Study of Success Criteria and Critical Success Factors in planning of infrastructure projects based on stakeholder views

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By

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ABSTRACT

The success of infrastructure projects in India was studied mostly from the implementation and management perspectives while few studies focused on the planning aspects as well, project user perspective remains largely unexplored, especially in Kerala. Despite the recent fast-paced infrastructure development in Kerala involving huge investments, concern over low success levels in infrastructure projects provokes this research to understand the reasons through a study of long-term project success in select transport and water &sanitation projects in Thiruvananthapuram city from stakeholder views.

A total of 506 project users and 47 project professionals in Thiruvananthapuram were surveyed on success levels, success criteria preferences, and success factors for six infrastructure projects to have a sector-wise and stakeholder-wise comparative analysis.

The study finding shows transport projects have higher familiarity among project users and higher success levels compared to water and sanitation projects. Project Success ratings by project users, as well as professionals, show similar trends. Success criteria preference shows a significant correlation to project success rating for some criteria in water and sanitation projects whereas the relationship is very weak in transport projects. Critical success factors (CSF) as per users and project professionals show no similarity among them which aligns with the widely accepted research view. Sectoral comparison of CSFs shows less

similarity between the two sectors with ‘Need-Based Concept’ the only common factor.

This study helps understand the interest and involvement of project users in Thiruvananthapuram on infrastructure development in the city and their needs/ expectations from projects taken up in the city. Inferences from this study in terms of success criteria and critical success factors will form inputs during future planning of infrastructure projects in the capital city as well as guidance for planning future projects in the Kerala state. Inputs from the study will help in better stakeholder engagement and provide ideas for developing a structured stakeholder management plan for such projects. The study limits itself to the success aspects of projects in two infrastructure project sectors viz., transport and water & sanitation focusing on the project planning aspect and long-term success parameters from user and professional viewpoints. The study paves the way for further studies involving a more comprehensive stakeholder assessment of infrastructure projects in various sectors. Project complexity and its effect on success is a newer dimension to focus on in the Kerala context.

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LIST OF ABBREVIATIONS

Acronym	Full Form
ADB	- Asian Development Bank
CFA	- Confirmatory factor analysis
CSF	- Critical Success Factor
EFA	- Exploratory Factor Analysis
GDP	- Gross Domestic Product
GoI	- Government of India
GoK	Government of Kerala
JICA	- Japan International Cooperation Agency
KSUDP	Kerala Sustainable Urban Development Project
KSRTC	Kerala State Road Transport Corporation
KWA	Kerala Water Authority
MOSPI	Ministry of Statistics and Program Implementation, Government of India.
NH	National Highway
NHAI	National Highway Authority of India
PWD	Public Works Department

CHAPTER I

INTRODUCTION

CHAPTER I. INTRODUCTION

1.1 INFRASTRUCTURE

Infrastructure serves to fulfil the human needs of the community, be it the need for shelter, clean air, safe drinking water, proper sanitation facilities, means of transport, communication requirements, power for household as well as to run establishments, security and area lighting, management of domestic and other modes of waste, water management for a variety of purposes, social infrastructure etc. India's population growth along with urban and rural development, changes in lifestyle of general public, newer entrepreneurial ventures have all necessitated development of new infrastructure as well as upgrading existing infrastructure throughout of the country resulting in more and more numbers of infrastructure development works being taken up over the years. The Report of Taskforce National Infrastructure Pipeline states that "*As per World Bank data, India's population has increased at a CAGR of 1.2% during the period 2011-2017 and is expected to reach 1.52 billion by 2030*(Department of Economic Affairs, 2020). *In the last decade, the urban population in India has increased at an annual rate of 2.4%. By 2030, it is estimated that around 42% of India's population would be urbanised from 31% in 2011*". The report also notes that "*70% of the global population will be living in urban centres, some in cities of more than 100 million people,*

infrastructure will determine their quality of life" (Department of Economic Affairs, 2020).The report acknowledges the infrastructure needs of the changing demographics and Environment by stating that "*The changed demographics and environment will need the converged development of a host of infrastructure facilities. From the provision of housing, to water and sanitation services, to digital and transportation needs, there is a compelling demand for increased and improved delivery across the entire infrastructure spectrum. Delivering the full spectrum of required infrastructure will ensure economic growth, ease of living as well as improved competitiveness across sectors."* Other challenges like sustainable and responsible energy management, providing access to clean drinking water and sanitation facilities, provision of social infrastructure and means of financing these infrastructure investments are well highlighted in the report.

Past studies have highlighted the link between physical infrastructure and a nation's development/economic growth(Ansar et al., 2016; Floater et al., 2014) and resilience to population growth, poverty alleviation and improving trade. The role of infrastructure in economic development was recognised as early as 1970s whereas linkage to poverty alleviation was examined in 1990s(MOSPI-GoI, 2013). Provision of infrastructure leading to enhancement in quality of life is testified, poor people shared dramatic impacts in their quality of lives caused due to access to

potable water, sanitation or to a road(Narayan &Petesch, 2015).Multiplier effects accumulate to the economy through infrastructure. Apart from immediate project effects like increased labour opportunities and material demand, there are long-term benefits to the community, businesses and the country through infrastructure improvements. Amitabh Kant of Niti Ayog notes that Reserve Bank of India and the National Institute of Public Finance and Policy have estimated a 2.5-3.5x multiplier for public infrastructure spending meaning. for every rupee spent by the government on infrastructure, GDP gains about Rs. 2.5-3.5.

Infrastructure broadly comprises constructing new facilities /improvements to existing facilities in the fields of housing and urban planning, utilities like drinking water supply treatment and distribution, sewerage and sewage treatment, sanitation and waste management, drainage and water management system, roads and transportation including traffic and pedestrian infrastructure, electricity, street and area lighting, gas supply, district cooling, communication and signalling, buildings for hosting public facilities like hospitals, schools, public resting and recreation facilities etc. Quoting Global Infrastructure Outlook 2017, the estimated global infrastructure investment requirement between 2016 to 2040 is $94 trillion of which about 50% is for Asia, roads and electricity being major sectors. India’s infrastructure investment is expected to be about $4.51 trillion on infrastructure by 2030 (Department of Economic Affairs, 2020).

1.2 INDIAN INFRASTRUCTURE HIGHLIGHTS

In an Indian context, Infrastructure statistics manual(MOSPI-GoI, 2013) by Government of India classifies infrastructure into several subheads which is reproduced in Table1.1 below:

Table1.1: Infrastructure Categories and sub-sectors

S.No	Category	Infrastructure sub-sectors
1	Transport	• Roads and bridges • Ports • Inland waterways • Airports • Railway Track, tunnels. viaducts, bridges • Urban Public Transport (except rolling stock in case of urban road transport)
2	Energy	• Electricity Generation • Electricity Transmission • Electricity Distribution • Oil pipelines • Oil/Gas/Liquefied Natural Gas (LNG) storage facility • Gas pipelines
3	Water & Sanitation	• Solid Waste Management • Water supply pipelines • Water treatment plants • Sewage collection, treatment and disposal system • Irrigation (dams, channels, embankments etc) • Storm Water Drainage System
4	Communication	• Telecommunication (Fixed network) • Telecommunication towers
5	Social and Commercial Infrastructure	• Education Institutions (capital stock) • Hospitals (capital stock) • Three-star or higher category classified hotels located outside cities with population of more than 1 million • Common infrastructure for industrial parks, SEZ, tourism facilities and agriculture markets. • Fertilizer (Capital investment) • Post-harvest storage infrastructure for agriculture and horticultural produce including cold storage • Terminal markets • Soil-testing laboratories • Cold chain

As per the National Infrastructure Pipeline Taskforce report, it is estimated that India would need to spend $ 4.5 trillion on infrastructure by 2030(Department of Economic Affairs, 2020). This report projects a vision for "Infrastructure services that raise the quality of life and ease of living in India to global standards" and elaborates on future infrastructure investment plans specifically highlighting project cases and has tabulated sector wise infrastructure investment details which is reproduced below as Figure 1.1.

Table 1 Sectoral share of overall infrastructure investment (Rs lakh crore)

Sector	FY13	FY14	FY15	FY16	FY17	FY18E	FY19E	Total
Power	2.3	2.5	2.5	2.7	3.2	2.6	1.9	**17.7**
Roads and bridges	1.0	1.1	1.2	1.4	1.8	1.9	1.9	**10.3**
Urban	0.7	0.9	1.1	1.2	1.3	1.7	1.8	**8.7**
Telecommunication	0.4	0.7	1.1	1.6	1.1	1	1	**6.9**
Railways	0.4	0.4	0.4	0.8	0.9	1.3	1.4	**5.6**
Irrigation	0.5	0.5	0.5	0.7	0.8	1	1.2	**5.2**
Airports	0.0	0.1	0.1	0.1	0.1	0.1	0.1	**0.6**
Ports	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**0.7**
Others	0.1	0.1	0.0	0.1	0.1	0.5	0.5	**1.4**
Total infra investments (A)	**5.3**	**6.3**	**7.0**	**8.5**	**9.2**	**10.2**	**10.0**	**56.7**
Nominal GDP (B)	99.4	112.3	124.7	137.6	153.6	171	190.1	**988.7**
% Infra investment of nominal GDP (A / B)	5.5%	5.6%	5.6%	6.2%	6.0%	6.0%	5.3%	**5.7%**

Source: Appraisal documents for five-year plans, CRIS estimates (investments and GDP values mentioned above are at current prices)

Figure 1.1: Infrastructure Investment Breakup
(Reproduced from (Department of Economic Affairs, 2020))

The report takes note of significant gap in solid waste management and waste water management infrastructure and access to potable drinking water as a major infrastructure deficit in urban areas.

As per Infrastructure Vision 2025 detailed in the report, "*strategic goals are aimed at meeting aspirations, propelling growth and improving ease of living or the physical quality of life for each individual in the country. Major goals are Affordable & clean energy, Convenient & efficient transportation and logistics, Housing and water supply for all, Digital services access for all, Quality education, Doubling farmers' income, Good health & well-being, Sustainable and smart cities. These goals would eventually contribute to the SDG 2030 agenda to which India is a signatory*" (Department of Economic Affairs, 2020) The report speaks about very ambitious infrastructure investment plans as shown below in Figure 1.2:

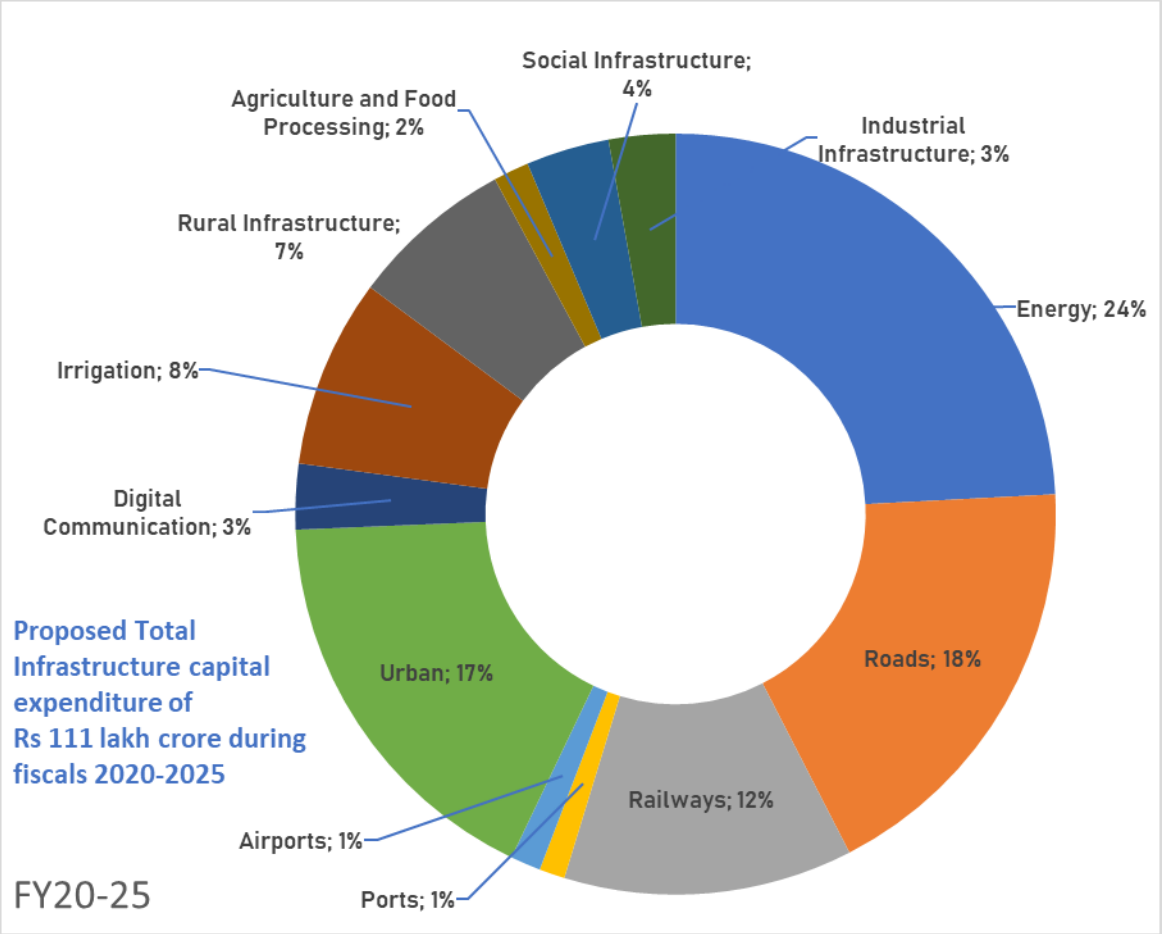

Figure 1.2: FY2020-25 Sector wise Infrastructure Investment
(Compiled based on NIP Report (Department of Economic Affairs, 2020)

