflecting his core role in a sustainable highway project. PEM is positioned in the People dimension reflecting his/her role as an intermediary between stakeholders/society and public project delivery organization. Similarly, CM is positioned in Prosperity dimension reflecting his/her role as an intermediary between market (contracting parties) and public project delivery organization. TM is positioned in the Planet dimension, based on his professional role, which significantly impacts the physical environment of a highway project. The fifth role, PCM is positioned outside the sustainability dimensions. PCM acts as a coordinator who has inter-dependency on other IPM roles to carry out his professional role and vice-versa. The I3PM model consists of sixteen SSFs which are positioned under five fundamental roles. The use of I3PM model could significantly improve chances of project success of a sustainability oriented highway project. This provides answers to the third research question *"How can the critical success factors be applied in an IPM model of a public project delivery organization?"*.

The final chapter provides discussion, conclusions and recommendations based on the outcome of this research.

Chapter 7

Discussion, Conclusions and Recommendations

This chapter will elaborate on research findings, limitations, conclusions and recommendations. In the first section, a discussion is made on the research findings and limitations. In the second section, the sub-research questions are answered sequentially, thereby providing an answer to the main research question. As one of the first studies of its kind, this research contributes to project management practice and sustainability in three ways. First, the study proposes a sustainability success sub-criteria framework of a sustainability oriented highway project. Second, the research proposes a list of SSFs (Sustainability Success Factors) which can be used to improve the chances of project success in the exploration and planning phase of a sustainability oriented highway project. Third, the research proposes a project management model for sustainability, which can be used in an integrated project team of a public project delivery organization. This model can be used to improve the chances of project success of a sustainability oriented highway project. The third section states recommendations based on findings of this research. In this section recommendations are provided to the public project delivery organization as well as recommendations to carry out further research.

7.1 Discussion

In this section, the research findings are discussed and limitations of research are acknowledged. The first section describes research findings and the second section states the limitations of this research.

7.1.1 Research Findings

This research was carried out to find the answer to the following main research question *"How can critical success factors be applied in an IPM model to improve the chances of project success during the exploration and planning phase of a sustainability oriented highway project?"* In order to achieve this, the research was divided in three chronological phases based on three sub-research questions.

In first phase, a literature review was conducted on project success criterion and sustainability. Elkington's 3P principle was selected as a sound sustainability theory. Findings from literature suggested use of

sustainability as an upcoming project success criterion. In order to establish sustainability as a project success criterion, a distinct set of success sub-criteria, which would serve as basis of judgment was required. A theoretical framework of 33 sustainable aspects of a tunnel was considered as a starting point. This framework was reviewed against recent literature, to identify sustainability success sub-criteria of a sustainability oriented highway project. After few exclusions and modifications, 29 sustainability success sub-criterion were identified with the help of literature. Based on three expert judgments, a total of 30 sustainability success sub-criteria were defined and validated. These success sub-criteria are used to formulate the interview protocol.

In second phase, a literature review focused on critical success factors in the construction industry was conducted. This led to identification of 28 CSFs, relevant for this research. An extensive document review of IPM model was conducted. The IPM model and its organization structure aptly reflects the project management practice of the public project delivery organization, this is confirmed by outcome of exploratory interviews. The five fundamental IPM roles can dominantly effect project success of any project. Thus, IPM roles were selected as main respondents for cross case methodology and analysis. The findings of first sub-research question and literature review on CSFs were used to formulate a three part interview protocol. This interview protocol was used for data collection, through twelve semi-structured interviews (four interviews per case study). All the three case studies identified large number of sustainability success sub-criteria. ATLAS.ti was used for data analysis. Based on a rule of thumb, that is, 75 percent of respondents must state a CSF to be generalized across the three case studies, sixteen CSFs were identified. These CSFs are deemed as Sustainability Success Factors or SSFs, which are means to achieve and improve chances of identified sustainability success sub-criteria of a sustainability oriented highway project. It is assumed that the respondents provided answers after due consideration of identified sustainability success sub-criteria in his/her highway project. Minimum bias to a particular sustainability success sub-criteria dimension could be assumed in the responses of IPM roles, based on random order, absence of categorization and significantly large number of identified sustainability success sub-criteria during the conducted exercise. Therefore, identified SSFs contribute to majority of sustainability success sub-criteria of a highway project.

In third phase, findings from cross-case analysis, sustainability theory from literature review and IPM model of public project delivery organization are used to conceptualize a project management model for sustainability. This model is called Integrated People Planet Prosperity Management model or I3PM model. The model is hypothesized with the help of discussion with a project management expert. The conceptual I3PM model consists of five fundamental roles, namely, Project Manager (PM), Project Control Manager (PCM), Project Environment Manager (PEM), Technical Manager (TM) and Contract Manager (CM). Based on findings from cross case analysis, four of these roles, namely PM, PEM, TM and CM, work in sustainability dimensions of People, Planet and Prosperity. The fifth role, PCM acts outside the dimensions of sustainability and performs the role of a coordinator, who has inter-dependency on other IPM roles to carry out his professional role and vice-versa. The I3PM model consists of sixteen SSFs, which were identified in second phase. Based on cross-case analysis, SSFs are positioned under the five fundamental roles. SSFs are carried out by a single IPM role or multiple IPM roles. The I3PM model is validated using expert judgments. Based on the expert discussions, fifteen hypotheses were confirmed and two changes were suggested. Use of validated I3PM model can help improve chances of project success of a sustainability oriented highway project during the exploration and planning phase.

Reflecting on problem statement formulated for this research, the research findings significantly contribute to the evolving literature of project management for sustainability. It is important to note that, there is no literature on critical success factors for sustainability oriented highway projects. This research has added to scientific literature, by presenting a list of sixteen SSFs, which can help to improve

chances of project success of a sustainability oriented highway project. With the help of SSFs, a conceptual project management model for sustainability is proposed. This model provides a direction for project managers to help improve project success of a sustainability oriented highway project during the exploration and planning phase.

7.1.2 Limitations of Research

This section acknowledges the limitations of conducted research.

1. The initial framework of sustainability aspects of a tunnel, which was considered as a starting point for this research, is based on building and built environment tools such as *BREEAM-NL 2012*, *CASBEE 2013*, *LEED neighbourhood 2013* and *GPR Urbanism 2011* and infrastructure assessment tools such as *Green roads 2014*, *Greenlites 2012*, *Envision 2012*, *BE2ST-in-Highways 2012*, *I-LAST- 2010* and *INVEST - 2012*. This research did not consider the use of any such tools.
2. CSFs are multiple interacting factors. This was also evident is findings of cross-case analysis. However, based on exploratory nature of this research, the interacting nature of CSFs was not considered.
3. Based on unavailability of fundamental IPM roles, two extra IPM roles were selected for cross-case methodology and analysis. Ideally, only the five fundamental roles must be considered.
4. After completion of first exercise of interview protocol, respondents were asked to answer the subsequent questions based on identified sustainability success sub-criterion of the studied highway project. This research assumes that the answers provided by the respondents reflect on majority of the identified sustainability success sub-criteria.
5. Sustainability theory considered in this research acknowledges overlapping domains of equitable, bearable and livable. In practice, IPM model also consists of extra roles, other than five fundamental roles. The proposed I3PM model did not consider overlapping domains and inclusion of extra IPM roles.

7.2 Conclusions

This section provides conclusion to the conducted research. In this section, answers to three sub-research questions are sequentially stated and discussed. Based on the conclusions of sub-research questions, the main research question is finally answered.

7.2.1 First Sub-Research Question

"What are the sustainability success sub-criteria of a highway?"

In order to answer this sub-research question, a literature review on project success criterion and sustainability was conducted. Elkington's 3P principle was selected as a sound sustainability theory. 29 sustainability success sub-criteria of a highway were identified through recent literature.

With the help of experts, 29 sustainability success sub-criteria were validated and one more was identified. Based on expert judgments, definitions were discussed and amended to develop a sustainability success

criterion framework. This framework consists on 30 sustainability success sub-criteria, which are grouped in People, Planet and Prosperity dimensions of sustainability. These findings (including definitions) are tabulated in tables 3.8, 3.9 and 3.10 respectively. These 30 sustainability success sub-criteria of a highway provides the answer to first sub-research question.

7.2.2 Second Sub-Research Question

"What are the critical success factors during exploration/planning phase of a sustainability oriented highway project?"

In order to answer this sub-research question, a literature review on critical success factors in the context of construction industry was conducted. This led to identification of 28 CSFs, relevant for this research. Organization overview and outcome of exploratory interviews confirmed IPM model as main project management practice within the the public project delivery organization. IPM model consists of five fundamental IPM roles, thus these roles were selected as main respondents for cross-case approach. Findings of first sub-research question and identified 28 CSFs from literature were used to develop an interview protocol. Twelve interviews were conducted (four per case study).

Based on cross-case analysis, sixteen CSFs were identified. These CSFs are deemed as Sustainability Success Factors or SSFs, which are means to achieve and improve chances of majority of sustainability success sub-criteria of a sustainability oriented highway project. These SSFs are defined in table 5.3. Among these SSFs, *affinity for sustainability* is a new CSF added to literature. It is defined as *presence of ambitious nature, personal drivers and like-mindedness within the project team for sustainability goals/ambitions*. Out of the sixteen SSFs, important SSFs are noted, which are *sustainability policy; clear goals; active involvement of stakeholders; client involvement; collaboration between project parties* and *proper selection of contracting strategy/tender process*. Based on focus group discussion (see chapter 6) SSF *flexible scope* is also considered as an important SSF. These sixteen SSFs provide answer to the second sub-research question.

7.2.3 Third Sub-Research Question

"How can the critical success factors be applied in an IPM model of a public project delivery organization?"

In order to answer this sub-research question, findings of second sub-research question and cross-case analysis are used. SSFs are synthesized in IPM model. A conceptual project management model, called Integrated People Planet Prosperity Management model or I3PM model is hypothesized with the help of a project management expert. This model is validated by nine experts.

The validated I3PM model consists of five fundamental roles, namely, Project Manager (PM), Project Control Manager (PCM), Project Environment Manager (PEM), Technical Manager (TM) and Contract Manager (CM). Four of these roles, namely PM, PEM, TM and CM, work in sustainability dimensions of People, Planet and Prosperity. PM is positioned in the center of three dimensions, reflecting his core role in a sustainable highway project. PEM is positioned in the People dimension reflecting his/her role as an intermediary between stakeholders/society and public project delivery organization. Similarly, CM is positioned in Prosperity dimension reflecting his/her role as an intermediary between market (contracting parties) and public project delivery organization. TM is positioned in the Planet dimension, based on

his professional role, which significantly impacts the physical environment of a highway project. The fifth role, PCM is positioned outside the sustainability dimensions. PCM acts as a coordinator who has inter-dependency on other IPM roles to carry out his professional role and vice-versa. The I3PM model consists of sixteen SSFs which are positioned under five fundamental roles. The model proposes SSFs, which must be carried out by a single IPM role and also proposes SSFs which are carried out by multiple IPM roles. The validated I3PM model provides answers to third sub-research question.

7.2.4 Answer to Main Research Question

"How can critical success factors be applied in an IPM model to improve the chances of project success during the exploration and planning phase of a sustainability oriented highway project?"

On the basis of results obtained from sub-research questions, the main research question can now be answered. The validated I3PM model (see 6.1, consists of five fundamental roles. These roles are responsible for the use of sixteen SSFs. Experts confirmed use of SSFs could improve chances of project success. Thus, this model provides a direction to focus on crucial areas during exploration and planning phase of a sustainability oriented highway project. I3PM model could help project management practice for better achieving sustainability goals/ambitions of a highway project.

7.3 Recommendations

This section consists of recommendation for the public project delivery organization and for further research. Based on the findings from this research, the following recommendations are suggested.

7.3.1 For public project delivery organization

- To ensure commitment of IPM roles and improve chances of success for sustainability in later phases of a highway project, it is recommended to identify sustainability goals which are explicit and sustainability ambitions which are implicit. Based on observations, it is suggested to do this through establishment of sustainability goals and ambitions in the requirement list formulated by client or *OPDRACHT*.
- Recent sustainability policy of public project delivery organization will undoubtedly increase number of sustainable highway projects in future. However there are current laws, regulations and administrative processes such as *ROK, laws for energy generation, laws for land use* etc. which inhibit use of innovative and sustainable solutions within highway projects. Few statements and an example which was observed in cases:

    1. Extensive discussions among experts regarding applicability of innovative solutions. The main cause of these discussions is the level of acceptable risk for public project delivery organization.
    2. Law prohibits public project delivery organization to generate surplus energy.
    3. Eco-sand solution, a sustainable concept from a contractor could not be immediately implemented on land owned by public project delivery organization. However, the same concept was implemented on land owned by municipality of Almere, with the help of a smoother administrative process.

The above statements and example shed light on issues which could come up in the future for sustainability oriented highway projects. It is highly recommended to discuss and research on ways to make current laws, regulations and administrative processes within the public project delivery organization more "friendly" and "supportive" for sustainability.