The Government of India has ambitious plans for the infrastructure sector with an estimated INR 304 lakh crore- of investment till 2040. Major infrastructure programmes like Power for All, Bharatmala, Sagarmala, Smart Cities mission, Housing for All, Swachh Bharat Mission, AMRUT, etc are taken up. All the same, project completion records show abysmal results, major challenges identified are regulatory clearances, land acquisition, Resettlement & Rehabilitation etc. Lack of upfront planning and risk management is another focus factor identified. Successful

adoption of globally accepted Project and Program Management practices is another requirement which the public sector is adapting based on private sector experiences so as to get better overall benefits from these investments (NITI Aayog, 2019). The report acknowledges large scale delay in project completion for projects in India (to the tune of 25%) and is developing a National Project/ Program Management Policy Framework (NPMPF)suiting the Indian context.

1.3 PROJECT MANAGEMENT IN INFRASTRUCTURE PROJECTS

The term 'project' finds numerous definitions in varying contexts. Few of the most relevant generic definitions are included here. Project Management Institute (PMI) defines a project as '*A project is a temporary endeavour undertaken to create a unique product, service, or result*'(Project Management Institute, 2019). In the American Management Association Handbook of Project Management, Francis M. Webster, Jr. and Joan Knutson states that '*projects consist of activities, which have interrelationships amongst one another, produce quality-approved deliverables, and involve multiple resources'*(Dinsmore & Brewin, 2006). For IPMA *'A project is a unique, temporary, multidisciplinary and organised endeavour to realise agreed deliverables within predefined requirements and constraints'*(IPMA, 2015). As per Cleland, "*A*

project is any undertaking that has a defined objective, a cost parameter, and a time element for its development", a bunch of activities bringing value to the customer/ user(Cleland, 2004).

PMI states that '*Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements*'(PMI, 2017) whereas for IPMA '*Project management is concerned with the application of methods, tools, techniques and competencies to a project to achieve goals. It is performed through processes and includes the integration of the various phases of the project lifecycle*'(IPMA, 2015). ICMR considers project management as a carefully planned and organised effort to accomplish a specific one-time effort.

Infrastructure projects are mostly multi-disciplinary and project management methodology and systems are widely employed. The smallest of infrastructure projects contain several interrelated activities involving variety of resources in terms of men, material, machinery, money etc and often use project management techniques. As projects get bigger and complex, project management system also become complicated, the system necessitates inputs from various dimensions to function satisfactorily.

1.4 MOTIVATION FOR THE STUDY

Science and technology have grown over time with several new inventions and applications of these new technologies in multiple fields including development projects. Humans have found ways to travel beyond the earth to the moon and outer space. Infrastructure projects under various sectors often witness adopting newer technologies, introducing innovative management models, and usage of various optimisation techniques. Despite these efforts, the fact remains that success rates in developmental projects are reported to be far from satisfactory(Flyvbjerg & Budzier, 2015; L. Ika & Saint-Macary, 2014; PMI, 2018) and this has prompted a study on success of infrastructure projects in Thiruvananthapuram to understand the stakeholder perspectives.

1.5 RELEVANCE OF THE STUDY

Public infrastructure projects are meant for the public, utilise public resources and hence have accountability to the public at large. These projects are expected to generate positive public opinion from the users. The researcher is of the view that lack of proper understanding and lesser importance given to human factors in infrastructure projects is among the reasons contributing to the dubious success levels in these projects. In an effort to investigate the above viewpoint in the context of long-term success of public infrastructure projects, this study explores

factors affecting success of infrastructure projects in the water& sanitation and transport sectors from a stakeholder viewpoint. Transport and Water & sanitation are two important sectors when it comes to public infrastructure. Though both these sectors have some differences between them with regards to the users/ consumers as well as the nature of projects and type of assets, both these project sectors touch the day to day lives of the local public.

1.6 SCOPE OF THE STUDY

The study focuses on public infrastructure projects in the two sectors viz., 'Water & Sanitation' and 'Transport'. The geographical study area is Thiruvananthapuram city. The study primarily focuses on the perspective of project beneficiaries or project users. Success levels in infrastructure projects in Thiruvananthapuram in the above sectors, criteria used for judging success of projects and critical success factors for long-term project success/ user benefit is the emphasis rather than technical issues, procedures and project management methodology. User and professional viewpoints on the success of projects in the above sectors is studied. The study compares user assessments about success, the assessment criteria and the main factors that contributed to the assessed performance of select projects in the two sectors. A comparison of users' views with that of project professionals is also carried out.

1.7 ORGANISATION OF THE STUDY/ THESIS OUTLINE

The current chapter gives an introduction to the research topic, motivation for research, research scope and thesis report outline.

Chapter 2 Review of Literature

This chapter presents a gist of various literature reviewed on project management in general, infrastructure projects and their management, success and failure of projects, project stakeholders, participatory project management etc. Review of project management life cycle, project success and project management success, the front-end planning, performance of infrastructure projects, complexity in infrastructure projects, project stakeholders and multiple views on success, success criteria and success factors are covered. This review gives added attention to the project front-end to identify success factors and to understand their importance. Among the infrastructure sectors, literature on transport and water sectors are concentrated to be in line with the sectors under study. A review of these literature helps in identifying the research gap based on which the research focus is firmed up.

Chapter 3 Research Methodology

In this chapter, the research questions are formally identified with the approach towards the problem. Research Objectives for the study is specified with the assumptions and subsequently,

hypothesis on various study elements is defined. Next, the methodology for the Pilot study and its implications are discussed. Based on a pilot study, the research framework is revised as required and firmed up. Necessary changes are made to sampling methodology/questionnaire and collection of primary data is carried out.

Chapter 4. Data Analysis and Interpretation

This chapter details the analysis techniques used starting with cleaning and compilation of the data to make it fit for analysis, the different statistical methods and tools employed in the analysis, description of the various statistical tests and hypothesis testing methods.

Chapter 5. Result, Discussions & Conclusions

This chapter presents the results obtained from analysis, discusses the inferences and conclusions arrived through analysis and their implications.

1.8 SUMMARY

An introduction to infrastructure projects and their management provides a broader context to the area of study. Public infrastructure projects in the transport and water & sanitation sectors are identified for the study. Importance and need for positive public appeal towards projects are sighted. Motivation for

the study and scope of study is detailed. A brief of the various chapters is presented as Thesis outline.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II. REVIEW OF LITERATURE

2.1 INTRODUCTION

Project Management as a stream of research has grown manifold over time expanding the focus into multiple dimensions. As more and more projects are taken up in various fields, the stream extends its scope to newer arenas. Project management research is parallelly progressing in many directions and more and more publications are adding up to the database. The following sections provide a brief on the various research literature reviewed for this study which is presented in subheads to suit the focus of this research.

2.2 LITERATURE REVIEWED

2.2.1 Project Management and Project Life-Cycle

Project management as a process continues through the various phases/stages of the project life-cycle whereas each phase has its own set of activities and additional stakeholders. Projects generally are undertaken as a one-time activity to have improvements in the existing system and hence has a link to the strategic priorities of the organisations taking up the project. Project life-cycle is the continuous set of stages that the project travels through starting from project idea generation till end of its

service/ decommissioning. Among the common definitions of project life cycle are "*The series of phases that a project passes through from initiation to closure*."(Project Management Institute, 2016). APMs definition "*A project management life cycle is a framework comprising a set of distinct high-level stages required to transform an idea of concept into reality in an orderly and efficient manner"* is another viewpoint. Wu and Leifer presents learning of project life-cycle stages proposed by various researchers which are reproduced in "Table 2.1 Predominant Definitions of Project Life-cycle" from Learning from Projects: A Life-Cycle Perspective (Wu & Leifer, 2006) by various researchers are included.

Table 2.1 Predominant Definitions of the 'Project Life Cycle

Table 1: Predominant Definitions of the 'Project Life-Cycle'

Adams and Brandt 1983; Pinto and Selvin 1988; Pinto 1995; Mian and Dai 1999; Cleland 1999	**Stuckenbruck 1981; Kerzner 1989; Cleland 1990; Kerzner 1995; Cleland 1999**	**PMBOK 1987; Webster 1993**
Conceptualization	Conceptualization (initiation)	Feasibility (concept & development)
Planning	Definition (growth/organization)	Acquisition (implementation-
Execution	Production (acquisition)	definition, procurement and execution)
Termination	Operational	Operation
	Divestment	Disposal

Source: Reproduced from (Wu & Leifer, 2006) Table 1: Predominant Definitions of the 'Project Life Cycle'

Wideman in his review of The Project Management Life Cycle by Jason Westland presents project life-cycle similar to the first case in the above giving further explanation to the phases as included below in Figure 2.1:

Figure 2.1: The four phases of Project Life cycle
(Wideman, 2006)

Locatelli presents project life cycle from the larger viewpoint of an organisations business and presents a comprehensive life cycle model comprising the corporate investment life cycle, the plant life cycle and the project life cycle(Locatelli, 2020b), illustration replicated below as Figure 2.2:

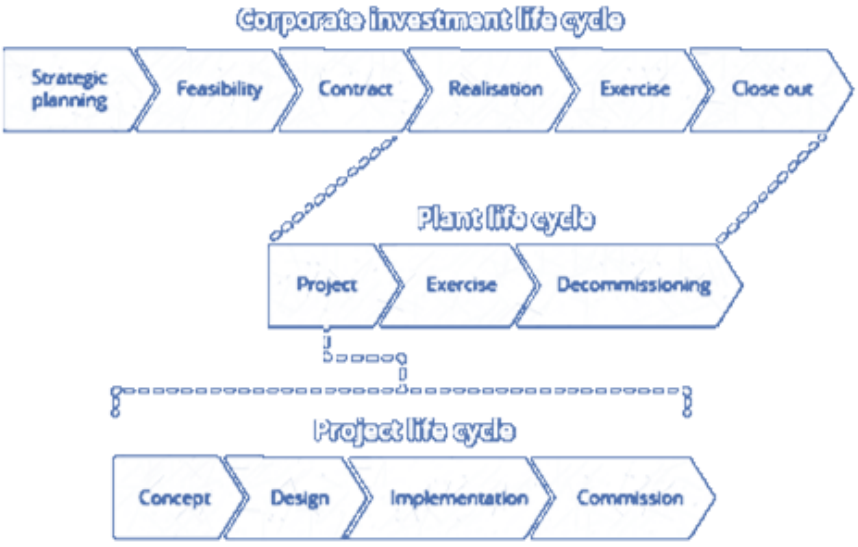

Figure 2.2: Comprehensive Life Cycle Model

(Reproduced from (Locatelli, 2020b))

In general, generic project life-cycle definitions are more or less in agreement with the four-phase model comprising Concept/ Initiation, Planning/Design, Execution/ Implementation and Closure/ Commission /Termination through exact terminologies slightly vary.