- Defining scope for a sustainability oriented highway project is a dynamic and complex scenario. It is recommended to keep the scope flexible and not "well-defined" in order to provide room for discussions and research about sustainable solutions. The scope must always be discussed with client, to match the minimum requirements and sustainable requirements of a highway project.
- It is recommended to involve client (ministry and regional authority) through timely consultations in order to create space and trust for sustainability goals/ambitions within a highway project. The decision making authority of client is paramount for project success of a sustainability oriented highway project
- Stakeholders must be involved as early as possible to establish mutual trust, improve commitment, increase transparency and minimize conflicts in a project. The same is recommended with respect to sustainability goals/ambitions for a highway project.
- Collaboration between project parties is essential to solve complex issues surrounding sustainability. One of the case studies (innovA58) exhibited use of "Living Lab", which is an open-innovation ecosystem consisting of project parties. "Living Lab" could be a good example, based on its use in practice and hence it is recommended to look into its functioning and note/document collaboration ways for further improvement.
- It is recommended to research on type of contracts which substantially improves the chances of inclusion of sustainability success sub-criteria in contract. Currently, EMAT criteria is used extensively to incorporate sustainability. DBFM type of contract is considered helpful due to "Finance and Maintain" aspects which transfers risk to contractor. However, new type of contracts such as DBFM plus and Innovative contracts are also suggested to help improve chances of inclusion of sustainability success sub-criteria in contract.
- Affinity for sustainability is a new CSF identified in the statements of IPM roles. It is recommended to check and see influence of this CSF on function of different IPM roles.
- In practice, IPM model consists of extra IPM roles. Testing and further development of I3PM model by inclusion of extra IPM roles or external project parties in the overlapping domains of sustainability is highly recommended. These extra roles/project parties could use the identified SSFs and/or perhaps depict use of other CSFs. Few observations from cases are stated below:

  1. Feasible domain - An extra IPM role such as Innovation Manager could be responsible to use SSFs and/or CSFs which help improve chances of feasible nature of innovative/sustainable solutions.
  2. Equitable domain - Social impact assessment could be one of the means to understand the "equitable" domain. A local resident group could be an external party that carries out a social impact assessment and depicts use of SSFs and/or CSFs.
  3. Bearable domain - A local environmental group or an extra IPM role could be responsible to ensure bearability of sustainable solutions on society and physical environment through use of SSFs and/or CSFs.

- Defining practical sustainability project goals was a concern for many respondents. It is recommended to use *omgevingswijzer* or developed sustainability success sub-criteria framework or both to define practical sustainability project goals during the exploration and planning phase. It is recommended to check and compare the established goals/ambitions at the end of each phase of a highway project.

7.3.2 Further research

- Generalization of proposed sustainability success sub-criterion framework for infrastructure projects. The initial considered sustainable aspects framework was taken from a tunnel project. Based on findings of this research, the developed sustainability framework could be generalized for highway projects. The next significant step would be to generalize this framework for large infrastructure projects.
- Importance of identified SSFs in other phases of highway projects. The identified SSFs are critical for exploration and planning phase. This does not confirm their importance in contracting or execution phase. Therefore, the identified SSFs could be considered as a starting point, for research in other phases of a sustainability oriented highway project.
- Inter-relationships between the sixteen SSFs were not considered in this research. It is recommended to acknowledge these relationships and identify inter-relationships among the sixteen SSFs.
- This research proposed the I3PM model within a public project delivery organization (predominantly based on a client's perspective). It is recommended to validate I3PM model through a consultant's/contractor's point of view.
- Applicability of I3PM model in procurement and execution phase is recommended. In practice, sustainability goals/ambitions change during different phases of highway. Also IPM roles change due to large duration of a highway project. These changes could influence the use of identified SSFs and/or use of other CSFs.

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Appendix A

Project Success Criterion - Sustainability

A.1 Ecosystems Approach

Elkington (1997) raised attention concerning the inter dependencies between social, environmental and economical aspects and tries to convey a system view on the complex problem of sustainability.Van Bueren et al. (2012) persuades to understand urban environments as ecosystems, which similar to an ordinary system has inputs, outputs and relationships among the elements present in that system. The built environment is the place where the three pillars of sustainable development – people, planet and profit – meet. Cities are neither good or bad, they are there and most of them are growing owing to economic growth. Consideration of this principle as a starting point, would help in attempts to make cities sustainable, a process in which one can use strategies of both mitigation and adaptation.Fiksel (2006) mentioned the need for a systems approach to sustainability. Challenges of complexity and resilience indicate that sustainability is a systems problem requiring collaborative solutions. According to Fiksel (2006), integrated assessment of sustainable systems cannot be accomplished by linking domain specific models together, in order to assess higher order interactions among interdependent systems requires new tools to capture emergent behaviours and dynamic relationships that characterize complex, adaptive systems such as highways. Van Bueren et al. (2012) explained the concept of (eco) system theory, which allows integration of sustainability by considering the built environment and nature as one ecosystem. This approach helps in more possibilities for making improvement in environmental conditions for the nature as well as humans. Concepts such as carrying capacity and ecological footprint analysis, life cycle analysis and the 'cradle to cradle' (C2C) are considered important in following an ecosystem approach. An ecosystem was defined as

finite wholes of abiotic and biotic components and the interactions between them constitute an ecosystem. An ecosystem indicates the integration level of water, soil, air, temperature, plants and animals and their interactions.

Humans are an integral part of ecosystems. A large and complex ecosystem can be broken down into smaller ecosystems and vice versa, for example the entire biosphere is an ecosystem consisting of smaller ecosystems like the ocean, lake or even a pond. A simple system consists of elements, relationships between elements, boundaries, inputs and outputs. Same holds good for an ecosystem as well, although

the extent of details depend on the complexity of system and availability of information.

A.2 Three Waves of public pressure

From 1960 to 2001, three great waves of public pressure have shaped the environmental agenda. The roles and responsibilities of governments and the public sector have mutated in response to each of these three waves and will continue to do so. These waves are described (Elkington, 2004) as follows:

- First Wave brought an understanding that environmental impacts and natural resource demands have to be limited, resulting in an initial outpouring of environmental legislation. The business response was defensive, focusing on compliance, at best.
- Second Wave brought a wider realization that new kinds of production technologies and new kinds of products are needed, culminating in the insight that development processes have to become sustainable – and a sense that business would often have to take the lead. The business response began to be more competitive.
- Third Wave focuses on the growing recognition that sustainable development will require profound changes in the governance of corporations and in the whole process of globalization, putting a renewed focus on government and on civil society. Now, in addition to the compliance and competitive dimensions, the business response will need to focus on market creation.

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A.3 Various stages of learning flywheel

Elkington (2004) asserted in order to achieve sustainability, governments and agencies will need to move through the various stages shown in the learning flywheel 2.2

- Stage 1 (Invasion): The first stage focuses on invasion, that is, the natural process by which an innovation (new technology or new business model) invades an opportunity space, creating economic, social or environmental impacts in the process. Government agencies play a key role in identification of new types of impact and pioneering assessment methods.
- Stage 2 (Internalization): Process by which a company or value web absorbs some of the costs previously externalized to society or the environment is called Internalization. Government involvement is critical to ensure externalities are properly costed and internalized.
- Stage 3 (Inclusion): Process by which a wide range of internal and external stakeholders are progressively engaged, their priorities established and their legitimate needs are identified is called Inclusion. The public sector will be increasingly significant in establishing key priorities for action and investment
- Stage 4 (Integration): This is the challenge of integration of identified priorities in stage 3. The challenges of integration will increasingly play out in four key areas. Balance sheet (transparency, accountability, reporting and assurance), boards (ultimate accountability corporate governance and strategy), brands (engaging investors, customers and consumers directly in sustainability issues) and business models (moving beyond profit minded corporate business models).

- Stage 5 (Incubation): Incubation is consideration of more sustainable technologies, business models and industries that can be incubated in modern world.

A.4 Principles of Sustainability (Seven revolutions concept)

Elkington (1997) mentions the seven sustainability revolutions (markets, values, transparency, life-cycle technology, partnership, time and corporate governance) in his famous book "Cannibals with forks". They are briefly elaborated below.

1. Markets (From Compliance to Competition)
   Sustainable development will increasingly be delivered by business through markets. He insists on the fact that the growing number of businesses and liberalization of markets will generate even more competition where the attitude towards 'zero impact' will have to be replaced by innovative strategies which enable to make a positive impact.
2. Values (From Hard to Soft)
   This principle suggests that there is an emergence of a renewed set of values. It is no longer a question about hard, predetermined rigid values. There is a tendency towards 'world citizen' values where quality replaces quantity and a long-term reflection becomes an obligation.
3. Transparency (From Closed to Open)
   This principle focuses on emerging stakeholder pressure with the of more transparency. Due to the development of information technology, businesses are becoming increasingly visible. For achieving sustainability, it has to be based on an active dialogue with different stakeholders as well as an external verification.
4. Life Cycle Technology (From Product to Function)
   Events such as Chernobyl, Bhopas Gas Tragedy and Enschede firework factory explosion have caused a shift. Organizations have to focus on the acceptability of the procedure of production and not only on their product. The result is organizations are responsible for the entire life-cycle of their products (cradle to cradle) rather than cradle to grave performance.
5. Partnerships (From Subversion to Symbiosis)
   This principle insists on obligation to cooperate and development of partnerships for the implementation of the Triple Bottom Line Principle. The role of complementarities (co-opetition) is increasing and the government-industry-NGO symbiosis is gaining importance. However, building trust is becoming crucial in economic relationships but earning this loyalty is a great challenge for business.
6. Time (From Wider to Longer)
   This principle evoked two dimensions of time becoming crucial for sustainability: organizations have to act as quickly as possible with transmission of information becoming immediate and long-term view requiring greater attention as foresight as an indicators of sustainability.
7. Corporate governance (From Exclusive to Inclusive)
   This principle focuses on governance aspect to become more inclusive by development of more inclusive ways of stakeholder capitalism. He also insists on the importance of diversity on decision-making levels.

A.5 Sustainability Success Sub-Criteria of a Highway

This section would elaborate on the literature review carried out to obtain the sustainability success sub-criteria of a highway.

TABLE A.1: Literature Review of Sustainability Objectives

		TOTAL	Hansmann et al 2012	Talbot & Venkataraman 2011	Fernandez 2010	Tsai 2012	Toth 2012	Marshall 2013	Miller 2013	Zheng 2013	Santos 2013	Smith 2013	Jullien 2014	Alonso 2015	Zhou 2015	Inyim 2016	Umer 2016	Zhang 2016	Haghshenas 2012	Shiau 2013	Miller 2016
1	Cultural Heritage	1		1																	
2	Visual & Experiential sustainability	0																			
3	Accessibility	7								1	1			1			1		1	1	1
4	Landscape Character	7	1			1	1		1	1	1						1				
5	Climate adaption	3	1		1				1												
6	Multifunctionality	1			1																
7	Functional Flexibility	1			1																
8	Construction waste	7	1		1	1		1		1				1	1						
9	Frugal and efficient use of materials and resources	3			1			1							1						
10	Re-use and use of recycled materials	2				1											1				
11	Energy use	9	1		1			1		1	1			1		1			1		1
12	Energy efficiency	2	1						1												
13	Non- renewable energy sources	4							1								1			1	1
14	Renewable energy sources	6	1		1		1			1									1	1	
15	Energy Production	4	1				1												1	1	
16	Construction Transportation	3				1				1										1	
17	Human Rights & Fair Trade	7								1	1			1			1		1	1	1
18	Safe Mobility	12			1			1	1	1	1	1		1	1		1	1	1	1	
19	Toxic materials	3						1		1		1									
20	Air Quality	16	1	1			1	1	1	1	1	1	1	1	1	1		1	1	1	1
	CO2 emissions	14	1		1		1	1	1		1	1	1	1	1	1		1		1	1
21	Noise	10			1	1			1	1	1	1		1				1	1		1
22	Traffic Level	10			1	1			1	1	1	1		1				1	1		1
23	Water Quality	5	1						1	1					1			1			
	Hydrological system	6			1	1		1		1					1		1				
24	Biodiversity	5	1		1	1				1									1		
25	Soil Quality	3	1		1					1											
26	Coordination and Collaboration (supply chain)	0																			
27	Operations & Maintenance Optimization	0																			
28	Local Stakeholder Involvement	5		1	1			1		1									1		
29	Knowledge Exchange	0																			
	Value Generation (Cumulative Opportunity)	1																			1
	Life Cycle Costing	4			1								1				1				1
	Sustainable Soil Management	0																			
	Environmental Impact Assessment	7	1		1	1		1		1				1	1						
	Sustainable Leadership	0																			
	Sustainable Business Operations	0																			

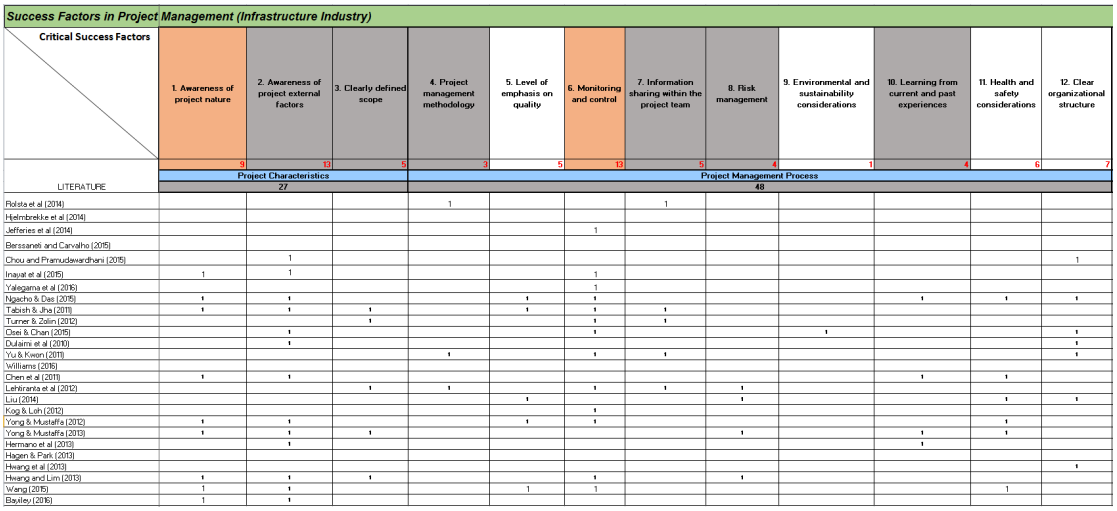
Recent literature Tsai & Chang (2012); Toth-Szabo & Várhelyi (2012); Marshall (2013); Miller et al. (2013); Zheng et al. (2013); Santos & Ribeiro (2013); Smith et al. (2013); Jullien et al. (2014); Alonso et al. (2015); Inyim et al. (2016); Umer et al. (2016); Haghshenas & Vaziri (2012); Shiau & Liu (2013); Miller et al. (2016) was reviewed to identify sustainability success sub-criteria of a highway with already developed sustainability assessment frameworks, sustainability indicator lists and sustainability performance metrics of urban transportation systems. Fernández-Sánchez & Rodríguez-López (2010) concludes an indicator list for infrastructure projects based on project management methodology. Zhou et al. (2015) conclude that their produced indicators are largely in line with the international practice. Zhang (2016) produce sustainable urbanization (rural/urban) evaluation parameters. Hansmann et al. (2012) surveyed sustainability professionals (N = 373) to identify different sustainability domains. Among the respondents the predominant professions were research (21%), environmental planning, and engineering offices (15%) and public administration (15%). Talbot & Venkataraman (2011) focuses on integrating sustainability in project management practice by developing a high-level indicator list, this list is considered to be applicable to highway projects as well.

Based on the above literature, the sustainability success sub-criteria were developed and their frequency of occurrence can be viewed in Table A.1. Accessibility, Landscape Character, Construction Waste, Energy Use, Safe Mobility, Air Quality, CO2 emissions, Noise and Traffic Level occurred in almost half of the reviewed literature. There are some sustainability success sub-criteria based on Gijzel (2014) which could not be found in literature, these are marked by red cells.

Appendix B

Project Success Factors - Construction Industry

This sections gives an overview of the literature review conducted on the initial Critical Success Factor list considered in this research. The below figures can be referred for a better understanding.

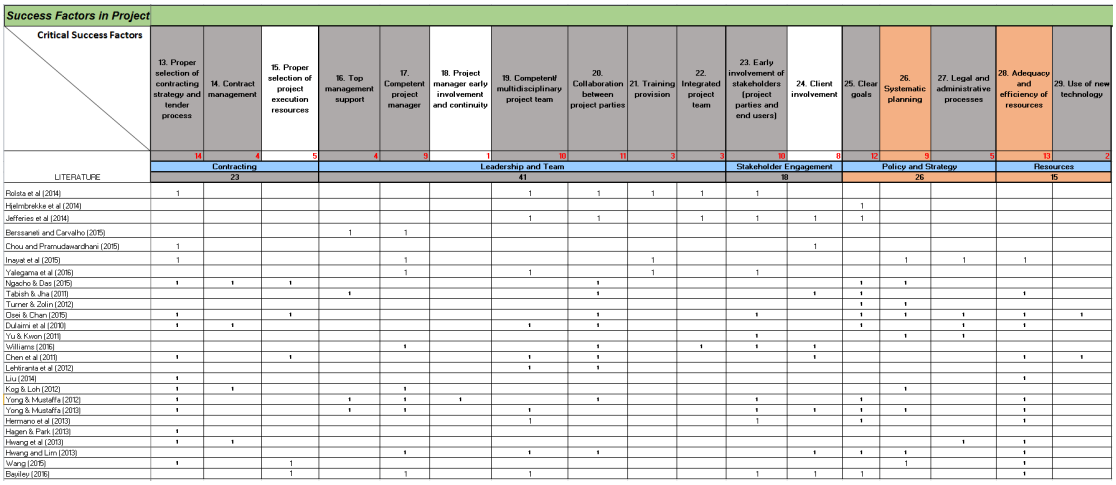


Success Factors in Project Management (Infrastructure Industry)												
Critical Success Factors	1. Awareness of project nature	2. Awareness of project external factors	3. Clearly defined scope	4. Project management methodology	5. Level of emphasis on quality	6. Monitoring and control	7. Information sharing within the project team	8. Risk management	9. Environmental and sustainability considerations	10. Learning from current and past experiences	11. Health and safety considerations	12. Clear organizational structure
	9	13	5	3	5	13	5	4	1	4	6	7
	Project Characteristics			Project Management Process								
LITERATURE	27			48								
Rolsta et al (2014)				1			1					
Hjelmbrekke et al (2014)												
Jefferies et al (2014)						1						
Berssaneti and Carvalho (2015)												
Chou and Pramudawardhani (2015)		1										1
Inayat et al (2015)	1	1				1						
Yalegama et al (2016)						1						
Ngacho & Das (2015)	1	1			1	1				1	1	1
Tabish & Jha (2011)	1	1	1		1	1	1					
Turner & Zolin (2012)			1			1	1					
Osei & Chan (2015)		1				1			1			1
Dulaimi et al (2010)		1										1
Yu & Kwon (2011)				1		1	1					1
Williams (2016)												
Chen et al (2011)	1	1								1	1	
Lehtiranta et al (2012)			1	1		1	1	1				
Liu (2014)					1			1			1	1
Kog & Loh (2012)						1						
Yong & Mustaffa (2012)	1	1			1	1					1	
Yong & Mustaffa (2013)	1	1	1					1		1	1	
Hermano et al (2013)		1								1		
Hagen & Park (2013)												
Hwang et al (2013)												1
Hwang and Lim (2013)	1	1	1			1		1				
Wang (2015)	1	1			1	1					1	
Bayley (2016)	1	1										

FIGURE B.1: Critical Success Factors Part 1 - Literature Review

B.1 Critical Success Factors (including definitions)

1. Awareness of project nature - The awareness of a project with respect to the context of project, urgency of project, demand of project and the recognition of complexity of the project.
2. Awareness of project external factors - The awareness of project with respect to social, technological, economic and political context.
3. Clearly defined scope - A clear, well defined scope through establishment of boundaries and constraints by the client



Success Factors in Project / Critical Success Factors	13. Proper selection of contracting strategy and tender process	14. Contract management	15. Proper selection of project execution resources	16. Top management support	17. Competent project manager	18. Project manager early involvement and continuity	19. Competent/ multidisciplinary project team	20. Collaboration between project parties	21. Training provision	22. Integrated project team	23. Early involvement of stakeholders (project parties and end users)	24. Client involvement	25. Clear goals	26. Systematic planning	27. Legal and administrative processes	28. Adequacy and efficiency of resources	29. Use of new technology
	14	4	5	4	9	1	10	11	3	3	10	0	12	5	5	13	2
	Contracting			Leadership and Team							Stakeholder Engagement		Policy and Strategy			Resources	
LITERATURE	23			41							10		26			15	
Polata et al (2014)	1						1	1	1	1	1						
Helmbrekke et al (2014)													1				
Jefferies et al (2014)							1	1		1	1	1	1				
Berssaneti and Carvalho (2015)				1	1												
Chou and Pramudawardhani (2015)	1											1					
Insyat et al (2015)	1				1				1					1	1	1	
Yalegama et al (2016)					1		1		1		1						
Ngacho & Das (2015)	1	1	1					1					1	1			
Tabish & Jha (2011)				1				1				1	1			1	
Turner & Zolin (2012)													1	1			
Osei & Chen (2015)	1		1					1			1		1	1	1	1	1
Dulaimi et al (2010)	1	1					1	1					1		1	1	
Yu & Kwon (2011)											1			1	1		
Williams (2016)					1			1		1	1	1					
Chen et al (2011)	1		1				1	1				1				1	1
Lehtiranta et al (2012)							1	1									
Liu (2014)	1															1	
Kog & Loh (2012)	1	1			1									1			
Yong & Mustaffa (2012)	1			1	1	1		1			1		1			1	
Yong & Mustaffa (2013)	1			1	1		1				1	1	1	1		1	
Hermano et al (2013)							1				1		1			1	
Hagen & Park (2013)	1																
Hwang et al (2013)	1	1													1	1	
Hwang and Lim (2013)					1		1	1				1	1	1		1	
Wang (2015)	1		1											1		1	
Bayley (2016)			1		1		1				1	1	1			1	

FIGURE B.2: Critical Success Factors Part 2 - Literature Review

4. Project management methodology - Experience of using appropriate/relevant management tools, techniques and processes for decision making based on sound data.
5. Level of emphasis on quality - Use of a quality policy which states effective quality control and effective quality assurance
6. Monitoring and control - Use of effective control and monitor mechanisms through detailed plan, change management process, site inspections/supervision, regular feedback mechanism to ensure acceptable progress on schedule, budget and scope.
7. Information sharing within the project team - Use of timely and valuable distribution of information through appropriate communication channels from different parties within the project team
8. Risk management - Use of appropriate and accurate risk assessment for identification of risks and their allocation/mitigation
9. Learning from current and past experiences - Presence of a learning environment within the organization through documentation of completed/past projects used for improvement of current/future projects
10. Health and safety considerations - Presence of a health and safety program for employees of the organization and also for personnel involved in the project
11. Clear organization structure - Presence of a formal and clear organization structure which has clear division of roles and responsibilities within the project team as well as project parties involved.
12. Proper selection of contracting strategy and tender process - Use of an adequate contracting strategy and competitive tender process through comprehensive contract documentation which states risk sharing among project parties and has clarity about sharing of responsibility.
13. Contract management - Management of contracts through effective contract modifications, contractual motives/incentives and presence of an effective procurement method
14. Proper selection of project execution resources - Selection of competent/qualified contractor(s) and consultant(s) who are technically and financially capable to execute the project.
15. Top management support - Presence of support/commitment from senior management of the organization for the undertaken project.

16. Competent project manager - Presence of a project manager who possesses the right leadership skills, technical skills, communication skills and required management capabilities to carry out the project.
17. Project manager early involvement and continuity - Early involvement of project manager at the start of project and continuity of project manager until the completion of the project
18. Competent/multidisciplinary project team - Use of an adequately skilled or suitably qualified project team who are committed to the project.
19. Collaboration between project parties - Required level of collaboration/cooperation among project participants by having mutual trust, clear understanding, open communication, frequent progress meetings, a win-win attitude, no blame philosophy and conflict resolutions.
20. Training provision - Presence of training provisions of human resources for development of skills demanded by the project
21. Integrated project team - Presence of a shared physical work-space
22. Early involvement of stakeholders - Early involvement of stakeholders in the early stages of the project to enhance commitment, increase transparency, provide continuous support, minimize conflicts, develop mutual trust and improve communication
23. Client involvement - Presence of continuous consultation of client for timely decisions, responsiveness to the needs of other stakeholders and commitment to the established scope of the project
24. Clear goals - Clear and realistic common goals linking to the requirements of the client
25. Systematic planning - Use of a realistic, detailed and accurate project plan to achieve the deliverable(s) of the project
26. Legal & administrative processes - Presence of a favourable legal framework for the project
27. Adequacy and efficiency of resources - Presence of available resources (monetary, technological and human resources) throughout the project.
28. Use of technology - Use of proven (up to date) technology or use of innovative technology after consideration of the uncertainty involved.