2.2.1.1 Extended Life-Cycle and Infrastructure Projects

The four-phase generic life-cycle model concentrates more on the creation of the asset as the project whereas operation and maintenance of the facilities assume greater importance especially in the case of public facilities. An “Extended life cycle” model is promulgated in the widely used Association for Project Management/APM Body of Knowledge as shown in Figure 2.3, in which these four basic phases are clearly shown and labelled

"Project life cycle." This model also shows an "Extended project life cycle model" that moves toward the comprehensive model, which researchers have studied in further detail. (Archibald et al., 2012)

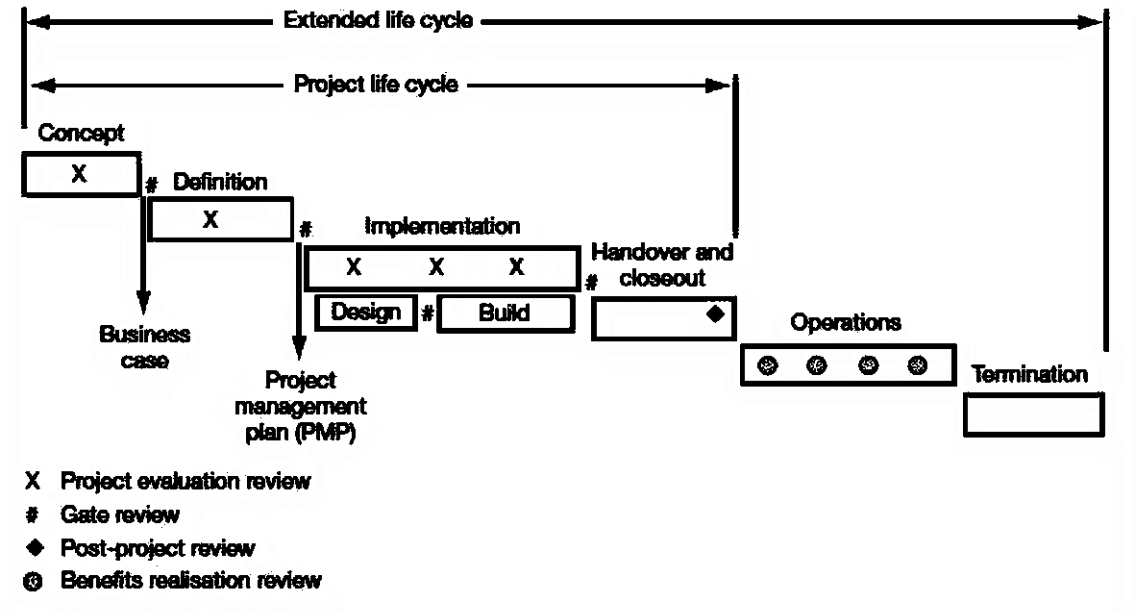

Figure 2.3: A second "standard" project and extended life cycle model

(APM 2006 p 80.) (Archibald et al., 2012)

Locatelli presents similar insights focusing on infrastructure projects through the infrastructure life cycle copied below(Locatelli, 2020a) as Figure 2.4.

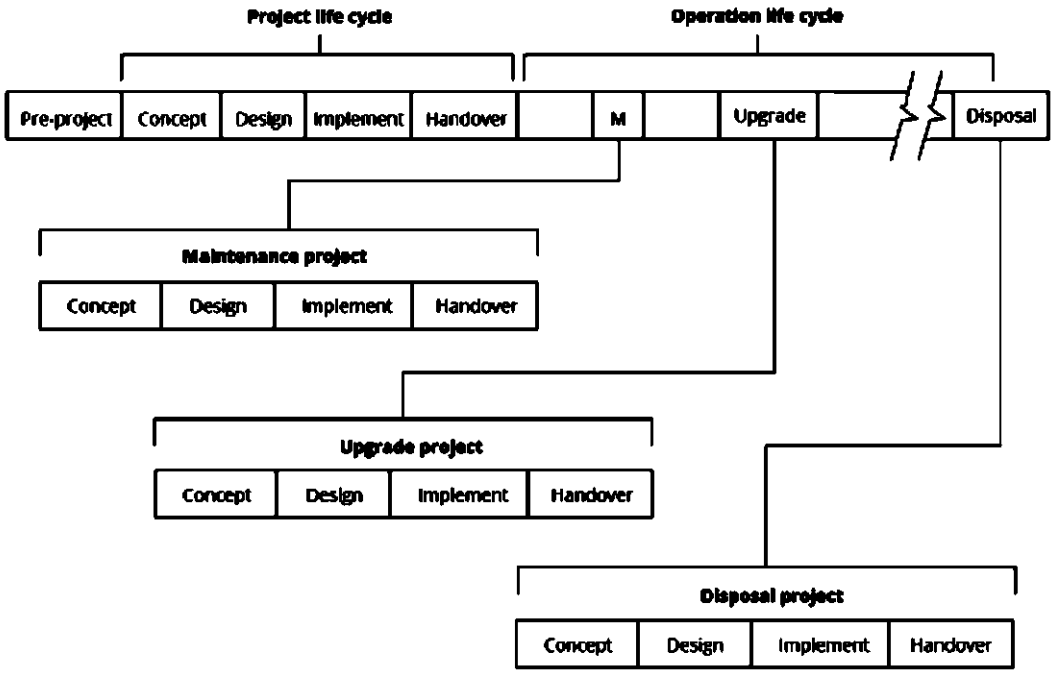

Figure 2.4: Infrastructure or Plant Life Cycle
(Locatelli, 2020a)

As can be seen from the illustration above, in the case of public infrastructure projects, the planning and execution phase are followed by an operation phase which is generally the longest phase in the life cycle in terms of the time span involved and the stage where actual usage of developed facility/assets by the intended stakeholders happens. In the case of projects executed under the various PPP models (BOT, BOOT, DBOT, Hybrid-Annuity Model (HAM) etc.), operations phase to a considerable extent gets included in the execution contractor's responsibility depending upon the contract arrangement. The limitation of the generic life-cycle model and the importance of operations phase in the life-cycle while managing long-term public infrastructure

projects, particularly PPP projects is well highlighted in research(Alexander et al., 2019).

2.2.2 Project Success and Project Management Success

The success of projects is a subject of interest for researchers for very long. Researchers during the seventies to eighties viewed project success as the achievement of management factors, successful projects were those that finished on time, near the budget cost and performed as envisaged. (Baker et al., 1974) distinguished between those factors which improve success and those which cause failures. Considerations like client satisfaction came into the picture later(Pinto &Slevin, 1988) and led to the understanding that management success and project success are not the same. As per (Atkinson, 1999), project performance over the years is habitually measured in terms of the management factors referred to as “iron triangle” comprising cost, time and quality factors. Researchers like de Wit, Munns and Bjeirmi separated project success and project management success and observed that an overall successful project management process is not sufficient for success of project whereas poor project management performance alone will not mean that the project failed(de Wit, 1988; Munns &Bjeirmi, 1996) Project success is multidimensional and includes both project management success efficiency (short-term) and the achievement of desired results

(longer-term) for the project, that is effectiveness and impact.(Jugdev& Thomas, 2001). Benefit realisation is key to project success (Pinto et al., 2022). The case of World Bank funded urban planning/ housing project for the cities of Mumbai and Chennai which was abandoned judging it as a failure only to witness the successful impact of completed components after twenty years(Owens et al., 2018) has valuable insights. Baccarini views that "*Project management success is measured in terms of internal factors (cost-time-quality) whereas achieving product success is concerned with project's external effectiveness*". "The tech is easy, people are hard" brings people focus to the fore(Scheepers et al., 2022). Further, project management success is subordinate to product success (Baccarini, 1999) as illustrated in Figure 2.5. In short, delivering project success is more difficult than delivering project management success as "*Goals and methods are liable to change whereas project management success is based on predetermined goals*"(Cooke-Davies, 2002).

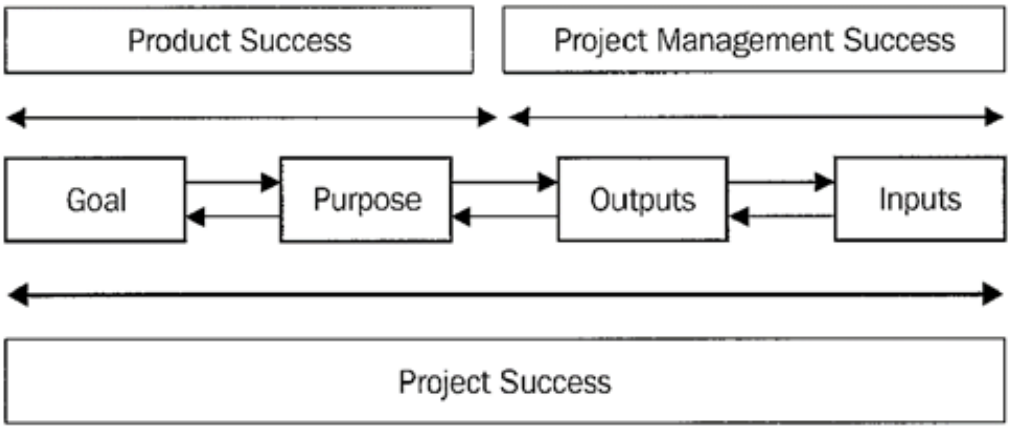

Figure 2.5 Link between PM Success:
Reproduced from (Baccarini, 1999)

2.2.3 Front-end Project Planning for Project Success

Projects evolve through the life-cycle with newer learnings and "*The emphasis of what is important in a project changes from one phase of the project to the next*"(de Wit, 1988). This said, the importance of early stages of the project or the project planning is well documented. Proper planning in terms of the initial project concept is highlighted as a key to success(K. F. Samset et al., 2006; K. Samset&Volden, 2016; Serrador, 2012; Williams et al., 2019). In the words of Edkins and Smith "*the early stages of a project are one of the primary points where strategic success or failure for the project is set*"(Williams et al., 2019). Nick Smallwood from Infrastructure and Projects Authority states "*The success or failure of a project is often determined in its early stages. Whilst successful project initiation can take more time at the start, this will be repaid many times over later on in delivery - so we must get it right from the start"*(IPA, 2020). Risk considerations along the project life cycle show that the project development phase has highest risk which decreases as projects move forward(Schwartz et al., 2014) as depicted below in Figure 2.6. The higher level of risk in the development phase highlights the importance and the additional care that needs to be exercised during this phase in projects.

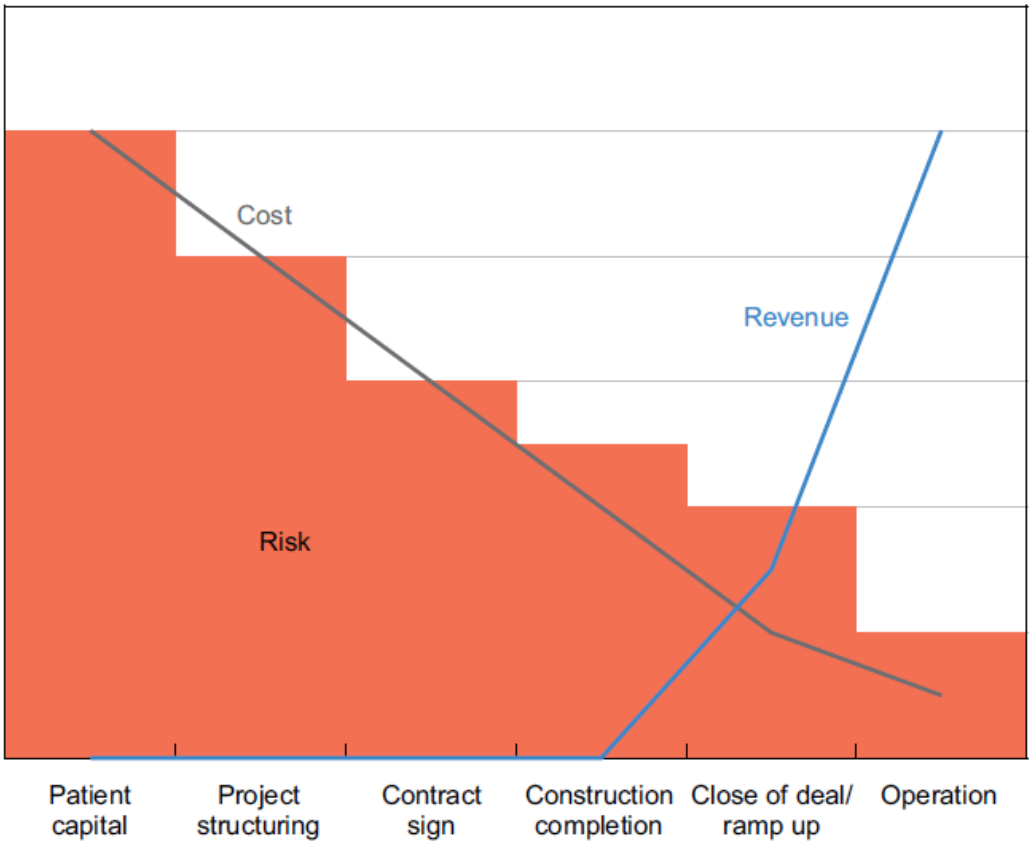

Figure 2.6: Risk profile over the project cycle

Reproduced from (Schwartz et al., 2014)

Research on construction project risk along project life cycle in Chinese projects identifies the construction stage as the riskiest phase whereas risks during the front-end phases and its importance is well highlighted(Zou et al., 2012). Relative importance of project risks as well as critical success factors are found to vary as the project progresses along the life -cycle(Pinto & Prescott, 1988; Zou et al., 2012) All these studies highlight the importance of studying factors affecting infrastructure projects and risks in the planning stage.