Appendix C

Organization Overview

C.1 Inter-relationships and dependencies within the core roles of the IPM model

The IPM model and its organization structure is designed in such a way that the five role model reflects a model of cooperation. This sections describes the relationships and dependencies between each role as follows

Relationships between PEM and TM

1. TEM prepares the need and requirements of stakeholders and interested parties. TM checks the technical feasibility (in scope and boundary conditions). TM supports TEM with possible options and solutions. The PM also gets involved for large development choices with large (financial) consequences or choices that are politically sensitive.
2. TEM combines transparency and possible solutions of the area back to stakeholders in an understandable language.
3. TEM and TM are better brought together in the planning phase and implementation phase and require mutual cooperation
4. The overlap of implementation and planning phase, the so-called plan-implementation phase, can have added value for the result/end product: the creativity of the market is used before all parties go through a legal decree or contract. Here the relationship of TEM, TM and CM is of great importance.
5. In maintenance phase, a short survey is conducted by the district (infraprovider and traffic manager), with the TEM playing a coordinating role. He ensures that legal aspects and maintenance needs are adequately translated into the contract.
6. TEM together with TM is responsible for the functional requirements to be interpretable by the stakeholders (use of target oriented language).

In conclusion, it is important to involve TEM at an early stage in order to achieve optimal collaboration with TM and CM.

Relationships between TM and CM

1. CM must determine the market approach strategy (type of contract) based on the risk profile present and in relation to the depth of the developed solutions. TM hereby supports the solutions, options and specifications of the technology
2. There is a translation of technical and functional specifications (TM) to contractual provisions (CM).
3. CM is required to conduct a market scan in the exploration phase. For the planning phase, a PSC and PPC are mandatory and a market consultation is optional. By using these instruments, the time of purchase and the type of contract comes forward. The marketability of solutions and options in a particular environment is addressed.
4. TM makes a contribution in the total system, with which the CM must approach the market.
5. TM based on his expertise conveys CM on tests required on risky processes and products. TM is responsible for the quality of tests (toetsen).
6. TM delivers test capacity/capability to the contract management (matrix).
7. CM is responsible for the execution time of the tests and also for the actions to be taken followed after tests. He also has the responsibility to pay the contractor.
8. In the event of proposed changes (by or to the contractor), technical assessments will be made by TM. If necessary, the EM will have to inform the stakeholders and review the changes to public and private law institutions.

Relationships between TEM and CM

1. TEM provides feedback to stakeholders of environmental aspects (for e.g. construction nuisance, noise) with the help of CM (or TM).
2. As more (business) environmental issues are added to the market, TEM interacts closer with CM.
3. Based on the needs of the environment, TEM makes them known via TM (in specs) and CM (in contract), based on the risk profile.
4. If investment in environmental management is increasing in the market, TEM will indicate to CM, depending on the size of the risks, the tests to be done by the contractor in relation to the environment.
5. At each stage, TEM must be able to explain to the stakeholders about the chosen type of contract and indicate how the contract management would take place during implementation (in a simple language).

Relationships between PCM and other roles

1. PCM sets the project management plan and the (internal) quality plan, which touches all roles and focus areas.
2. PCM takes care of internal quality assurance (IKB) and does interface management with all other roles and is partly supportive.
3. PCM is responsible for risk management and touches all the roles.
4. PCM is responsible for cost management and scope management, which touches all the roles.
5. PCM will incur cost management expertise within his team and provides support to the technical team and the contract team (estimates).
6. In the context of risk management, the other roles are challenged by the PCM.

Relationships between PM and other roles

1. PM has the ultimate responsibility of the overall project
2. PM handles the accountability report, which is prepared by PCM, to the client.
3. PM directs the team and ensures monitoring of mutual common ground and touches all roles.
4. PM ensures team building and intervenes in a timely manner when otherwise.
5. PM supports the remaining roles as requested from him.
6. In the context of the environment, PM often in conjunction with EM has administrative contacts with the stakeholders. Note: The region is primarily responsible for the environmental contacts. This means that in particular a Chief Engineering Director places claim on administrative contacts.
7. PM ensures sufficient capacity from the line management for his or her project and leaves it to the PCM to control it.
8. PM is responsible for setting up of an escalation model, both within the project organization and in collaboration with the contractor.
9. PM will, if he feels the need, have an independent test of the operation of the project team.
10. PM also focuses on his responsibility to the client. In addition, he has a sense of influence (external RWS zoals control, regional agencies, DGP, HID, DG staff etc.) that is important to his project. He knows about possible problems in his project, to ensure escalation of the project in a timely manner.

Appendix D

Interview Protocol

This section gives a detail view of the interview protocol followed for the semi-structured interviews conducted for this research.

D.1 Introduction

The interview begins with brief introduction of the interviewer and his research. Followed by permission to record the interview, ensuring anonymity of interviewees and asking for acceptance of interview transcript. Personal information of the interviewee, such as Name, Educational background, Professional role within the public project delivery organization, Total years of experience in projects, Years of experience in highway project and Years of experience as an IPM role in the organization was asked.

D.2 Identification of Sustainability Success Sub-criteria

The first part is to ask the interviewee about the sustainability success sub-criteria or sustainability themes present in his/her highway project. After this discussion, the interviewer shows his validated list of sustainability success sub-criteria of a highway, along with definitions mentioned in 3.4. First, the interviewee identifies (marks) the sustainability success sub-criteria in his or her project. If they are not present, the reasons are asked by the interviewer. Secondly, the interviewee is asked to rank the identified sustainability success sub-criteria on a scale of 1 to 5. The scale is described as follows

1. = Least Important
2. = Less Important
3. = Neutral
4. = Important
5. = Very Important

Based on his/her personal opinion, the sustainability success sub-criteria are marked. This marks the end of this exercise.

D.3 Semi-Structured Interview Questions

This section elaborated on the various categories of success factors to be covered in the interview.

D.3.1 Project Characteristics (Awareness of project nature; Awareness of project external factors; Clearly defined scope)

1. What were the main drivers (external factors: political, social) behind incorporating those success sub-criteria?
   (a) Any problems/solutions that were encountered?
   (b) How did you treat/respond to those external factors?
2. Were there any difficulties in getting support for these success sub-criteria
   (a) If yes, please elaborate
3. How did you define the functional requirements/system/scope for these success sub-criteria?
   (a) Any problems that were encountered?
   (b) How those problems were treated?

D.3.2 Policy & Strategy (Clear goals; Systematic planning; Legal and administrative processes)

1. Were there fixed priorities or actions for these success sub-criteria?
   (a) If Yes, how did you set priorities/actions?
   (b) If No, what was the reason behind this choice?
2. Did you encounter any delay for these success sub-criteria?
   (a) Give examples
   (b) How did you respond/mitigate them?

D.3.3 Stakeholder Engagement: Early involvement of stakeholders (project parties and end users); Client involvement

1. Who are the key stakeholders for these success sub-criteria?
   (a) How did you involve the key stakeholders?/How did you incorporate their viewpoints/wishes in the project?
   (b) Please explain your choice
2. Was there any difficulty in managing the key stakeholders?
   (a) Why/why not?

D.3.4 Leadership Team: Top management support; Competent project manager; Project manager early involvement and continuity; Competent/multidisciplinary project team; Collaboration between project parties (team); Training provision; Integrated project team

1. To what extent was the organization, especially top management, committed to these success sub-criteria?
   (a) Why/why not?
2. Describe/comment on the commitment level of IPM team for these success sub-criteria?
3. How did IPM roles as a team, contribute to these success sub-criteria?
4. Could you describe instances (give example) where the IPM team agreed (together) on success sub-criteria?
   (a) what is the reason behind this?
5. Could you describe instances (give example) where the IPM team did not agree on success sub-criteria?
   (a) what is the reason behind this?
6. Did these success sub-criteria affect your role in IPM model?
   (a) If yes, how did it affect?
   (b) How did you comprehend these success sub-criteria in your role?
   (c) If no, why not?
7. Do you think collaboration (within IPM team) is important for achieving these success sub-criteria?
   (a) Why do you think so?
8. Do you think collaboration (with external parties) is important for achieving these success sub-criteria?
   (a) Why do you think so?

D.3.5 PM Process: Project management methodology; Level of emphasis on quality; Monitoring and control; Information sharing within the project team; Risk management; Learning from current and past experiences; Health & Safety considerations; Clear organizational structure

1. How did you communicate within the IPM team for these success sub-criteria?
   (a) Did the amount of information sharing increase/decrease within the team for these success sub-criteria?
   (b) Why, why not?

2. Which project management methodology/tools/monitoring techniques did you use for these success sub-criteria?
   (a) How did you assign tasks?
   (b) Were the tool(s) sufficient?
   (c) Why do you think so?
3. What were the risks involved for these success sub-criteria?
   (a) How did you tackle/monitor them?
4. How did you manage quality, time, costs for these success sub-criteria?
   (a) Please elaborate on each aspect
5. How were these objectives integrated into the conceptual/basic design?
   (a) Reasons behind this approach?
   (b) Is this different than regular approach for non-sustainable highways?

D.3.6 Resources: Adequacy and efficiency of resources; Use of new technology

1. Do you think it was an efficient use of resources (monetary, technological, HR) for these success sub-criteria?
   (a) Why do you think so?
2. Did IPM team members prefer use of proven technology?
   (a) Why is it so?
3. Comment on the use of innovation within your project?
   (a) Why were these choices made?

D.3.7 Contracting: Proper selection of contracting strategy and tender process; Contract management; Proper selection of project execution resources

1. Did these success sub-criteria affect the choice of contract?
   (a) If yes, how did it affect?
   (b) If not, why did it not affect the choice of contract?
2. Which contractual characteristics/agreements do you think are important for success of these success sub-criteria?

D.3.8 Open Questions

- What are the MAIN problems for you (or for managers of IPM team) during verkenning/-planstudie phase in these sustainability success sub-criteria which can effect project success?
- How can you (as a role of IPM) ensure success of these sustainability success sub-criteria?
    1. Do you have any suggestion for improvement?
- In which ways can other IPM roles help you to ensure success of the sustainability success sub-criteria?
- In which ways can you help other IPM roles to ensure success of the sustainability success sub-criteria?
- According to you, are there any activities, processes or skills missing, which could contribute to these sustainability success sub-criteria?
- Are you satisfied with the use of sustainability tools (such as Omgevingswijzer/Ambitieweb)?
    1. Any suggestions for improvement in those tools?

D.4 Verification of Critical Success Factors

With the means of an exercise, identical to the exercise carried out for the identification of the sustainability success sub-criteria, critical success factors identified in literature and showed to the interviewee. He/She begins marking the success factors used within his/her highway project and then ranks them on a scale of 1 to 5. Finally, the interviewee is asked to state any critical success factor(s) which are missing in the framework.

Appendix E

Cross-Case Analysis

E.1 Inclination of extra IPM roles towards the Sustainability Dimensions

The below pie charts show the inclination of extra-IPM roles such as Innovation Manager and Plan Study Manager. It can be observed that Innovation Manager is inclined more towards prosperity and planet dimensions. This could be the case, since by profession an innovation manager is responsible to help innovate and improve use of practical sustainable solutions in a highway. In sustainability literature, this professional area could possibly lie in the "feasible" domain, where both prosperity and planet dimensions work in harmony. Similarly, based on results of the pie chart, a Plan Study Manager could lie in "bearable" domain, which represent harmony between people and planet dimensions. The above two statements are mere observations and no concrete judgment can be made due to low number of respondents.

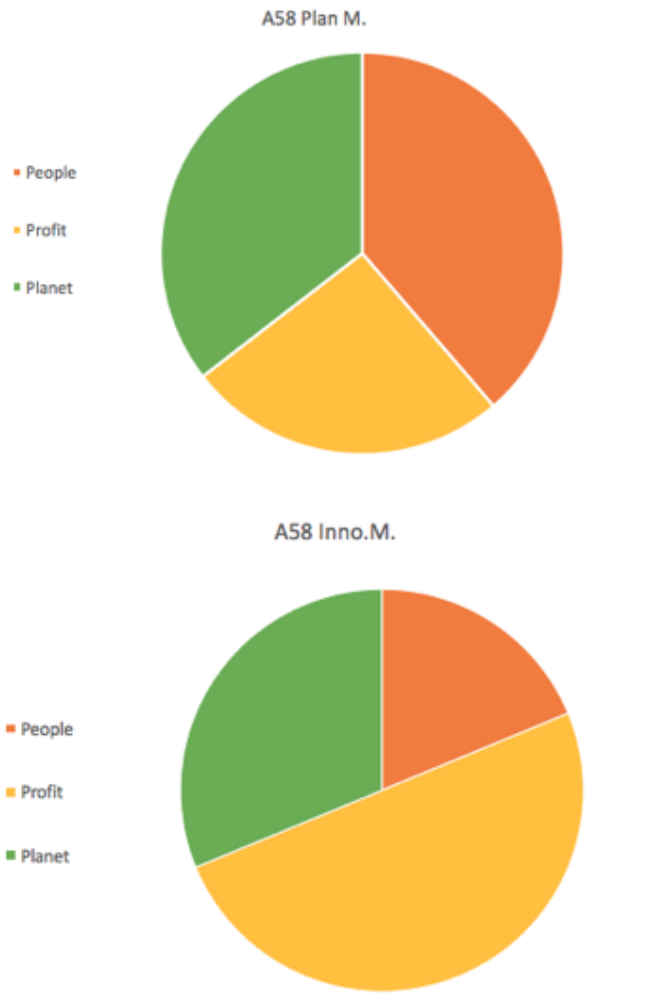


FIGURE E.1: Inclination of extra IPM roles towards sustainability dimensions

Appendix F

I3PM Model

F.0.1 Validation Protocol

A researcher will have to follow a five stage process to successfully conduct a focus group session;

Stage 1 : Defining the purpose Focus group sessions have been used for multiple purposes in research; to explore a new topic, to develop a program, to evaluate a topic etc. In this case a focus group session has been held to evaluate the success of a model.