2.2.4 Infrastructure projects and performance levels

Infrastructure project performance levels are far from satisfactory. As per (Flyvbjerg & Budzier, 2015) "*Projects across industries and geographies struggle to meet the most basic targets. Five out of 10 technology projects, six out of 10 energy projects, seven out of 10 energy projects, seven out of 10 dams, nine out of 10 transport projects and 10 out of 10 Olympic Games do not meet their cost targets. This trend has been constant, and there has been no improvement over the past century".* PMI states that "*According to one study, only 20% of projects meet schedule, budget, and quality goals"*(PMI, 2018). In the case of ADB projects, "*Despite a general trend to higher numbers of projects being rated successful or better over the past few years, issues of project performance and project quality continue to arise on projects funded by the Asian Development Bank"*(Operations Evaluation Department ADB, 2008). Researchers probing the NASA's Mars Climate Orbiter project failure opines that "*When important projects fail, the investigation is often focused on the engineering and technical reasons for the failure …in many cases the root cause of the failure is not technical, but managerial*"(Sauser et al., 2009). Similar actions can be commonly observed in the case of less expensive/less complex infrastructure projects as well. In an Indian context as well, infrastructure project performance levels are rather dismal with

more than 60% of economically viable projects not considered successful based on time, cost, quality, and value addition parameters(Babli, 2020).

2.2.5 Project Complexity

In the words of (Baccarini, 1996), Complexity is defined as "*Consisting of many varied interrelated parts*" and "*Complicated, involved, intricate*" Also, "*Construction projects are invariably complex and since World War II have become progressively more so*". "*In fact, the construction process may be considered the most complex undertaking in any industry*". "*However, the construction industry has displayed great difficulty in coping with the increasing complexity of major construction projects*(Baccarini, 1996)". *"Shenhar and Dvir proposed various types of project complexity like 1) assembly project complexity, which deals with a component or device within a larger system that perform a single function; 2) system project complexity - related to systems (such as computers), full platforms (cars, buildings), or business units; and finally, 3) array project complexity - associated with systems that, while functioning together, are spread out geographically"*(Cleveland, 2017). Understanding project complexity is of high importance while managing projects successfully (Roy, 2019)

Bosch-Rekveldt et al. investigated the multiplicity of drivers of project complexity and proposed project complexity framework in large engineering projects, which can be used to adapt the front–end development phase of engineering projects to better manage the complexity of that project (Bosch-Rekveldt et al., 2011; Cleveland, 2017). This study developed TOE (Technical, Organizational, and Environmental) framework with elements contributing to project complexity from theoretical as well as a practical perspective. Another complexity measurement model with 28 factors under technological, organizational, goal, environmental, cultural and information complexity categories is formulated for megaprojects based on Shanghai Expo construction project in China using fuzzy analytic network process (FANP) (He et al., 2015)

2.2.6 Project Stakeholders and multiple views on success

A Stakeholder is “An individual, group, or organization who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project, program, or portfolio” (PMI, 2013 as cited in(Oliver & Miller, 2015)). Projects usually have multiple stakeholders with different points of view who perceive project success differently (Aaltonen & Kujala, 2010; Davis, 2017, 2018; di Maddaloni & Davis, 2018; Lloyd-walker et al., 2014; Shenhar et al., 2001). In contrast to success of project

management based on time, cost and quality performances, project success evaluation needs to consider the objectives of all stakeholders along various hierarchy levels as well as different stages of the project life cycle (de Wit, 1988). A Study of software projects based on respondents from Australia, Italy and Sweden pointed to similarities in successful project characteristics among various respondents and differences with respect to factors leading to their success (Egorova et al., 2009).

Laroche's work on cultural aspects of international projects warns that "Differences in approaches, values and expectations between customers, suppliers and team members with different cultural backgrounds have led to many project failures"(Laroche et al., 1998). Project success is an abstract concept and determining whether a project is successful is subjective and extremely complex (Parfitt and Sanvido, 1993; Chan, 2002) Success criteria preferences for same project type shows variations due to subjective factors like cross cultural differences, beliefs, values and suggests the view(A. P. C. Chan, 2001; Sanvido, 1992) that expectations of various stakeholders about the project outcome and its fulfilment also plays a role in their respective opinions on success. Perceptions and expectations of different stakeholders as well as the stage of assessment assumes special importance(de Wit, 1988). A project success model minimally agreeable to all project stakeholders remains as a challenge (Ika & Pinto, 2022).

2.2.7 Engaging Stakeholders for Project Success

The project organisations' responsibility of informing the community or engaging with the community at various project stages is well highlighted(Loosemore, 2011). In the words of Altonnen and Kujala, "*Understanding stakeholders, their influences and devising engagement strategies based on the analyses of stakeholder landscapes has become one of the key capabilities within project-based firms*".(Aaltonen &Kujala, 2016). Increased attention on stakeholder management recently has resulted in recognizing it as project success factor(Cuppen et al., 2016).While highlighting the importance of stakeholder engagement for project success, PMI article notes the importance of external stakeholders as "*In complex infrastructure projects, external stakeholders are generally the most influential group due to land acquisition problems, right of way issues, environmental issues, and government regulations and policies*"(Manavasi Ramesh, 2020). Broader inclusiveness of local community is needed to improve success of major infrastructure projects (Di Maddaloni & Davis, 2017).

2.2.8 Success Factors and Success Criteria

Success criteria and success factors are often confused from each other despite several definitions differentiating the characteristics. As per Morris and Hough, success criteria is "*the*

measures used to judge the success or failure of a project; these are dependent variables that measure success"(Joslin & Müller, 2014). Success Criteria are those measures used to assess/evaluate success levels of projects. As per Cooke-Davies, "*Success criteria refer to the measurement of project success whereas success factors refer to the those inputs to management system that lead directly/ indirectly to the success of project/ business*"(Cooke-Davies, 2002). Success criteria includes both tangible and intangible elements, these are otherwise referred to as hard and soft factors. Baccarini views that "*Hard factors like cost, time, quality is relatively easy to measure. Soft factors like happiness, job satisfaction, enhanced reputation are subtle and difficult to measure*"(Baccarini, 1999).

Review of past research on success of projects and related criteria shows criteria suiting all projects is hard to find. According to Wateridge "*Success criteria will differ from project to project depending on a number of issues, for example, size, uniqueness and complexity*"(Wateridge, 1998). Hussein categorises studies on project success criteria from literature into three major groups – success criteria grouping, rationale behind these criteria and risk factors linked to such criteria(B. A. Hussein, 2013). For de Wit, "*The most appropriate criteria for success are the project objectives. The degree to which these objectives have been met determine the success of the project*"(de Wit, 1988). Multiple project objectives and multiple project stakeholders increases the

complexity of the issue. The importance for success criteria varies along the project life cycle as with the criteria itself. Quoting de Wit again, "*The emphasis on what is important in a project, changes from one phase of the project to the next*"(de Wit, 1988). Further, Shenhar and Wideman studied different stages of project and classifies them as "*Internal Project Objectives (Pre-completion), Benefit to Customer (Short term), Direct Contribution (Medium term) and Future Opportunity (Long term) with multiple criteria under each category*"(Shenhar& Wideman, 1996). Muller and Turner based on their survey of project managers explored and modelled a relation between importance assigned to success criteria against success rating to obtain a link between these variables(Müller & Turner, 2007).

2.3 RESEARCH GAP

Planning and management in infrastructure projects is a vibrant research field in recent years and several researchers have studied the risks in infrastructure projects in different parts of the world. Public- Private-Partnership (PPP) projects have been widely studied to identify critical success factors (CSF) with the majority of these focusing on few countries like Australia, UK, China and Hongkong (Osei-Kyei& Chan, 2015). Studies on risks in infrastructure projects focused mainly on Project Manager views (Elkington & Smallman, 2001) while others focused on the

Contractors' (Shen et al., 2001) and owner viewpoint (Pawar et al., 2015). Studies in an end-user perspective is comparatively less. Whilst stakeholder management is considered as a project success factor, studies on stakeholder management in complex projects are limited(Mannan Adnan, 2018). Stakeholder views on projects were mostly explored from the project manager's point of view (Davis, 2018) Less attention given to understand stakeholder side of project stakeholder management (Aaltonen &Kujala, 2010) with user views among the least explored. In India, researches on infrastructure projects have focused on factors in the project execution stage and relate to contract management. Research on Indian projects have focussed more on the objective project management success criteria and its impact whereas less importance given to subjective success criteria and its effect on project performance. Many studies have identified critical risks like project delays and focused on associated cost-overrun. Researches on planning stage or front-end factors in infrastructure projects are relatively less altogether whereas studies on the same in the Indian context were not found, let alone studies focusing on Kerala. Moreover, comparative study of different infrastructure sectors with respect to either success criteria or critical success factors is rare. Studies to assess complexity of infrastructure projects in Kerala could not be found whereas its relation to project success remains relatively unexplored.

On the basis of review of related literature and involvement of users in projects in Kerala, the researcher is convinced of the influence of users in the success of infrastructure projects and of the necessity to explore success criteria preferences among users and success factors in planning of infrastructure projects from a user perspective.

The present study focuses on planning of select infrastructure projects in Thiruvananthapuram city in Kerala based on the perception of users and professionals of Water & Sanitation and Transportation projects to identify success criteria preferences as well as critical success factors. Comparative analyses of success criteria and critical success factors for the two project sectors in Kerala adds a new aspect in the analysis.

2.4 SUMMARY

Project success is a topic of valuable research with studies diversifying into various perspectives. Early researchers studied conventional project mechanisms with respect to the performance of operational parameters along the project implementation phase. Subsequently, research extended to other stages in the lifecycle as well as into strategic, longer-term perspectives with a stress on project outcomes and community impact. This also meant that focus on project team/ internal stakeholders got widened to include external stakeholders and comprehensive stage specific

stakeholder identification and inclusion of their views. Meanwhile, newer project mechanisms through participatory and hybrid models evolved. Extending the above concept to such projects also meant multidirectional research on project success. From the wide set of project success studies, literature suiting the present context is included above under specific topics.

CHAPTER III

RESEARCH METHODOLOGY

CHAPTER III. RESEARCH METHODOLOGY

3.1 INTRODUCTION

Infrastructure projects in the transport and water & sanitation sectors are analysed for success parameters on the basis of long-term benefit perspective from the stakeholder viewpoint giving emphasis to the project user opinions. Local residents benefitted by the project are considered as the major respondent group. Household survey of residents in Thiruvananthapuram city is carried out using the methodology described in detail in the subsequent sections. A survey of other stakeholders is conducted for comparison of the user views.

3.2 RESEARCH QUESTION

The infrastructure sector is developing drastically in recent years as more and more projects are taken up throughout the country as part of the overall emphasis on the sector's development (Department of Economic Affairs, 2020; MOSPI-GoI, 2013). Many times, there are concerns regarding incomplete projects, unsatisfactory performance of the created assets, non-achievement of envisaged benefits and so forth. In a Kerala scenario and especially in the capital city Thiruvananthapuram, one can observe that lot of ambitious infrastructure projects are taken up while the

success of most of these infrastructure projects is dubious which raise questions on apt planning of infrastructure projects. Questions concerning

(i) How successful were infrastructure projects in Thiruvananthapuram, the basis for assessing success and factors affecting/deterring success of these projects?

This study attempts to answer the above questions in relation to project success levels, identification and analysis of success criteria and critical success factors for infrastructure project planning in the water and sanitation, transportation sectors from the project users' viewpoint. A comparison with the project professional lookout is also attempted. The study tries to give more emphasis on project benefit over project management methodology and thus excludes an analysis of time schedules and any variations in project scope and cost. The study explores in detail the following questions pertaining to infrastructure projects in Thiruvananthapuram:

1. What success criteria do stakeholders consider while assessing the success of infrastructure projects?
2. How successful are infrastructure projects in Thiruvananthapuram as per project users? how does this vary among the sectors?
3. How do project professionals assess the success of these projects?
4. Which factors affect project success the most for these sectors?

3.3 STATEMENT OF THE PROBLEM

Infrastructure projects have long life-cycles spanning several decades and in some cases centuries (Ramachandran, 2019; Winkler, 2017)– from the time the project idea is conceptualised through its planning, design, resource mobilisation phase to its execution, operation/maintenance and eventually its upgradation/ decommissioning. In most infrastructure projects, operation/ maintenance phase is the longest (Locatelli, 2020a) and the phase where utility/ benefit of the project is actually experienced and evaluated. It is also the main phase where the benefits/ problems due to the project are passed on to the beneficiaries and the broader outcome and impact due to the project is felt at large. Thus, success levels of projects due to the project planning and implementation efforts become clear at this stage. The project organisation or in other words the primary team members involved in planning and execution would normally have moved on from the project whereas the project beneficiaries substantially use the facility. In this sense, the beneficiaries are the set of stakeholders who have primary experience of the infrastructure status prior to and post the project implementation and hence are better placed to express their views on the project outcome and success levels. Moreover, less attention given to the stakeholder side (Aaltonen &Kujala, 2010) Taking cognisance of this fact, the present study

focuses on user viewpoint on the success of infrastructure projects.

3.4 OBJECTIVES OF THE STUDY

The wider objective of this research is to study on success of select infrastructure projects in Thiruvananthapuram in the transport and water & sanitation sectors, success criteria for these projects and critical success factors impacting these projects. In line with this broad objective, specific objectives focussed are listed below:

1. To obtain project success rating for select infrastructure projects in the transport and water & sanitation sectors in Thiruvananthapuram and carryout sector wise and stakeholder wise comparison of project success levels
2. To assess the user preferences for success criteria and explore possible relation between success criteria preference and project success rating for infrastructure projects in Thiruvananthapuram.
3. To identify the critical success factors in project planning that affect infrastructure projects in the transport and water & sanitation sectors based on user viewpoint and compare with that from project professionals.
4. To compare the critical success factors between the project sectors

3.5 HYPOTHESIS FORMULATION

The following hypotheses are formulated based on the researchers' existing perceptions/understanding about infrastructure projects in Thiruvananthapuram obtained through literature review and field experience in projects which will be subject to detailed research and hypothesis testing under the study. A total of three hypothesis is proposed for testing as elaborated below:

1. **Null Hypothesis** H_1 – Success rating by project users for Transport and Water & sanitation projects are relatively similar.

   Alternate Hypothesis H_{1A} – Success Rating by project users for Transport and Water & sanitation Projects are significantly different

   This hypothesis is related to the first research objective to obtain project success rating for the select infrastructure projects in the transport and water & sanitation sectors in Thiruvananthapuram to carryout sector wise comparison. In the context of infrastructure development in Kerala and more specific to the needs of Thiruvananthapuram city, Transportation and Water & sanitation sectors are of prime importance. These two sectors are interlinked to each other in many aspects and projects under these sectors are often combined as part of major urban infrastructure programs. In

this sense, success of projects in these two sectors can be assumed to be similar, Yet, the very nature of the assets and its community impact differentiates them. We test the hypothesis that there is significance difference in success rating by users for projects in the two sectors

2. **Null Hypothesis** H_2 – Success rating for infrastructure projects in Thiruvananthapuram by Users and project professionals are similar.

   Alternate Hypothesis H_{2A} – Success rating for infrastructure projects in Thiruvananthapuram by Users varies significantly from that of project professionals.

   This hypothesis aligns itself with the first objective to conduct stakeholder wise comparison of success rating. Project Success perceptions of different stakeholders for the same project often vary highlighting its subjective nature. Project users are generally expected to be more interested in the broader project outcome and benefits whereas the project teams' focus on operational and project management aspects along with governance issues. This means the level of success in projects perceived by these stakeholders need not always be similar. This aspect of stakeholder assessment of project success is tested between project users and project team members.

3. **Null Hypothesis H_3** –Preference level for success criterion is unrelated to the success rating

Alternate Hypothesis H_{3A} - Preference level for success criterion and success rating are significantly related

This hypothesis relates to the second research objective to assess the user preferences for success criteria and explore possible relation between success criteria preference and project success rating for infrastructure projects in Thiruvananthapuram. Success perception of projects among stakeholders is highly subjective. Different stakeholders consider different criteria as important while judging the success levels. This means there possibly could be a relation between the preference for success criteria and the success rating. Testing of presence of a relation between success criteria preference and success rating is carried out under this hypothesis.

3.6 STUDY AREA

Thiruvananthapuram is called Land of Lord SRI PADMANABHA. “The place was referred to as Ananthankadu before settlements existed. The place gets its name from the word ‘Thiru-Anantha-Puram’ which means ‘The town of Lord ANANTHA’, the abode of the sacred serpent ‘Anantha’ upon whose coils reclines Lord VISHNU …”(Thiruvananthapuram Corporation & Department of Town and Country Planning, 2012).

Thiruvananthapuram was the headquarters of the erstwhile Travancore Kingdom, later the capital of the Travancore- Cochin state and is currently the capital of Kerala state since November 1956. The administrative body serving the city is Thiruvananthapuram Corporation. Over the years, the city expanded adding more areas from the periphery into the city limits. The Thiruvananthapuram Municipality was formed in 1920 and was converted into Corporation in 1940 with 24 wards covering an area of 30.66 km² from which the city corporation has grown up to the current 100 wards(Thiruvananthapuram Corporation & Department of Town and Country Planning, 2012). The basic characteristics of Thiruvananthapuram city are provided in the Table 3.1 below:

Table 3.1: Thiruvananthapuram City Salient Features

(Thiruvananthapuram Corporation & Department of Town and Country Planning, 2012).

City Name	Thiruvananthapuram
Urban Local Body	Thiruvananthapuram Corporation
Population (2011)	9,86,578 persons***
Projected Population (2031)	10,32,292 persons
Area (2012)	215.86 sq.km
No. of Wards (2012)	100
City Location	8°30 N and 76°54 E. Bounded by Lakshadweep Sea to its west and the Western Ghats to its east.
Rainfall	Average 170cm/ annum
Literacy Rate	83.82%
Major Water bodies	Karamana River, Killiyaar, Parvathy puthanar, Akkulam-Veli lake
Transport System	Well-connected road and rail network. Thiruvananthapuram International Airport within city. Inland water Transport used widely in olden times

*** Total population based on ward wise split-up data is 9,57,691, which is used in sampling for data collection

Map of Thiruvananthapuram city shown below in Figure 3.1 is prepared by combining information from external sources (Thiruvananthapuram Corporation & Department of Town and Country Planning, 2012, www.mapsofindia.org)

Figure 3.1: Thiruvananthapuram Corporation Map

Thiruvananthapuram is well connected to all parts of the country though transport system comprising road, rail and air connectivity and has very good internal connectivity through its city road

network. The city has good provision of basic infrastructure in terms of roads, water supply and sanitation facilities, electricity and telecommunication. Internet connectivity facilities etc. Thiruvananthapuram is a smart city under the smart city mission programme of Government of India and is also developed as Solar city. Vizhinjam Seaport is getting developed as an important sea terminal.

In terms of infrastructure projects, Thiruvananthapuram as the state capital and biggest city of Kerala is the planning and monitoring hub for all development projects in the state and also hosts headquarters of state departments and many organisations of national importance. Thiruvananthapuram also has many completed and ongoing infrastructure projects funded by state, centre, bilateral/ multilateral agencies and a host of private cum participatory projects – Thiruvananthapuram Airport International Terminal, Vizhinjam International Seaport, Thiruvananthapuram City roads project, JICA Water Supply Project, Brahmos Aerospace, Thiruvananthapuram Technopark etc. to name a few. Newer infrastructure programs are planned here and mostly piloting or implementation is taken up in this city along with other locations. The city has witnessed many public infrastructure projects getting implemented since 2000. Transport and Water & sanitation form two important sectors where projects were implemented in Thiruvananthapuram.

3.7 RESEARCH DESIGN

A descriptive research design is followed with some correlational analysis between project users and project professionals, **Figure 3.2** shows the research design flowchart. A step-by-step description of the activities and research tools/ techniques used is subsequently included.

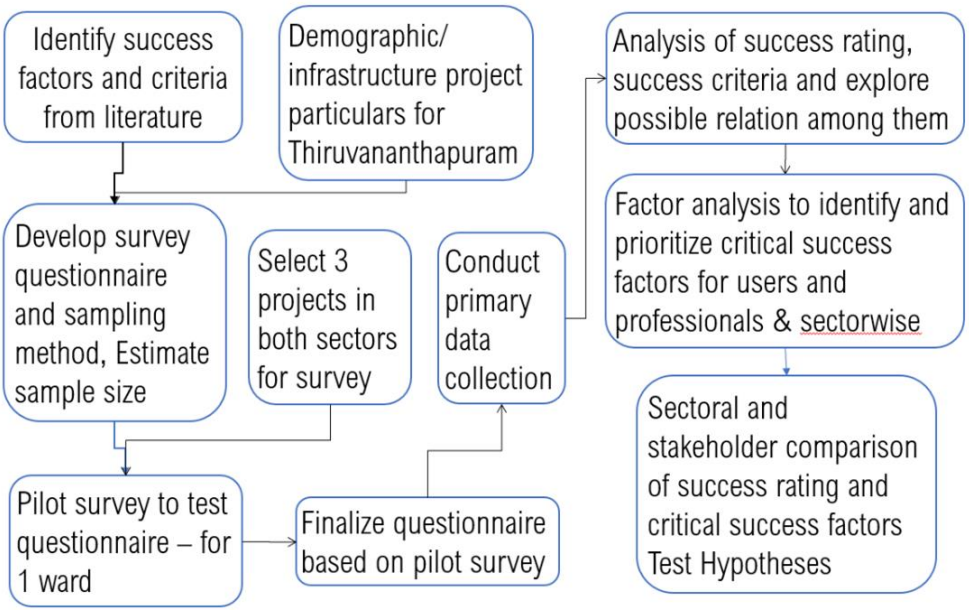

Figure 3.2: Research Methodology Flow Diagram

(Compiled by Researcher)

3.8 Success criteria and Success factors from literature

A comprehensive review of project management literature on projects and its performance, success and failure of projects and affected parameters, infrastructure sector and development projects is carried out. Success criteria and success factors identified from the literature is refined in the context of

infrastructure projects. A set of 13 success criteria is finalised for the study as tabulated below in Table 3.2:

Table 3.2: Success Criteria Identified from Literature

S. No	Project Success Criteria and Corresponding (Variable name)	Reference Source
1.	Timely Completion (Time)	(Shenhar& Wideman, 1996),(Atkinson, 1999)
2.	Within Project budget (Budget)	(Shenhar& Wideman, 1996), (Atkinson, 1999), (deWit, 1988), (Joslin & Müller, 2015)
3.	Project meets/ exceeds expected benefits (ExpBen)	(Atkinson, 1999)(B. Hussein et al., 2011)
4.	Quality of Finished Infrastructure (InfQua)	(Baccarini, 1999)
5.	Good User Satisfaction (Customer satisfaction) (USatis)	(Shenhar& Wideman, 1996), (Atkinson, 1999), (deWit, 1988), (Dvir&Shenhar, 2007), (Subiyakto et al., 2015)
6.	Use of new/ improved/innovative technology (NuTek)	(Shenhar& Wideman, 1996), (Dvir&Shenhar, 2007)
7.	Improved service delivery after project (ImpSer)	(Subiyakto et al., 2015)
8.	Less Public Disturbance during work (PuDist)	(Morris & Wilkinson, 2016)
9.	No adverse impact on society and surroundings (AdvImp)	(Atkinson, 1999)
10.	Good Public interaction during project (PuCons)	(Bannerman, 2008)
11.	Ease of Access/Use (EazUse)	(Subiyakto et al., 2015)
12.	Lower Usage Cost (UsCost)	(Baccarini, 1999)
13.	Social Responsibility (SocResp)	(Atkinson, 1999)