Stage 2 : Developing a methodology In stage two critical decisions are made in regard to conducting the session. The decisions include; finding the right members for the session, developing the semi-structured interview questions and preparing the logistics.

Stage 3: To facilitate the session Before the start of the session, the facilitator should be abreast with the questions and the necessary prompts' to encourage discussion, second a note taker should be appointed to record or take important notes of the proceedings. Once all the members have arrived it is important to introduce the members to make them feel comfortable. After a brief introduction the facilitator will begin to convene the rest of the session.

Stage 4: Analyzing Data Right after the session, it is important to gather all the information from the session and dissect it to make meaningful analysis. An important method of data analysis is data reduction and data grouping. This can be done through the development of concept maps, different shapes and line thicknesses can be used to represent relevance and importance of concepts.

Stage 5: Reporting The last stage is to report the entire process followed and conclude with findings from the analysis stage.

After following the above steps, the below validation protocol is followed. There are two aims of the validation procedure which reflect in the validation protocol. First, validation of hypothesized SSFs under stated IPM roles and validation of proposed definitions of SSFs. In order to do this, the context of research, findings of cross case analysis and reason for conducting a focus group session is explained to the experts by means of a power-point presentation. At the end of the presentation, there is discussion among experts to provide critique and suggestions to the proposed model. After the discussion, experts are handed over a questionnaire (see below for questionnaire). This questionnaire consists of sixteen SSFs with their definitions and hypothesis under responsible IPM roles. At the end of questionnaire

session, there are three close-ended questions and an open question which help in validation of I3PM model.

Appendix G

Meta-Matrices and Validation Exercise

Name/IPM Role	Educational background	Professional Role within RWS	Experience in RWS projects (in yrs)	Experience in highway projects (in yrs)	Experience as an IPM role (in yrs)	SSS	Feelings/Concerns	Inclination to sustainability dimensions	CSFs related to Project Characteristics	CSFs related to Project Management	CSFs related to Contracting	CSFs related to Leadership & Team	CSFs related to Policy & Strategy	CSFs related to Stakeholder Engagement	CSFs related to Resources	Interactions of IPM roles	CSFs suggested for other IPM roles	Main Problems	Suggestions	Top CSFs	New CSFs
CM	Civil Engineering (concrete mechanics) TU Delft	Contract Manager	26	25-26	10	CO2 prestatie ladder, DuboCalc (frugal and efficient use of materials); ENMI criteria; Landscape character; accessibility; construction waste; energy efficiency; energy production; construction transport; safe mobility; traffic level; 26; 27; local stakeholder involvement; knowledge exchange and value	energy neutral highway is possible; sustainability is not a challenge, change in mindset required, there is support from others (stakeholders and RWS)	Market (contractors) oriented profession (More prosperity and people dimensions)	RWS Koers 2020 ; Municipality of Almere wants a green image and helped in scoping; Everyone wants an energy neutral road	Risk management carried out from EMVI criterion; information is needed (land use plans) before implementing a solution; land use plans are needed before planning for a solution on land, we need to check with law, to use solar panels or a wind mill	EMVI criterion was used for sustainability; EMVI to tackle risks related to high impact; DBFM contract was used for Operations and Maintenance; SSS, EMAT; **DBFM contract helps in sustainability**	Our minister supports the project; we have DM and CM who also have a technical background - easier to communicate; I do not have all the answers I need to ask others (experts within or outside RWS)	Increase in planning duration lot of checks, strict regulations of RWS for innovations	Early involvement and Partner nature of Municipality of Almere; our minister wants this project	Invest more in the beginning, it is possible to achieve a energy neutral highway	OM and TM must consider SSS in TB procedure, after that it is my responsibility to make sure it does; we are a pilot for early involvement of same IPM team	Project management methodology and information sharing was done by MPB	Introvert nature, in discussions. Be open, work together not against	Team members must have affinity for sustainability; Have ambitions dont think it terms of risks but chances; Not saying NO too early, have an open approach (extrovert nature very imp), involve stakeholders at an early stage, listen to them to reduce future difficulties	Project Characteristics; Contract Management, Collaboration between project parties, stakeholder engagement, clear goals	Be ambitious, don't think in terms of risks but chances; open & ambitious team;presence of extroverts
TM	Civil Engg in TU Delft	Technical Manager	16	9	9	Energy production; multifunctional; energy use; energy efficiency; construction waste; construction transport; visual & experential sustainability; local stakeholder involvement	The process could be quicker; lot of checks for sustainability	(Two main goals for a TM - ensure quality and safety of people; (More Planet oriented)	Municipality of Almere wants a green city; RWS 2020;we made a system step to that goal	we check on quality is high enough; health and safety considerations;	DBFM contract, more details with CM	The fact that our PM stated the idea of sustainability way earlier helped us; she is a strong woman with a wide network	saying to contractor we need energy neutral highway was too broad, we had to establish the energy demand;	Check with stakeholders (about land use plans) before you think about a solution (wind mills or solar panels you need permits	Ecoxand solution; When I don't have a person like that in my team, I have to find him/her somewhere in the organization. And if it is not in the organization, then the market is approached (external hiring).	Not only technical, I also think about stakeholders and contact with other roles; when you have to do things together, you have to communicate and understand each other. And it takes time to understand. It is not a problem I think it as a challenge	Technical background of other roles helps in communication; MPB can help in estimating NKI in future;	New things are difficult (hard to do new things) - too many checks in RWS (Because we have a big organization, someone wants to know everything. We have to talk, about permits, rules, regulations. So we check, check and check, until the contractor can use that idea); Mostly innovation has its risks and the risk we (RWS) don't want to take; due to certain laws we could not implement ecoxand concept on property owned by RWS; it is extra, then he (minister) say well I don't want extra things, just do the things we have to do and not move than that.	Have discussions with client about SSS, I have ideas but I don't know how much it costs; when there is someone on a higher, at the government who says we want this goal, we want to do it better, there are more possibilities	competent pm, pm early, competent team; early involvement of stakeholders - Because, the fact that ingebog has mentioned this as an opportunity at a very early stage of the project, in planstudie, we made it (happen); learning from current & past experiences; use of tech; early involvement of stakeholders	Generating value; have good/smart/out of box thinkers for achieving cost
MPB	Physical Geography	MPB	10	5	5 (Was also PM for a water project)	/	My role is to monitor only	/	When I came to the project, sustainability was already there	I have team, who does WBS, Risk Management, Quality control; I am responsible for information management, not coming up with information, this other roles have to do and I help in distribution	/	I coordinate the weekly meetings; I prepare the agenda; when a role is not on track I tell him look you are running late;	My team carries out the planning and monitors progress, we ask the IPM roles how much time and money they need; after discussions with TM/OM I discuss with PM if we can have the resources; I need clear goals to carry out my task	Municipality of Almere is an important stakeholder in our project; you know about Floriade	If they (IPM roles) need more resources, they come to me	I talk to all roles, directly or indirectly (one of my team persons goes and talks to their team person, if there is any problem)	Other roles should tell me earlier how much time and cost do they require, then I can arrange it; not to be too late	No problems for my role	More communication	CSFs in project characteristics; Top management support (without it you cant do anything); collaboration (natuurlijk for sustainability); integrated team (it is a team work, not individual task); stakeholder	/
OM	Civil Engineering (Rail, road construction and traffic - TU Delft)	OM	20	20	8	Energy neutral theme	Stakeholders and environment is important; also higher management	Stakeholders /Society oriented (People dimension)	RWS policy; personal drivers; support from Almere (due to Floriade); during the process ambition about SSS grew (increase in Scope)	We had a strong MPB, who was monitoring us, checking on the risks; we work in the same building wherever needed we walk to each other's room for a talk;	DBFM contract, more details with CM	4 years ago they were not very supportive in my opinion but later on, the policy of the ministry changed, they became more supportive, despite that fact, the budget was still very important; we had talks with Almere and other stakeholders who later become our partners; I think we are a good team; Our PM was in talks with the minister, she did a lot of advertising and that helped	We started it early in the discussion, planning was smooth; RWS policy	We had support from local government; Our PM was in talks with the minister, she did a lot of advertising and that helped	In terms of sustainability experts, RWS has quality but not quantity	For IPM team, in our situation we are all working on the floor above here. Very close to each other. So we talk on the, breaks, and we walk in each other's room , very easily; manager projectbeheersing she was very strict. She is also the chairman of our meetings, not the project manager. And that helped a lot, that one person has responsibility for progress. Has the power to force is to limit	I work with TM and CM, for developing the eisen (requirements); they have to listen to the wishes of the environment	Ah, the cooperation of the stakeholders is very important and luckily they did cooperate, even stimulate in the case of Almere. It helped a lot; What also influenced the process was the standards within RWS, the best practices, there is a RWS internal website, lot of best practices and rules that we have to follow, unless we have good arguments ; There was a strict budget about energy neutrality and we had to prove that and as I told you, we could prove that with business case and the fact that we had a DBFM contract that helped	It should always be part of the OPDRAOIT, that is very important. At this moment in time, you need some project to investigate things, lot of sustainability themes are developing very fast. We need some budget to make it practical in our projects; More communication and lesson learned,, We do that not very frequently within RWS, can be a lot better	I can certainly not do that alone, ah, most important is to keep talking about it, keep selling, keep communicating and ah yeah. We repeat very often why we do it and what we want	/

Stakeholder s - RWS as owner, municipality of Almere, province of Flevoland, sector authority, Havel authority

	People	Planet	Property
CM	4	4	4
TM	3	4	5
OM		1	
MPB			

Name/IPM Role	Educational background	Professional Role within RWS	Experience in RWS projects (in yrs)	Experience in highway projects (in yrs)	Experience as an IPM role (in yrs)	SSS	Feelings/Concerns	Inclination to sustainability dimensions
PM	Engineer Technical Hogeschool Delft	Project Director	30	10 to 15	8	Visual & experiential; Landscape character; safe mobility, toxic materials, noise, energy use, energy efficiency, renewable energy sources, energy production, frugal efficient use of materials, transport, Local stakeholder involvement, knowledge exchange and value optimization	Sustainability is a demand from society	All dimensions (see pie chart)
MPB	Civil Engineering and Management	Senior Advisor Project Beheersing	18	13	10 (sometimes as CM)	Visual & experiential; Landscape character; accessibility, functional flexibility, frugal efficient use of materials, transport, air quality, noise, Local stakeholder involvement, knowledge exchange and value optimization	I like working for RWS, previously I worked for engineering firms, they are always about profit, profit, profit. Here (in RWS) we make roads or bridges considering the environment and society	Professional role not effected
CM	Technische Bedrijfskunde, Civil Engineering	Contract Manager	15	15	10 (PM -1, MPB - 4, CM -5)	Improve mobility and livability (noise, air quality including CO2); our motto - they have to enjoy, while we are working; For noise reduction, there was a special goal between RWS, Rotterdam and Lansingerland, it was called SALDO NULL (Balance 0) we said we cant make more noise, than the noise there was in 2012	Sustainability needs to be understood clearly	Almost balanced
OM	Civil Engg (specialized in spatial planning)	OM (deal with external relations of project)	10 to 12	10 to 12	10	Visual & experiential; Landscape character; accessibility, climate adaption, toxic materials; air quality; noise; water quality and hydrological system; Biodiversity; Local stakeholder involvement	it is an open construction with screens (geluid screermen – noise screens) but the population and local authorities said, it must be closed construction or tunnel, to make it acceptable for us	More society/stakeholders oriented

Name/IPM Role	CSFs related to Project Characteristics	CSFs related to Project Management	CSFs related to Contracting	CSFs related to Leadership & Team	CSFs related to Policy & Strategy
PM	We have a tunnel, which is now half underground due to noise, air quality reasons said by locals	Sustainability means a lot of discussions with stakeholders and also among us, for these discussions we have to conduct some studies and discuss within before we discuss with them.	EMVI criterion	I am more of a soft skills focused manager, those are very important for me; sustainability must be important for everyone in the team; support from higher management is necessary for any project	There were few delays (almost 2 years) because of external lobbying
MPB	Clearly defined scope is very important for any project, irrespective of sustainability	We discuss risks and then I make sure to monitor them regularly, As a MPB this is one of my main tasks, along with information management and quality control.	We had EMVI criteria for sustainability; whether sustainability affects the choice of contract I cannot comment on it	We had a slight issue, a delay of 3 years, it could have been lesser if we knew about those issues earlier;	
CM	Main client (Minister) wants it and also our internal assest manager (main driver for energy reduction); Policy 2020; need more discussions or earlier goals (difficult to define scope)	We organize brainstorm sessions, risks are managed through choice of contract (DBFM, reduces risks on us)	one of the three criteria in EMVI is sustainability; To get the right contractor	We also have to consultate the COB – a knowledge platform of tunnelling for our project wrt to SSS; IPM team was more committed to sustainability; we also organized brainstorm sessions to, find out what is achievable and what can and what cant. And if you make specific objectives, specific goals, you make them realistic, you discuss about it, organize brainstorm sessions and also in our dialogue, we talk with our contractors, if it is realistic enough, we ask more, can the target be higher or more less; the project manager has an important role in, getting supporters from the bosses and stakehodlers. That is an important goal, without supporters, you cannot reach any goal.	if you make it, integral part of your work of project, it can be achieved, without delay. Sustainability cannot be separated from your main project, has to be integral part of it and then it isn't the case of delay; selection of 5 themes helped in clearer goals
OM	there is a tension between the ambitions of the local groups and ambitions of RWS based on legal standards, when you take into account sustainability, you see a tendency to give more attention to the higher ambitions of the local authorities, it goes in the direction of our ambitions with regard to sustainability but we cant, not all those ambitions are realistic given limitations of budget and so on, so there is a tension. Uhm, but sustainability gives extra motivation to discussion, to come to a higher ambition with RWS, to dimish the difference between ambition of RWS ambitions and local ambitions.	For managing risks, In principle, there is tension between the approach used by RWS and from the environment (omgeving), population and local authorities. When you take into account the ambitions with sustainability, it gives more, same address as earlier, it gives more discussions about standards	EMVI criterion	they (new SSS) added more time, like caused more delays, we have to do more talking and more discussions with the respective parties; there is a lot of support for some issues but for some issues it is far less, at first we didn't do it then the community went to court , lot of discussions and those issues were relevant and we have to do them, one way or the other; conflict about inclusion of community in decision making: We (IPM or RWS) can say we don't have to listen to the population, but when a local authority says, you have to deal with our subjects (population), if you don't, you have a problem with us. That was the point where IPM team came together about the approach.	Legislation on number of subjects, discussion with stakeholders; As it comes to the visual and aesthetic sustainability, and landscape, it wasn't part of the planning, at forehand, so it gave a lot of difficulties during the planning. These things came up in planstudie, these issues were more tension, you had to do with it and then there is, uh, there were lot of difficulties with regard to planning.

Name/IPM Role	CSFs related to Stakeholder Engagement	CSFs related to Resources	Interactions of IPM roles	CSFs suggested for other IPM roles	Main Problems	Suggestions	Top CSFs	New CSFs
PM	OM takes care of demands from the stakeholders; OM is involved with municipalities	Sometimes we need help from experts; An external agency was consulted to help us with sustainability	I have to look over everyone; I must know everything about the project, not in detail but I must know, it is my responsibility; sustainability is in the eyes of the beholder	Contract management is extensively used by CM; PCM is responsible for coordinating tasks (such as risks and planning) OM takes care of the environment; if any of them have a problem that they cant solve, PM gets involved and tries to solve it	Defining good sustainable goals; which are practical; having space for sustainability	Talk more to the client about it; also get to know the wishes of stakeholder early	Awareness of project nature; awareness of project external factors; information sharing within the team; contracting; collaboration between parties; early involvement of stakeholders	
MPB	The local community is important, they have the right to go to court if they don't feel good about the project		Helicopter view is a big word, I am a level lower to PM, I am facilitating everybody to do their thing; I oversee tasks of other IPM roles	It is same way as before, the OM wants to please stakeholders to get the approvals for highway, then TM is focused only on road (number of lanes); for sustainability you need talk about it with each other, not separately	\	More communication required; involve stakeholders;	Clearly defined scope, Monitoring and control, Risk Management, Proper selection of contracting strategy; Early involvement of stakeholders	
CM	we looked at our needs for the way, we called it "samen hamen built", together we make one design where we can fit the way in the environment – that was our team, for the design of area; PM getting support from bosses is important	The budget was not an issue, because the targets in sustainability helped the budget, reducing energy also helps to reduce the costs. So we had same goal, or same direction, (PB and CM). and this project is not a project where the costs is that much important, we have enough budget. So it is easier to do something more than possible/we can.	TM makes the reference design; The most interaction is between CM and TM. Specially, the technical manager in combing all the issues together, look where there is conflict of issues, between sustainability and technical construction, costs; With OM the interactions are to know the need of stakeholders	So my contract and contracting process are two instruments so every target we want to achieve with our organization. I have only two instruments, so put the wishes in the contract and in the process, then I can manage them; if organization don't want it, I cant achieve it	Really difficult, each stakeholder has own target and has own, what he finds important, so till now, there is discussion what is important for them, what is important for us, and it is becoming less and less but there is still discussions; I think the most discussion was about the theme sustainability, is the step from sustainability to specific themes. What themes can we chose, when we chose the 5, it was ok but before that, the 12 was difficult. Every manager has his own view about sustainability. Some maybe really big, some make it really small. That was the discussion, when you have themes, when you have targets, then it will become ok.	Have discussions, the sooner the better; You must pick specific teams, specific targets and specific projects. That makes it manageable; also I think it needs to be part of our format! It is not a standard in our formats, have it in the policy – sustainability be part of project plans, opdracht. And then it is for projects easy to give a, to make it part of the project.	Awareness of project nature; top management support; competent team; integrated project team; client involvement; clear goals	
OM	this was the starting point of the negotiation, negotiation is not only discussion with the minister and local authorities. Lot of work, lot of co-designing, lot of looking for alternatives, and to assess those alternatives for quality and area around the road and the costs and after a lot of studies and discussions, there was an agreement about a construction, um, as a tunnel – closed construction – half in the ground, half over the ground, it was a made a plan to adapt the area		Responsibility of CM to make requirements; Its very important to take into account sustainability in discussions with the external parties prior to the contract phase, so I can help the CM.; With the PB, its mainly then the issue with respect to the scope of the project. What we are doing, how much time it costs us and so on.; the OM can assist the TM in defining the technical requirements on the project result based on design solutions. The TM can help OM by judging the, he can say, whether a certain solution is realistic or technically feasible or not.	I don't think, that is an issue for IPM team. Use of proven or new tech is a decision for the contractor.	Discussions about tunnel; Noise protection; Local stakeholders; To protest or complain, yes and the local authorities were convinced that their wishes were realistic – nah, to make it reasonable or feasible? it wasn't feasible first, it could be feasible in the next discussion; for me one of the main problem is that, there is not a clear definition of sustainability. Everyone gives his own view, his own approach. Its not always easy, often very difficult to come to an agreement, how to define sustainability and to make, to come to a common approach.	At the end we said, Rotterdam has to do it, the minister is not responsible for the recreation connection; it is important to get the population a certain role, when you look to the issues and type of agreements, the agenda and final agreements, then sustainability and omgevingsweizer has an influence, LARGE influence, because it gives more ruimte (space) for the discussions/decisions about the standards and quality of the end result; For me, the omgevingsweizer, is very fine and useful method. In a project now, I am using omgevingsweizer, just to come to a common approach; it is very important for the OM to come to an approach where duurzaamheid/sustainability is part of the political discussions;	Awareness of project external factors; proper selection of contracting strategy; proper selection of project execution resources; early involvement of stakeholders	

main stakeholders : governments of Rotterdam and Lansingerland, two water authorities and the province of zuid Holland. Other stakeholders which are also important but not that important as previous mentioned – HSL, RandStadRail and ProRail van railway station Rotterdam and Gouda, we cant disturb them, so we have to make to build the project without affecting their work.
Those were governmental stakeholders, also the locals, inhabitants, local companies and we have also, Airport. It was not an active stakeholder but were considered, they also did not want any disturbance in their respective areas, while designing or making the highway.

150 different stakeh

Name/IPM Role	Educational background	Professional Role within RWS	Experience in RWS projects (in yrs)	Experience in highway projects (in yrs)	Experience as an IPM role (in yrs)	SSS	Feelings/Concerns	Inclination to sustainability dimensions	CSFs related to Project Characteristics	CSFs related to Project Management
IM	University of Twente, Civil Engineering and Management	Works in Sweco (Smart Mobility Department); since December 2016 as an Innovation Manager to RWS	17	17	7 years of experience in role of innovation manager (has worked as OM and TM for RWS projects also)	Circular economy, carbon reduction, less energy consumption, minimize environmental impact - these are main goals, we have many ambitions as well	Sustainability is a demand from society	Works in feasibility domain	The public mind-set now is that, it has to be sustainable or more sustainable than it used to be; You also see in politics now, with the climate agreement in Paris and I also hope with the new cabinet in Netherlands, sustainability becomes a very important theme for the new govt; project environment asks for it; for scoping we look if the innovation helps us to reach one or multiple of our goals; also if it helps SMARTWAYZ programme	Risk sessions, Risk of high expectations; Risk - innovations cant be implemented due to a rule/norm (inform decisionsmakers, create enough understanding within RWS); weekly info meetings with IPM,
MPB	Two Master degrees – Planning and Economic Geography (University of Groningen)	Project Control Manager	Around 9-10 years	2	1.5			Well not, actually not that much. The only thing you see is, you get more, the process of Risk Management doesn't necessarily change because of it. But we do have different risks than other projects; I am still doing financial management, the way I normally do it	Clearly defined scope is very important for any project, irrespective of sustainability; The drivers I think are politics also	everybody wants to say something about, a decision that we are making or something that we are doing, which is not good for the process, cuz its slowing the process of decision making or money or getting things done (too many stakeholders cause of this problem); sustainability is part of innovations and innovations was part of WBS
TM	HTS – higher technical school	Technical Manager (Line Manager)	37	37	11	I think the most important for me, functional flexibilit; multi functionality; construction waste; safe mobility; noise; I think materials, circular economy, circular ontwerp, new type of asphalt; reduce the noise, NOx, CO2.		Physical impact on the surroundings		
PSM	Specialized in spatial planning	Plan Study Manager	25	20	11 (PM - 10 to 12; OM - 5)	LCC, zero environment effects; stimulate innovation		More society/stakeholders oriented	there were very interesting innovations if you compare them with the new policy goals; Several companies were connected to the verkenning fase, they see innovA as a good showcase; scoping in innovations you have to select, some things, that is a problem - to make a good selection of things you have to do in a project and the things you cannot; for support It was not clear enough, on what we have to do. RWS is an organization that want to have a very clear scope	we have weekly, together with the IPM team, like this morning. We have issues, we talk about them; We have a risk managemen (through risk sessions) t, we got scope management (scope beheer). Planning

Name/IPM Role	CSFs related to Contracting	CSFs related to Leadership & Team	CSFs related to Policy & Strategy	CSFs related to Stakeholder Engagement	CSFs related to Resources
IM	That is complex with innovation, if there is only one party who can do innovation, it is not possible to hire that party. So that's another difficulty, especially now what we are doing in our living lab, to hire that part that has the best idea.	list of 100 plus innovations by interviewing constructors, other kind of parties in the market, discussions with schools, universities, Lot of people from RWS and these discussions gave us a long list,	RWS has a lot of norms, for asphalt, structures, for everything there is a norm, at least one; we have doestelling in dutch and ambities in our planning; so far no delay in planning but in next there are crucial moments for innovations to be proven in living lab	100 list of innovations; We had three sessions with our stakeholders, where we discuss and present our results; ask them, what are their wishes, what are their requirements; contact with client is done by PM	we started to work with expert teams within RWS; Capacity, hands and brains. That is continuous struggle within RWS,
MPB	BVP for hiring witteven en bos for OTB procedure	Yes, certainly collaboration is must. Because there is a lot of knowledge that RWS does not have about sustainability		evenings where we invite people over and talk about the project and we put this in a big database with their wishes.	that makes it hard and it also happens sometimes that we need signatures for decisions or the money we need to have and then it takes a long time to get the signature, because they (Huub, Dick) need to know all the details what is going on and some other people also, so yeah its hard; It was always a problem to get the team filled for innovation and sustainability
TM	best value contract, they have told us how they bring these, we think it is a good plan van aanpak to do this job, it is only a feeling that they can deliver us a good result.	we don't make design on our own, with witteven bos, we have to do	RWS has a whole package of rules and norms; witteven bos has to go through various stages within the planstudie phase, where they have to show you the design. During these stages, my responsibility is to check, but innovations are new, so far I have a good feeling	So if we have a circular economy design, the owner has to take it from us to maintain it. So that is a very important, key stakeholder. In this, so he has to be informed, he has his own rules, maybe, but is a very important stakeholder.	
PSM	DBFM - contract manager has more information	top support - I think the internal organization here, there is not so much support, for them most important is that, when the works are ready (on time). That is the most important point, the environmental goals are secondary; very high commitment level. of IPM team; if we do something with renewable energy, we want to have energy and a energy neutral highway. Then we have to, to produce electricity, we cant produce on our own assets, so we have, for instance we need a windmill, solar screens/panels	because of rules and sometimes, new things are difficult; you have an innovation for noise, a new technique, there are rules by law, they are strictly defined in law, what you can do and what you not can do, and you can only use proven technology; sometimes you have to take the time that is necessary to have a good answer on questions.	all organizations have one representative person, and there are having a group, the group is advising the project, PM talks regularly to our client	