In the case of success factors, further refining is carried out to filter factors in project planning. A total of 27 success factors are identified for the study, the detailed list is given in Table 3.3,

Table 3.3: Success factors Identified from Literature

SNo	Symbol	Variable Name	Success Factor	Literature reference
1.	V1	Vision	Project Mission/ Clarity of Goals	(Wai et al., 2013)(Pinto & Prescott, 1988)(Babu & Sudhakar, 2015)(Osei-Kyei& Chan, 2015)(Wai et al., 2013)(Baccarini& Collins, 2003)
2.	V2	PolWill	Top Management Support (Political will and Govt. Support)	(Pinto & Prescott, 1988)(Babu & Sudhakar, 2015)(Jha &Iyer, 2007)(Baccarini& Collins, 2003)(Wai et al., 2013), Munns and Bjeirmi (1996); Nguyen et al. (2004);Jha and Iyer (2007)(Qiao et al., 2001)
3.	V3	ComSupp	Public/ Community/ Social Support	(Węgrzyn, 2016)(Baggett et al., 2006)(Bing et al., 2005)(Pawar et al., 2015)(Osei-Kyei& Chan, 2015)
4.	V4	RespSha	Collective Responsibility/ Risk Sharing among stakeholders	(Węgrzyn, 2016)(Bing et al., 2005)(Osei-Kyei& Chan, 2015)(Bing et al., 2005)(Liu et al., 2014),
5.	V5	NdsAss	Needs Assessment	(Baggett et al., 2006)(Wai et al., 2013)(Baccarini& Collins, 2003)
6.	V6	Feasi	Thorough Feasibility Study	(Węgrzyn, 2016)(Bing et al., 2005)(Shen et al., 2001)(Osei-Kyei& Chan, 2015)(Qiao et al., 2001)
7.	V7	CBA	Diligent Cost-Benefit Assessment	(Węgrzyn, 2016)(Flyvbjerg, 2013)(Baggett et al., 2006)(Bing et al., 2005)(Bing et al., 2005)(Qiao et al., 2001)
8.	V8	SocEnv	Social and Environmental Assessment	(Silvius et al., 2013; Silvius & Schipper, 2015)

SNo	Symbol	Variable Name	Success Factor	Literature reference
9.	V9	CliInv	Client Involvement/ Control in project	(Dunham B, 1984)
10.	V10	PlanDes	Detailed Project Planning and Design	(Khona et al., 2016)
11.	V11	QAQC	Quality Assurance/ Control in Planning	Tabish and Jha 2015
12.	V12	FundPlan	Project Funding Plan	(Haarmeyer & Mody, 1998)
13.	V13	Sched	Realistic Program Schedule/ Milestones	(Babu & Sudhakar, 2015; Pinto & Prescott, 1990)
14.	V14	TransProc	Mode and Transparency of Procurement	(Węgrzyn, 2016)(Bing et al., 2005)(Wai et al., 2013)(Jefferies et al., 2002)
15.	V15	WorkDef	Clear Scope and Work Definition in Tender	(D. W. M. Chan et al., 2010; Songer & Molenaar, 1997; Tabish & Jha, 2011; Xia et al., 2014)
16.	V16	QCrite	Effective Qualification/ Selection Criteria in Tender	(Babu & Sudhakar, 2015; A. P. C. Chan, 2001)
17.	V17	CommAge	Well organized and committed Project agency	(Węgrzyn, 2016)(Bing et al., 2005)(Jha &Iyer, 2007)
18.	V18	StkCo	Coordination/communication among project participants	(Zou et al., 2012)(Babu & Sudhakar, 2015)(Tabish & Jha, 2012)(Wai et al., 2013)(Baccarini& Collins, 2003)(Rafindadi et al., 2014)(Jha &Iyer, 2006)
19.	V19	ClrRul	Clear-cut rules and responsibilities	(Chua, 1999; Nicolini, 2002)
20.	V20	ChReq	Change in requirements/ design	(Qiao et al., 2001; Tabish & Jha, 2011)

SNo	Symbol	Variable Name	Success Factor	Literature reference
21.	V21	DlaApp	Incomplete Approvals/ Delay in Approvals	(Rajkumar et al., 2013)
22.	V22	InexTm	Lack of experienced project team	(Babu & Sudhakar, 2015)
23.	V23	StaChng	Frequent changes to project staff	(Jha & Iyer, 2006)
24.	V24	PolChan	Major policy level changes	(Rajkumar et al., 2013)
25.	V25	ExtInfl	External influences on project	(Hadipriono & Chang, 1988; Jha & Iyer, 2007; T. H. D. Nguyen et al., 2019)
26.	V26	Omission	Errors/ Omissions in project	(Babu & Sudhakar, 2015)
27.	V27	Corrupt	Corruption in the project	(Kassel, 2008; Rajkumar et al., 2013)

3.9 DEMOGRAPHIC/ PROJECT PARTICULARS

Demographic particulars including total population, infrastructure service status in different parts of the city, future planning for the city etc. are collected from the masterplan. A map of Thiruvananthapuram Corporation with ward boundaries and Ward wise population was collected from the Corporation office whereas booth wise voters list for the wards collected from the election cell.

The study focuses on select transport and water projects in Thiruvananthapuram that has completed the execution of works. Secondary data on major infrastructure projects in

Thiruvananthapuram having a project value of a minimum five crore rupees taken up during the last fifteen to twenty years was collected.

3.10 SURVEY QUESTIONNAIRE AND SAMPLE SIZE

The study focuses on infrastructure project users in Thiruvananthapuram as the main respondents and project professionals as the secondary respondents. Project users are basically the city residents in the project served area while project professionals are professionals working/previously worked in the two select infrastructure project sectors (Transportation and Water & Sanitation) in some capacity who can either be residents of Thiruvananthapuram or residing elsewhere but involved in Thiruvananthapuram projects under the transport/ water & sanitation sectors. Survey of project professionals is conducted to compare the results from project user survey.

3.10.1 Population

The respondent Population includes the entire city residents since most of the selected projects serve the city as a whole. Upon compilation of the demographic particulars from the masterplan and ward wise population details collected, it was observed that there is a small difference in the total population from the two sources. Masterplan gives total population as 9.8 lakhs whereas

total population based on ward wise split up details collected is 9.57 lakhs. Taking into consideration the requirement of ward wise population details in the sampling methodology, respondent population is taken as 9.57 lakh persons and the same is used in sample size computation.

Data from voters list is used as the basis for identifying the sample households for survey.

3.10.2 Sample Size Estimation

Sample size is computed using Cochran's formula (Israel, 1992) as below:

Sample size for large population

$$n_o = \frac{Z^2 pq}{e^2}$$

- Where n_0 is the sample size, Z is the abscissa of the normal curve that cuts off an area α at the tails, 1- α is the confidence level, e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population and q is 1-p.
- Confidence level chosen is 95%, Z= 1.96
- For precision level of 5%, sample size obtained is 385

The sample size obtained is rechecked using an alternate method for sample size by Yamane (Israel, 1992), which assumes 95% confidence level and p = 0.5 and is expressed as

$$n = \frac{N}{1 + N(e)^2}$$

- Where n is the sample size, N is population and e is the level of precision
- For e = 5%, sample size is 400.

Considering the sample sizes obtained from both the formula, sample size of 400 is fixed.

The final sample size chosen and distribution of samples is described in detail in the sampling methodology section.

3.10.3 Sampling Method

The total sample size required for a household survey based on the city population is 400. Mult-stage clustered sampling technique is used for household survey. Multi-stage cluster sampling is a technique that is used in household surveys where population size is huge. This technique is adopted mainly due to reasons of operational efficiency and cost in cases where data are collected by personal interviews in household surveys. One advantage is that multi-stage sampling helps concentrate the sample in a limited number of areas, which is important (Valliant et al., 2015)(Cochran, 1977).

Thiruvananthapuram city is administratively divided into 100 wards, each ward is further split into multiple booth areas for the purpose of elections in the voters list with each booth having a group of households. Multi-stage sampling methodology followed is depicted in Figure 3.3 below. Details of density cluster and the different stages is discussed in the subsequent sections.

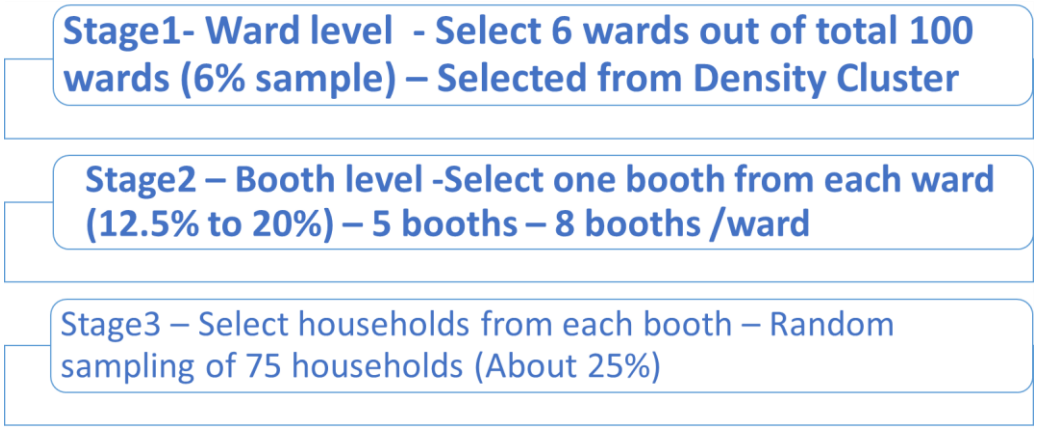

Figure 3.3: Multistage Cluster Sampling – Methodology

3.10.3.1Density Clusters

Density-based clustering to understand project impact of urban infrastructure projects is commonly used in studies like(Gao & Buffalo, n.d.; Khanani et al., 2021). In the present study for Thiruvananthapuram, population density clusters for the city area (100 wards) is developed. In other words, the city area is divided into clusters based on population density and administrative ward boundaries. Three density clusters are developed – HIGH DENSITY, MEDIUM DENSITY and LOW DENSITY. The clusters are identified such that total population is each of the clusters is

on average about one-third of the total population (around 3 lakh persons per cluster). Similar density-cluster based sampling approach using population density is followed in other infrastructure studies(Khavari et al., 2021). Figure 3.4 below shows the concept of density cluster

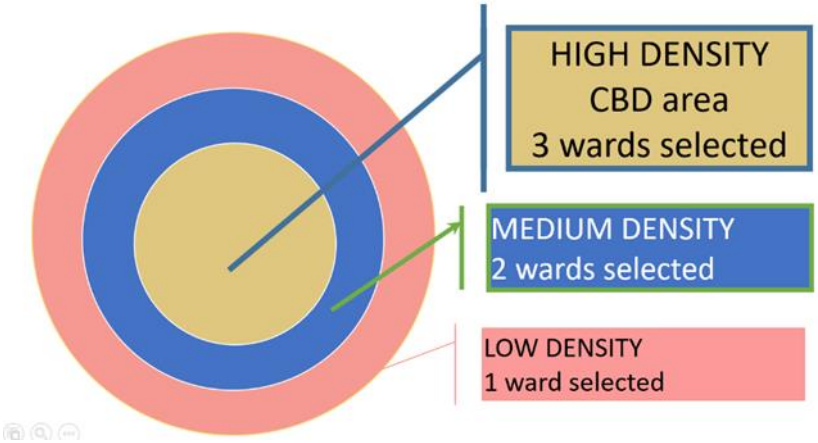

Figure 3.4: Density Cluster Concept

Map of Thiruvananthapuram Corporation is collected and the same is digitised into GIS format and analysed using QGIS software to prepare the Population Density Cluster map for the city. The map showing density clusters in separate colours is included below as Figure 3.5 and cluster wise details included in Table 3.4:

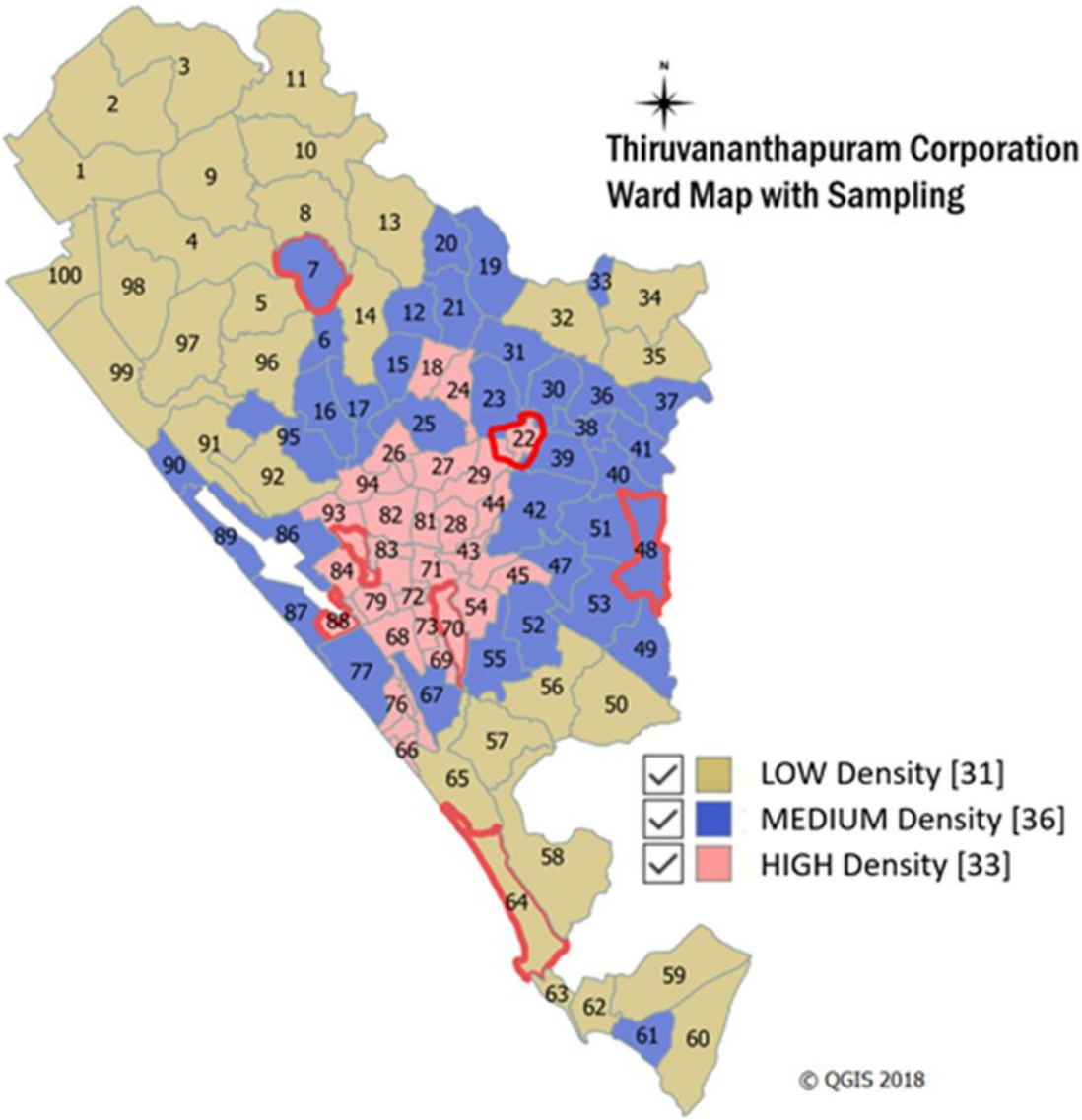

Figure 3.5: Thiruvananthapuram City Map with Density Clusters and Sample Wards

(Map prepared by researcher using QGIS from ward map and population)

Table 3.4: Details of Density Clusters

Cluster	Ward	Population	% Area	Average Density
HIGH DENSITY	33 wards	3,08,886	12.6	9120
MEDIUM DENSITY	36 wards	3,50,417	30.7	4257
LOW DENSITY	31 wards	2,98,388	56.6	1966
Total	**100 wards**	**9,57,691**	**100%**	

Among the total 100 wards, 6 wards (6%) are sampled at the first stage. In city development projects, it is normally observed that economic impact due to the development project is more predominant in the core city area when compared with the peripheral areas. Taking this factor into consideration, the 6 wards were selected such that 3 wards from HIGH DENSITY cluster, 2 wards from MEDIUM DENSITY cluster and 1 ward from LOW DENSITY cluster. After identification of the sample wards, one polling booth each from each ward was randomly selected in the second stage (Stage 2). Polling Booths are smaller areas within each ward identified for the purpose of local and general elections. Though a map showing the polling booths and respective areas are not readily available, booth numbers and their names with household list is clearly identified in the Voters list for the city which was already collected from the election cell. Number of booths in each ward varied from 5 to 8 between the wards. Under the particular booth selected in stage2 from respective wards, households are randomly selected for survey in the third stage. Initially it was planned to select household numbers in each ward proportional to the population in each ward and accordingly the number of households in each ward was fixed. For a sample size of 400, the number of households in any ward varies between 63 and 72. Subsequently, in order to simplify the enumeration process, 75 samples are collected from each Ward/ Booth thereby

resulting in a higher sample size. It may be noted that in the case of Vellar ward, 75 households were surveyed.

However, data for 19 households' samples could not be used, thereby making the sample size 506.

Pilot survey was carried out in one ward (75 households), further details of pilot explained in 3.10.5.1.

Thus, a total of 506 data samples are used for analysis. Sampling details with breakup of sample households is included in Table 3.5 below:

Table 3.5: Clustered Sample Particulars

S. No	Cluster	Ward No	Ward Name [Stage1]	Ward Population	No. of Booths in the Ward	Booth Selected [Stage2]	Sample Households/ Ward [Stage3]
P1	HIGH	22	Saasthamangalam (Pilot Ward)	10490	5	1	75
1	HIGH	88	Vallakadavu	8790	5	1	75
2	HIGH	85	Palkulangara	8941	6	1	75
3	HIGH	70	Attukal	8699	7	2	75
4	MEDIUM	7	Edavacode	8659	7	5	56
5	MEDIUM	48	Thrikkannapuram	9856	7	3	75
6	LOW	64	Vellar	9758	5	1	75
			TOTAL				506

3.10.4 Selecting projects under both sectors

Details of major infrastructure projects in Thiruvananthapuram was collected from online and other departmental sources. Of these, a total of six major/ bigger sized infrastructure projects - three major transport projects and three major water projects that have recently completed execution is chosen for detailed study.

These projects are assigned project codes from P1 to P6. Transport projects are coded from P1 to P3 whereas water &sanitation projects have codes P4 to P6. Basic project particulars of these six projects are tabulated below as Table 3.6:

Table 3.6: Projects Selected for Study

Code	Project Name and Description
	TRANSPORT PROJECTS
P1	**Karamana- Kaliyikkavila NH project** The project scope is four laning of Karamana – Kaliyikkavila National Highway (NH 47(66)) Phase I Reach I of 5.50 km from Karamana to Pravachambalam. Works commenced during 2014 and was completed in Jan 2016 for the Contract Value of about 75 Crores. Traditional Procurement method followed by NHAI

Code	Project Name and Description
P2	Thiruvananthapuram City Roads Improvement Project The project consists of improvements to the Thiruvananthapuram city's roads by way of development of ten corridors and three NH-bypass links totalling 42 km. The PPP project is innovative with interventions like solar-powered GPS enabled traffic signals, lush green traffic islands with fruit-bearing plants and bushes etc and is financed on an annuity mode. The total financial commitment for the project over a 15-year period annuity is Rs. 532.5 Crores. The project was completed in 2016 with various stretches achieving commissioning status during intermediate timeframes. The project was innovative and user friendly in its design allowing special considerations for pedestrian users. The project got recognition from United Nations for achieving Sustainable Development Goals by Public Private Partnership (PPP) forum of the United Nations Economic Commission for Europe (UNECE) held at Geneva.

P3	**Thampanoor Bus Terminal** The project involved development of a new comprehensive central bus terminus with associated facilities at Thampanoor in Thiruvananthapuram city. The bus stand caters for public bus transport operated by Kerala State Road Transport Corporation (KSRTC). KSRTC operates long distance intra-state buses as well as inter-state buses to various destinations from this new bust stand as well as city buses to few locations. The project was developed by Kerala Transport Development Finance Corporation (KTDFC) in association with KSRTC, both wings of the Transport department of Government of Kerala The work involves construction of the Main Block in 10 floors and Administrative Block. There is parking area for 330 cars and 500 two wheelers. The buses entering the building will have a single entry and single exit system. The project is completed at a cost of Rs. 81 Crores, works commenced during March 2010 and the facility was completed and opened to public in 2016.

Code	Project Name and Description
WATER PROJECTS	
P4	**JICA water supply Project** The project is intended to augment the existing water supply system for Thiruvananthapuram by adding additional capacity of 74 million litres per day (MLD) and improving system efficiency through reduction in non-revenue water from 37% to 29% Population Served – 147 thousand The scope of works included Augmentation from 190MLD to 264 MLD, Water Treatment Plant of 74MLD, Transmission system, Distribution Network 410 km and 11 numbers service reservoirs, The project commenced during 1997 and got commissioned during February 2010 at an overall project cost of over 400 Crores.

Code	Project Name and Description
P5	**Muttathara Sewage Treatment Plant (STP)** The project involved setting up of a sewage treatment plant (STP) at Muttathara in the existing sewage farm campus to carry out treatment sewage from the city. The STP of 107 million litres per day (MLD)capacity using activated sludge plus extended aeration process is constructed under the KSUDP project funded by Asian Development Bank (ADB) through a design- build contract mechanism at a capital cost of Rs. 72 Crores and operation and maintenance (O&M) cost of about 8 Crores The project commenced in 2010, testing and commissioning of the facility was completed by June 2013 after which O&M of the facility is by Kerala Water Authority (KWA). The plant has design capacity to cater to the entire requirement of Thiruvananthapuram city; however, currently sewerage system exists only for limited areas in the city.

Code	Project Name and Description
P6	**Operation Anantha** Operation Anantha is a flood management program in core city areas of Thiruvananthapuram taken up under Disaster Management project in the wake of flash floods in the core city areas during 2015. Major components included improvements to urban drains and waterways by clearing of encroachments, widening and rehabilitation, constructing cross drainage structures. The project was relatively of shorter duration due to planning and execution under disaster management special provisions with the works directly co-ordinated by the Office of Chief Secretary to Government of Kerala.

Figure 3.6 below shows a map of the project locations juxtaposed with survey locations.