Name/IPM Role	Interactions of IPM roles	CSFs suggested for other IPM roles	Main Problems	Suggestions	Top CSFs	New CSFs
IM	Mainly TM and OM, to discuss about innovations; The CM can help me by thinking with me in ways to set those experiments into the market (innovative partnerships)	The least with the TM, but sometimes also with the TM, with the CM and OM it is not always clear what impact innovation would have on their role. So we discuss that, but I do not always have the answer	I think the most difficult is to create space for innovations in the internal RWS norms; There is a lot of information about things like circular economy, to me the main challenge is to get the right information out of all this overkill of information		Clearly defined scope, top management support, clear goals	They think what we cant solve now can be solved by innovations and that creates high expectations about innovation. And it is not wise to have that high expectations on these short terms.
MPB	we have our innovation manager and I have a risk manager in my team. The risk manager is having challenge sessions with the innovation manager; We are already talking about measures if it would happen, what would we do and what can be done and I am not sure about all the measures because I am not the planstudie manager or environmental manager but we talk with OM and PSM with these kind of risks, during the challenge sessions but also during the IPM team	challenge sessions, risk sessions	expectations; having two bosses at the same time – yeah exactly	Expectation management, PM defines boundaries; sharing of information	Awareness of project external factors; monitoring and control; information sharing within the project team; proper selection of tender process; collaboartion between parties; early involvement of stakeholders; clear goals, legal processes	
TM	Need documents for witteven en bos, So within the team Omgeving Management, we have a good feeling together to solve this problem, that is another important point for TM for get the people together and bring the documents that is needed.		specialists of RWS, don't agree with changing the rules/norms etc and then innovation can't go further. That is my BIGGEST WORRY for Innovations. (ROK)	I don't know, I don't know! I haven't the experience from other projects because innovations is something new. That is the point that worries me the most, I cant get specialists behind me, to change the rules.	Risk management; top management; competent team; collaboration between parties; integrated project team	
PSM	I think Planstudie Manager and OM must be one. So we help each other. TM I try to help him, to let him understand what we need for group decision making, not only to make a good ontwerp (design) sometimes you have to make another design to compare things.		expectations are really high. They expect many environmental solutions, that is not always possible, so yeah, its very difficult problem; problem in RWS organization, sometimes it is not, it doesn't fit by the rules, or by the way we do maintenance of a highway is done	We tell everybody we try to do it, but we are also not sure that it will be like that. Expectation management	Awareness of project external factors; competent team; integrated project team; client involvement	showcases, you can, if early in the process if you have things, that can be seen, if you have a pilot or a showcase

	SSF	Definitions					Level of Agreement
Project Characteristics	1. Awareness of project external factors	The awareness of project regarding sustainability goals/ambitions with respect to policy, society, technology and economic context					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	✓	✓	✓	✓	✓	Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
	2. Clearly defined scope	A clear, well defined scope for sustainability goals/ambitions through establishment of boundaries and constraints (standards) & acknowledgement of ambitions by the client					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	✓	✓	✓	✓	✓	Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
Project Management Process	3. Information sharing within the project team	Use of timely (active) distribution of necessary and valuable information regarding sustainability goals/ambitions through efficient communication channels from different project parties within the project team					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis		✓				Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
	4. Monitoring & Control	Use of standard control and monitor mechanisms for sustainability goals/ambitions through detailed plan, change management process, inspection/supervision and feedback mechanism to ensure acceptable progress on time, cost and scope.					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis		✓				Agree/Disagree
	Your interpretation						
	Comments/Suggestions						

	5. Risk Management	Use of risk oriented warning system and risk sessions to identify, define, analyse and assess risks pertaining to sustainability goals/ambitions					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis		✓				Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
Contracting	6. Proper selection of contracting strategy/tender process	Use of an adequate contracting strategy and competitive tender process that incorporates and promotes sustainability goals/ambitions (explicitly states sharing of risks and clarity about responsibility)					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis					✓	Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
Leadership and Teamr	7. Collaboration between project parties	Required level of collaboration/cooperation among project participants for definition and implementation of sustainability goals/ambitions through an open (positive) attitude and effetive communication					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis			✓	✓	✓	Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
	8. Competent/multidisciplinary team	Use of a suitably qualified project team to define and achieve sustainability goals/ambitions					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	✓					Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
	9. Top management support	Commitment of senior management of the organization for the sustainability goals/ambitions					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	✓					Agree/Disagree
	Your interpretation						
	Comments/Suggestions						

	16. Affinity for sustainability	Presence of ambitious nature, personal drivers and like-mindedness within the project team for sustainability goals/ambitions					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	✓					Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
Stakeholder Engagement	10. Client involvement	Timely consultation of client for decisions and support regarding sustainability goals/ambitions					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	✓					Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
	11. Active involvement of stakeholders	Timely involvement of stakeholders, in various stages of project to improve commitment, provide continuous support, lay grounds for negotiations, minimize opposition, develop mutual trust and improve overall communication for the sustainability goals/ambitions					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis			✓			Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
Policy and Strategy	12. Clear Goals & Ambitions	Clear goals (obligatory) & ambitions (that have added value) regarding sustainability, linking to the requirements of the client					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	✓	✓	✓	✓	✓	Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
	13. Sustainability Policy	Presence and awareness of a sustainability policy within the organization which helps in achieving sustainability goals/ambitions					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	✓		✓	✓	✓	Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
	14. Systematic planning	Use of a realistic and detailed project plan to achieve the sustainability goals/ambitions					Agree/Disagree

	Responsible lPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis		✓				Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
Resources	15. Adequacy & Efficiency of Resources	Presence of available and competent resources for achieving sustainability goals/ambitions					Agree/Disagree
	Responsible lPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	✓	✓				Agree/Disagree
	Your interpretation						
	Comments/Suggestions						
Questions							
	Can you confirm whether the proposed SSFs could help improve chances of project success of a sustainability oriented highway project?						Yes/No
	Comments/Suggestions:						
	Should something be introduced and/or changed within the boundaries of the proposed model?						Yes/No
	Comments/Suggestions:						
	Would you re-structure the proposed model?						Yes/No
	If Yes, How?						
	In addition to the proposed solution , what would you recommend to management sustainability in highway projects?						
	Comment/Suggestions:						
	Dank je wel!						

Project Characteristics

	SSF	*Definitions*					Level of Agreement
	1. Awareness of project external factors	The awareness of project regarding sustainability goals/ambitions with respect to policy, society, technology and economic context					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	X	X	X	X	X	
	Expert 1	✓		✓			Planmanager very important, sustainability is not restricted to a project but needs a area/societal orientation
	Expert 2	✓	✓	✓	✓	✓	In definition, add the word "environment"
	Expert 3	✓	✓	✓	✓	✓	Agree
	Expert 4	✓		✓	✓		MPB and CM join later, in beginning of project PM, OM, TM must be more aware
	Expert 5	✓	✓	✓	✓	✓	Agree
	Expert 6	✓	✓	✓	✓	✓	Agree
	Expert 7	✓	✓	✓	✓		Disagree: CM is only for contracting
	Expert 8	✓	✓	✓	✓	✓	Agree
	Expert 9	✓✓	✓	✓	✓	✓	Yes, important to everybody but most important to PM, so I give two here.
	Summarize	100.00	87.50	100.00	88.89	66.67	
	Comments/Suggestions						
	2. Clearly defined scope	A clear, well defined scope for sustainability goals/ambitions through establishment of boundaries and constraints (standards) & acknowledgement of ambitions by the client					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	X	X	X	X	X	
	Expert 1	✓	✓	✓			Contradiction between clearly defined scope and sustainability ambition, which need space for exploration

Expert 2	✓	✓	✓	✓	✓	Well defined scope & goals could contradict. A clear defined scope can limit the goals/ambitions. Scope must be flexible.
Expert 3	✓	✓	✓	✓	✓	Disagree: As OM you're looking for the extra space, and extra profit (benefits) for stakeholders, you have got to be flexible
Expert 4	✓		✓		✓	Disagree : same as 1
Expert 5	✓	✓	✓	✓	✓	Instead of boundaries, the focus could be on goals, a boundary can be a minimum
Expert 6	✓	✓	✓	✓	✓	Agree
Expert 7	✓	✓	✓	✓	✓	Agree
Expert 8	✓	✓	✓	✓	✓	Standards are implicit, RWS is expected to uphold them
Expert 9	✓ ✓	✓✓	✓	✓	✓	most important to PM and MPB (to create and monitor)
Summarize	100.00	88.89	100.00	77.78	88.89	
Your interpretation						
Comments/Suggestions						
3. Information sharing within the project team	Use of timely (active) distribution of necessary and valuable information regarding sustainability goals/ambitions through efficient communication channels from different project parties within the project team					Agree/Disagree
Responsible IPM Role	PM	MPB	OM	TM	CM	
Researcher's Hypothesis		X				
Expert 1	✓	✓	✓			Disagree: PM has role in sharing info from outside project. OM also from environment
Expert 2		✓				Information sharing between teams is important
Expert 3		✓				Agree
Expert 4	✓	✓	✓	✓	✓	Disagree: All need to share information regarding sustaianbility

Project Management Process

Expert 5		✓	✓	✓		OM & TM have access to information, that can be distributed
Expert 6	✓	✓	✓	✓	✓	Disagree: Information sharing is a responsibility for every roleholder. MPB is facilitating this.
Expert 7		✓	✓			OM is source of many information and responsible for communication
Expert 8	✓	✓	✓	✓		There are many sources of information. Some (more formal ones) are responsibility of MPB. Others, such as new policy, technical developments etc. are not (primarily)
Expert 9		✓				Classically yes, others should remain proactive
Summarize	44.44	100.00	66.67	44.44	22.22	
Your interpretation						
Comments/Suggestions						
4. Monitoring & Control	Use of standard control and monitor mechanisms for sustainability goals/ambitions through detailed plan, change management process, inspection/supervision and feedback mechanism to ensure acceptable progress on time, cost and scope.					Agree/Disagree
Responsible IPM Role	PM	MPB	OM	TM	CM	
Researcher's Hypothesis		X				
Expert 1		✓				Agree
Expert 2		✓				Agree: Standard; are they flexible?
Expert 3		✓				Agree But - also the other way round, MPB can facilitate opportunities
Expert 4	✓	✓				Disagree: PM also controls
Expert 5		✓			✓	Within CM it is possible to monitor goals & ambitions; it can be part of contract
Expert 6		✓				Agree
Expert 7		✓			✓	Disagree: For the contract part - CM is responsible

Expert 8		✓				Administrating the M&C instruments belongs to the MPB. Acting upon them belongs to all.
Expert 9		✓				Same as above, remain proactive
Summarize	11.11	100.00	0.00	0.00	22.22	
Your interpretation						
Comments/Suggestions						
5. Risk Management	Use of risk oriented warning system and risk sessions to identify, define, analyse and assess risks pertaining to sustainability goals/ambitions					Agree/Disagree
Responsible IPM Role	PM	MPB	OM	TM	CM	
Researcher's Hypothesis		X				
Expert 1	✓	✓	✓			Disagree: Sustainability asks for opportunity management, looking for chances
Expert 2		✓				Neutral: including opportunities
Expert 3		✓				Agree But - also the other way round, MPB can facilitate opportunities
Expert 4	✓	✓	✓	✓	✓	Disagree: Risk sessions are done by all IPM roles
Expert 5	✓	✓	✓	✓	✓	All roles should participate in the risk process.
Expert 6		✓				Agree
Expert 7		✓				Agree
Expert 8		✓				Agree
Expert 9		✓				plus Opportunity Management as discussed
Summarize	33.33	100.00	33.33	22.22	22.22	
Your interpretation						
Comments/Suggestions						
6. Proper selection of contracting strategy/tender process	Use of an adequate contracting strategy and competitive tender process that incorporates and promotes sustainability goals/ambitions (explicitly states sharing of risks and clarity about responsibility)					Agree/Disagree
Responsible IPM Role	PM	MPB	OM	TM	CM	