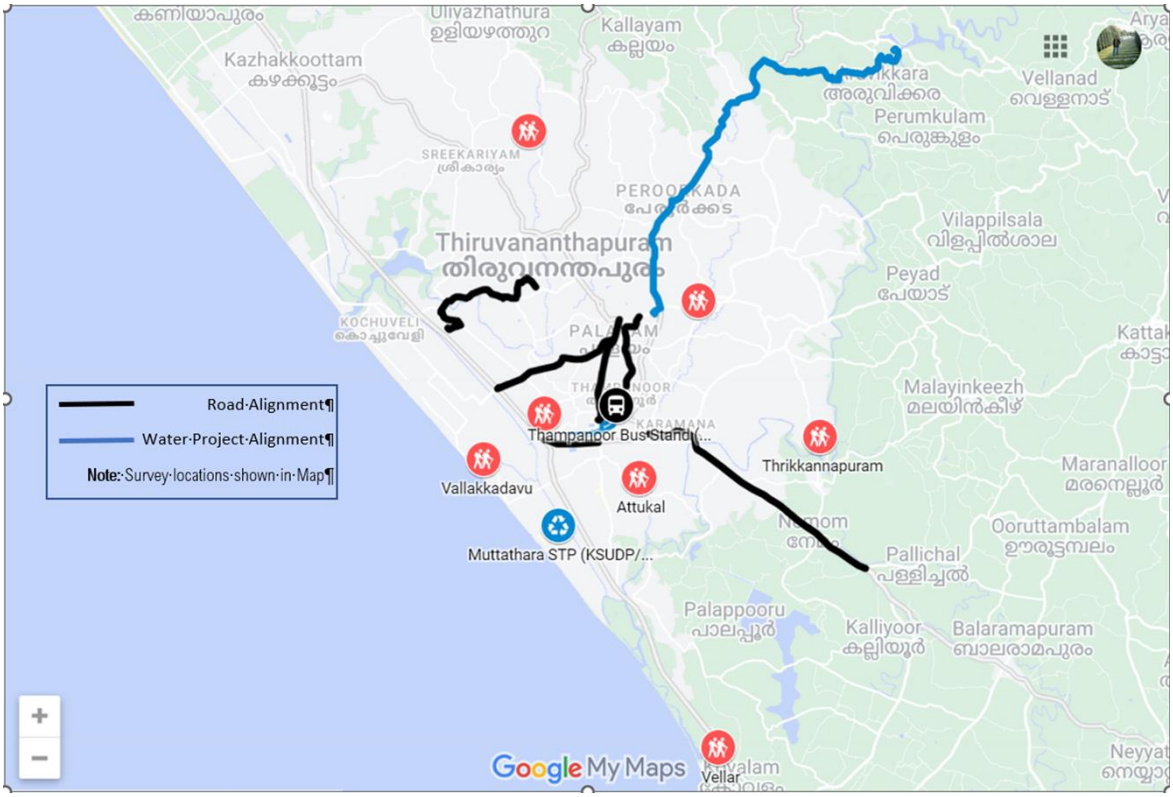

Figure 3.6: Project locations and Survey Areas

(Map prepared by researcher using Google Maps)

3.10.5 Survey Questionnaire

The main survey respondents are project users who are basically city residents while project professionals are the secondary respondents. A household survey of project users is proposed through a structured sampling approach whereas in the case of project professionals, those professionals with involvement in the project sectors were be identified through liaison and survey was conducted either through direct handover of questionnaire or transmission of questionnaire online. A household survey questionnaire was initially developed and the same underwent few

rounds of revisions based on review comments, important comments were:

- Including specific projects in the questionnaire to create proper responses instead of open-ended question. Accordingly, three projects from each sector (Transport and Water & sanitation) were selected
- Question on success factor rating split into three
- Respondent to first provide rating for project familiarity, performance level and criteria/ basis for assessing performance for each of the six projects.
- Separate question for rating impact of success factors
- Reverse ordered items separated into a separate question
- Additional question on infrastructure service availability in household (Access Road, Potable water connection, sewerage connection) included.
- Including a survey of project professionals for comparison/ validation
- Changing scale from three-point to five-point Likert scale.

After addressing the comments, the questionnaire was finalised to include questions on

- ✓ Basic respondent details like Name, Age, Gender, Address, Designation, Nature of work, Years of experience
- ✓ Personal profile including education level and position in family

- ✓ Infrastructure services in household, like access road, potable water connection, sewerage connection/ septic tank
- ✓ Familiarity, Awareness level and nature of involvement in both the infrastructure projects under study
- ✓ Project familiarity, project success rating, success criteria preference for each of the selected projects.
- ✓ Rating on the impact of each success factor on performance of the particular project collected for each of the six projects.

Survey questionnaire was translated into the local language Malayalam by providing side by side Malayalam version for the questions.

3.10.5.1 Pilot survey

A pilot survey of the questionnaire was conducted to test questionnaire for content and respondent understanding as well as explore additional factors. Taking into consideration the multistage sampling method adopted, one pilot ward was chosen and pilot survey was administered adhering the same modality thereby choosing 75 sample households for the pilot study. Sasthamangalam Ward (Ward No.22) located in the core city area was chosen for pilot survey.

Upon completion of the pilot, the revised questionnaire was again administered to the same respondents in the pilot ward thereby collecting data from an additional ward area also.

3.10.5.2 Finalize questionnaire based on pilot survey.

Based on the responses and observations from pilot, certain modifications were made in the questionnaire, important among the revisions are as below:

- Scale revised from 3-point as per pilot to 5-point Likert scale for both success criteria preference rating and rating for impact of success factors as per comment.
- Question on Success criteria revised to enable collection of success criteria preference for each project.
- Open ended question maintained to collect additional factors
- In pilot, difficulty in comprehending reverse ordered factors was observed among users despite explanation. Question split to separate reverse ordered items.

The Finalised questionnaire is enclosed as Annexure

3.10.6 Variable Scales

- ✓ Demographic and personal particulars of respondents are unique to each respondent and hence nominal in scale
- ✓ Infrastructure availability in household is collected as binary data.

- ✓ Awareness level and nature of participation in transport and water sector collected for each respondent in nominal scale.
- ✓ Project performance level is collected in percentage success and hence ratio scale
- ✓ Project Familiarity of respondent for each project collected in 5- point Likert scale.
- ✓ Rating on 5-point scale of each project for 13 Success Criteria and 27 success factors of which 8 factors are Reverse Ordered Items.
- ✓ Open ended question for additional factors/ views is nominal data as text.

3.10.7 Conduct primary data collection

Primary data collection for the study comprise two sets of survey data collected separately in independent rounds as explained below:

3.10.7.1 Household survey of Project Users -

The household survey questionnaire of project users is finalised after pilot household survey for one ward. In line with the sampling methodology described in the 3.10.3, the sample households were first located in each of the selected ward/ booth areas through the information available in the Voters list and through inquiry with local contacts in the area. In continuation, local support was gathered and date for survey fixed to visit the

households. As previously explained, the final questionnaire included both English as well as Malayalam translation (local language) side by side which helped in gathering the attention of respondents and making them understand the study focus. The questionnaire was administered to the sampled households after giving a study brief. Collection was mostly as schedule responses were directly collected from users to fill the questionnaire. In few cases, questionnaire forms were handed over to the respondents for their convenience and filled up forms were collected at a later date through coordination with local representatives

3.10.7.2 Survey of Project Professionals

A survey of project professionals was conducted as a validation/ comparison of the user survey results. Since there were initial doubts on awareness level of users on infrastructure project planning, it was initially proposed to have a focus group discussion of members for each project and verify/test the user survey inferences. However, in the wake of the ensuing COVID19 restrictions, it became difficult to materialise such a meeting through online options. Due to this, a survey of professionals was carried out in lieu of the focus group discussion. In line with the main questionnaire, a separate questionnaire was prepared without changing the scale and rating methodology for project performance, success factors and success criteria. The

questionnaire was converted into an online interface using Questionpro website and administered to the respondents. A list of respondents was prepared in advance based on enquiry/ discussions with available contacts. Based on the list and through professional groups, the questionnaire was transmitted. Few respondents were directly contacted over email and responses sought. A total of 47 useful responses were obtained.

3.10.8 Analysis of success criteria, success rating and its relation

The collected data includes success criteria preferences for each of the thirteen criteria on a five-point Likert scale. Success rating for each project rated as a percentage is another data collected from each of the respondents. Relation between the two is already reported in earlier studies on project managers (Müller & Turner, 2007) and possible relation between Success criteria preference and success rating for our projects is analysed by conducting correlation analysis with Polyserial Correlation and identifying criteria with significant correlation to success. Comparative analysis of correlations for the two sectors as well as between users and project professionals is also performed.

3.10.8.1 Polyserial Correlation

As per Olsson, Drasgow, and Dorans, association between a continuous and a categorical (ordinal) variable can be

measured using Polyserial correlation as defined in (Olsson et al., 1982)*,"…the case where one observed variable is polychotomous and ordinal, and the other observed variable is continuous. The product moment correlation between these observed variables is called the point polyserial correlation…*". Polyserial correlation coefficient for association between each variable pair is calculated in LISREL 10.20 software (Jöreskog, K.G. &Sörbom, 2018).

Three sets of analysis were conducted, the first set with all projects together and separate analysis for the individual sectors. Polyserial correlation is well suited for the present analysis since our dependent variable (Project success rating) is a continuous scalar variable and the independent variable (success criteria preference level) has 5-point Likert scale.

3.10.9 Identify and prioritize critical factors

Factor analysis of the success factors is proposed to identify underlying latent variables among the success factors which are referred to as critical success factors. Prior to conducting the factor analysis, Kaiser-Meyer-Olkin (KMO) test of sampling adequacy and Bartlett's test of sphericity is tested to confirm suitability of data for factor analysis. Ordinal Factor analysis based on procedure by Joreskog is performed on the dataset to identify the critical success factors

3.10.9.1 Ordinal Factor Analysis

Many studies in the social and behavioural sciences like the present study use variables with scale similar to the current 5-point Likert scale, the scale needs to be considered as ordinal rather than continuous. "*Observations on an ordinal variable are assumed to represent responses to a set of ordered categories such as a five-category Likert scale*".(Jöreskog, 1994a)(Jöreskog, 1994b). "*Ordinal variables are not continuous variables and should not be treated as if they are. Ordinal variables do not have origins or units of measurements. Means, variances, and covariances of ordinal variables have no meaning".* "*The only information we have are counts of cases in each cell of a multiway contingency table"*(Choi et al., 2010). "*Ordinal data do not provide metrical information and, therefore, one needs to analyse frequency information in a contingency table"*(Choi et al., 2010).

An analysis option used in such variables is to hypothesize an underlying metrical variable associated with the observed ordinal data(Jöreskog, 1994b). As per Joreskog's method Each ordinal variable z is assumed to have an underlying continuous variable $z*$. which can be used in structural equation modelling instead of the observed variable z. and is assumed to have a

range from $-\infty$ to $+\infty$. The underlying variable assigns a metric to the ordinal variable.

If z has m categories labeled 1, 2, . . . , m, the connection between z and $z*$ is

$z = i \Leftrightarrow \tau i-1 < z* < \tau i$, i= 1, 2, . . . , m ,

where

$-\infty = \tau 0 < \tau 1 < \tau 2 < .. . < \tau m-1 < \tau m = +\infty$,

are parameters called threshold values.

With m categories, there are m − 1 threshold parameters $\tau 1, \tau 2$, . . . , $\tau m-1$. ”(Jöreskog, 1994b).

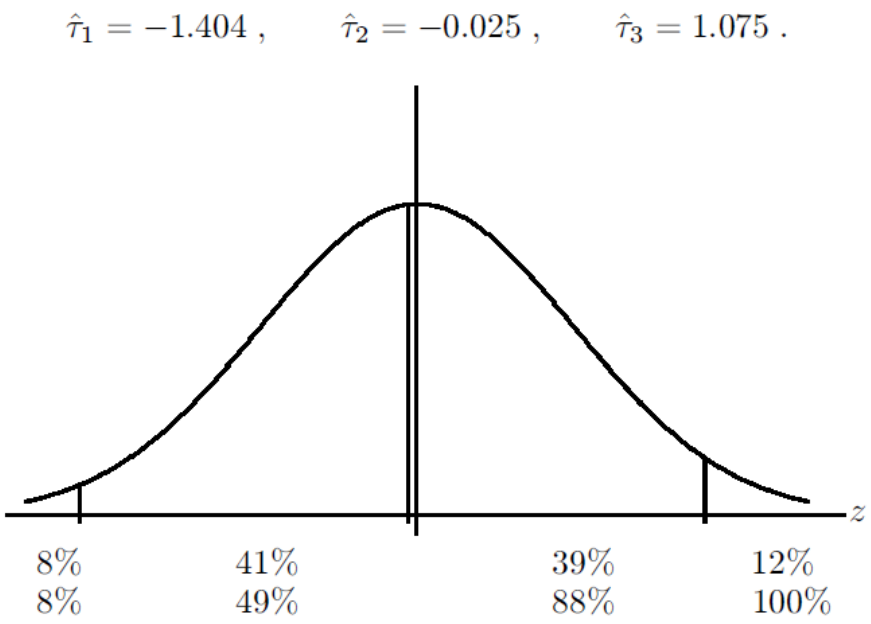

Figure 3.7: Illustrating Thresholds,

Reproduced from (Jöreskog, 1994b)

As per Joreskog’s description of the estimation of thresholds illustrated above “Suppose there are 8, 41, 39, and 12%

responding in category 1, 2, 3, and 4, respectively. Cumulatively this is 8, 49, 88, 100%. The first threshold is located where the area under the normal to the left of the threshold is 8%. The second threshold is located where the area under the normal to the left of the threshold is 49%. The third threshold is located where the area under the normal to the left of the threshold is 88%. This gives approximately $\hat{\tau}1 = -1.404$, $\hat{\tau}2 = -0.025$, $\hat{\tau}3 = 1.075$" (Choi et al., 2010)