Contracting

Researcher's Hypothesis					X	
Expert 1	✓	✓			✓	Disagree
Expert 2					✓	Agree
Expert 3					✓	Agree
Expert 4	✓				✓	Disagree
Expert 5				✓	✓	TM is involved with the knowledge about what's possible
Expert 6					✓	Agree
Expert 7					✓	Agree
Expert 8					✓	Agree
Expert 9	✓				✓	I think it also, boss work
Summarize	33.33	11.11	0.00	11.11	100.00	
Your interpretation						
Comments/Suggestions						
7. Collaboration between project parties	Required level of collaboration/cooperation among project participants for definition and implementation of sustainability goals/ambitions through an open (positive) attitude and effetive communication					Agree/Disagree
Responsible IPM Role	PM	MPB	OM	TM	CM	
Researcher's Hypothesis			X	X	X	
Expert 1	✓		✓	✓		Neutral: Also Planstudy manager
Expert 2			✓	✓	✓	Agree
Expert 3	✓		✓	✓	✓	PM has to take a leading position to seduce other local govts and to conect with the own higher management, the minister and his/her staff
Expert 4	✓		✓	✓	✓	PM also facilitates collaboration
Expert 5	✓		✓	✓	✓	PM has contacts on a higher level across different projects
Expert 6			✓	✓	✓	Agree
Expert 7			✓	✓	✓	Agree

Expert 8	✓		✓	✓	✓	Agree: Depends on the project (size & complexity) and the stakeholders implied in the term "parties"
Expert 9	✓		✓	✓	✓	PM should also be responsible
Summarize	66.67	0.00	100.00	100.00	88.89	
Your interpretation						
Comments/Suggestions						
8. Competent/multidisciplinary team	Use of a suitably qualified project team to define and achieve sustainability goals/ambitions					Agree/Disagree
Responsible IPM Role	PM	MPB	OM	TM	CM	
Researcher's Hypothesis	X					
Expert 1	✓					Agree
Expert 2		✓				MPB manages capacity on project
Expert 3	✓					Agree
Expert 4	✓					Agree
Expert 5	✓					Neutral: On larger project each manager is responsible for a smaller and qualified team, the PM is leading
Expert 6	✓					Agree
Expert 7	✓					Agree
Expert 8	✓					Agree
Expert 9	✓					Certainly his role
Summarize	88.89	11.11	0.00	0.00	0.00	
Your interpretation						
Comments/Suggestions						
9. Top management support	Commitment of senior management of the organization for the sustainability goals/ambitions					Agree/Disagree
Responsible IPM Role	PM	MPB	OM	TM	CM	
Researcher's Hypothesis	X					
Expert 1	✓					Agree
Expert 2	✓					Agree

Leadership and Tearr

Expert 3	✓					Agree : also mentioned this in 7.
Expert 4	✓					Agree
Expert 5	✓	✓			✓	Specific for RWS; MPB & CM have a role with gaining commitment
Expert 6	✓					Agree
Expert 7	✓		✓			OM can also get support
Expert 8	✓					Agree
Expert 9	✓					This is top dock work
Summarize	100.00	11.11	11.11	0.00	11.11	
Your interpretation						
Comments/Suggestions						
16. Affinity for sustainability	Presence of ambitious nature, personal drivers and like-mindedness within the project team for sustainability goals/ambitions					Agree/Disagree
Responsible IPM Role	PM	MPB	OM	TM	CM	
Researcher's Hypothesis	X					
Expert 1	✓	✓	✓	✓	✓	Disagree: All IPM roles need affinity
Expert 2		✓	✓	✓	✓	Disagree: Everyone should make their own team aware and be willing for sustainability.
Expert 3	✓	✓	✓	✓	✓	Disagree: is not limited to the PM
Expert 4	✓	✓	✓	✓	✓	Disagree: All IPM roles need affinity
Expert 5	✓	✓	✓	✓	✓	It helps if all roles have affinity, otherwise their focus will be on defending their area instead of trying to help another role
Expert 6	✓					Agree
Expert 7	✓		✓	✓		OM is responsible for process and TM for the context
Expert 8	✓					Agree
Expert 9	✓	✓	✓	✓	✓	Must be there for all
Summarize	88.89	66.67	77.78	77.78	66.67	
Your interpretation						

	Comments/Suggestions						
	10. Client involvement	Timely consultation of client for decisions and support regarding sustainability goals/ambitions					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	X					
	Expert 1	✓					Agree
	Expert 2	✓					Agree
	Expert 3	✓					Agree
	Expert 4	✓		✓			Disagree: OM also helps in client (local) involvement
	Expert 5	✓					Agree
	Expert 6	✓					Agree
	Expert 7	✓		✓			Disagree: OM also helps in client (local) involvement
	Expert 8	✓					Agree
	Expert 9	✓					Plus Line Managers
	Summarize	100.00	0.00	22.22	0.00	0.00	
	Your interpretation						
Stakeholder Engagement	*Comments/Suggestions*						
	11. Active involvement of stakeholders	Timely involvement of stakeholders, in various stages of project to improve commitment, provide continuous support, lay grounds for negotiations, minimize opposition, develop mutual trust and improve overall communication for the sustainability goals/ambitions					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis			X			
	Expert 1	✓		✓			Agree
	Expert 2			✓			Agree
	Expert 3	✓		✓	✓	✓	Project should be integral
	Expert 4	✓		✓			PM is also responsible for this SSF
	Expert 5	✓		✓			Both PM & OM to attach to different levels
	Expert 6			✓			Agree

	Expert 7			✓			Agree
	Expert 8			✓			Agree
	Expert 9	✓	✓	✓	✓	✓	Must be there for all
	Summarize	55.56	11.11	100.00	22.22	22.22	
	Your interpretation						
	Comments/Suggestions						
	12.Clear Goals & Ambitions	Clear goals (obligatory) & ambitions (that have added value) regarding sustainability, linking to the requirements of the client					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	X	X	X	X	X	
	Expert 1	✓		✓			Disagree: The PM has to set goals and ambition is wrt environment
	Expert 2	✓	✓	✓	✓	✓	Agree
	Expert 3	✓	✓	✓	✓	✓	Agree
	Expert 4	✓	✓	✓	✓	✓	Agree
	Expert 5	✓	✓	✓	✓	✓	Agree
	Expert 6	✓	✓	✓	✓	✓	Agree
	Expert 7	✓	✓	✓	✓	✓	Agree
	Expert 8	✓	✓	✓	✓	✓	Agree: Translation of policy goals in "practical goals"
	Expert 9	✓	✓	✓	✓	✓	PM could be leading (binary classification)
	Summarize	100.00	88.89	100.00	88.89	88.89	
	Your interpretation						
	Comments/Suggestions						
	13.Sustainability Policy	Presence and awareness of a sustainability policy within the organization which helps in achieving sustainability goals/ambitions					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	X		X	X	X	
	Expert 1	✓	✓	✓	✓	✓	Agree for all

Policy and Strategy

Expert 2	✓		✓	✓	✓	Agree
Expert 3	✓	✓	✓	✓	✓	Is not the direct responsibility of MPB but it is essential that MPB also contributes
Expert 4	✓					Only PM
Expert 5	✓		✓	✓	✓	Agree
Expert 6	✓		✓	✓	✓	Agree
Expert 7	✓		✓	✓	✓	Agree
Expert 8	✓	✓	✓	✓	✓	MPB has a role in making sure those policies find their way in formal monitoring and control systems
Expert 9	✓	✓	✓	✓	✓	MPB for inbetween things
Summarize	100.00	44.44	88.89	88.89	88.89	
Your interpretation						
Comments/Suggestions						
14.Systematic planning	Use of a realistic and detailed project plan to achieve the sustainability goals/ambitions					Agree/Disagree
Responsible IPM Role	PM	MPB	OM	TM	CM	
Researcher's Hypothesis		X				
Expert 1	✓		✓			Disagree: PM is prime responsible. MPB is only coordinating.
Expert 2		✓				Planning should include risks & opportunities (probabilistic planning)
Expert 3		✓				Agree: MPB is the consciousness (geweten) of the project.
Expert 4	✓	✓				PM is also responsible for planning
Expert 5		✓			✓	Both MPB and CM to make sure the planning is realistic; contract also has planning; the contractor has to show their planning, how they do it.
Expert 6		✓				Agree

	Expert 7	✓	✓				PM is also responsible for planning
	Expert 8		✓				Agree
	Expert 9	✓	✓				With room for deviations, sustainability is a quest
	Summarize	44.44	88.89	11.11	0.00	0.00	
	Your interpretation						
	Comments/Suggestions						
Resources	15. Adequacy & Efficiency of Resources	Presence of available and competent resources for achieving sustainability goals/ambitions					Agree/Disagree
	Responsible IPM Role	PM	MPB	OM	TM	CM	
	Researcher's Hypothesis	X	X				
	Expert 1	✓	✓	✓			Agree
	Expert 2					✓	Disagree: Selection of contarctor lies in the contract, thus CM
	Expert 3	✓	✓				Agree
	Expert 4	✓	✓				Agree
	Expert 5	✓	✓				Agree
	Expert 6	✓	✓			?	Agreed after discussion
	Expert 7	✓	✓				Agree
	Expert 8	✓	✓				Agree
	Expert 9	✓	✓				MPB leading
	Summarize	88.89	88.89	11.11	0.00	22.22	
	Your interpretation						
	Comments/Suggestions						
	Can you confirm whether the proposed SSFs could help improve chances of project success of a sustainability oriented highway project?						Yes/No
	Expert 1 Comments/Suggestions: YES. Only if client agree on goals and are prepared to give opportunity space in the scope						
	Expert 2 Comments/Suggestions: YES. But they (SSF) should be flexible.						
	Expert 3 Comments/Suggestions: YES						

Expert 4 Comments/Suggestions:YES	
Expert 5 Comments/Suggestions:YES	
Expert 6 Comments/Suggestions:YES, take in mind that sustainability is not only a project "thing: but more for the whole society	
Expert 7 Comments/Suggestions: YES	
Expert 8 Comments/Suggestions:YES	
Expert 9 Comments/Suggestions: YES, the chances of success are better	
Summary Comment/Suggestions: ALL RESPONDENTS AGREE	
Should something be introduced and/or changed within the boundaries of the proposed model?	Yes/No
Expert 1 Comments/Suggestions: YES. The model says nothing about prioritization. What goals have priority. As long as mobility measures are first, sustainability is additional	
Expert 2 Comments/Suggestions: YES. Flexibility is important for sustainability and innovation.	
Expert 3 Comments/Suggestions: YES, more involvement /engagement of the distrcit & asset manager	
Expert 4 Comments/Suggestions:NO, for this moment NO, but maybe there are other SSFs also.	
Expert 5 Comments/Suggestions:NO	
Expert 6 Comments/Suggestions:NO	
Expert 7 Comments/Suggestions:YES, something with integral responsibility	
Expert 8 Comments/Suggestions: YES, PM in the center. In applying the model, don't be too strict in assigning roles to a particular dimension of sustainability. Be Flexible	
Expert 9 Comments/Suggestions: Yes, I think we should build up, like the innovation manager, community manager, regional environmental agency.	
Summary Comments/Suggestions: During the focus group discussion, experts talked more about flexibiliy in scope and support from client to have a flexible scope/opportunity space for sustainability. Majority of respondents agreed to the conceptual boundaries of the model and had suggestions on improving them and NOT about change to the original model.	
Would you re-structure the proposed model?	Yes/No
Expert 1 Comments/Suggestions: NO	
Expert 2 Comments/Suggestions: NO.	
Expert 3 Comments/Suggestions: NO	
Expert 4 Comments/Suggestions:NO.	
Expert 5 Comments/Suggestions:NO	
Expert 6 Comments/Suggestions: Maybe you can give example of extra roles like planstudie manager and innovatie manager and how they fit in the model.	
Expert 7 Comments/Suggestions: YES, Integral responsibility	
Expert 8 Comments/Suggestions: NO	
Expert 9 Comments/Suggestions: NO, only small elements need to be changed.	
NO changes to the model. Inclusion of extra roles, suggested by 2 respondents	

Questions

In addition to the proposed solution , what would you recommend to management sustainability in highway projects?
Expert 1 Comments/Suggestions: Clear goals, shared by client and environment and opportunity space for the project to reach these goals.
Expert 2 Comments/Suggestions: Freedom to go after goals/ambitions, not limited by scope. Look for combinations with other projects, not focus on your own project.
Expert 3 Comments/Suggestions: Sustainability should be incorporated in the scope
Expert 4 Comments/Suggestions: -
Expert 5 Comments/Suggestions: Make sure there is always an ambiton beyond the scope of the project, and have resources to achieve them.
Expert 6 Comments/Suggestions: To position the sustainable highway as a "area goal" (gebeidsopgave) instead of a project goal.
Expert 7 Comments/Suggestions: Sustainability within the scope of project
Expert 8 Comments/Suggestions: Leadership. Check with client regularly: are we getting there? (wrt sustainability)
Expert 9 Comments/Suggestions: Create external pressure, a watch dog.
Summary Comment/Suggestions:
Dank je wel!

7-Sep-17

Name: Signature: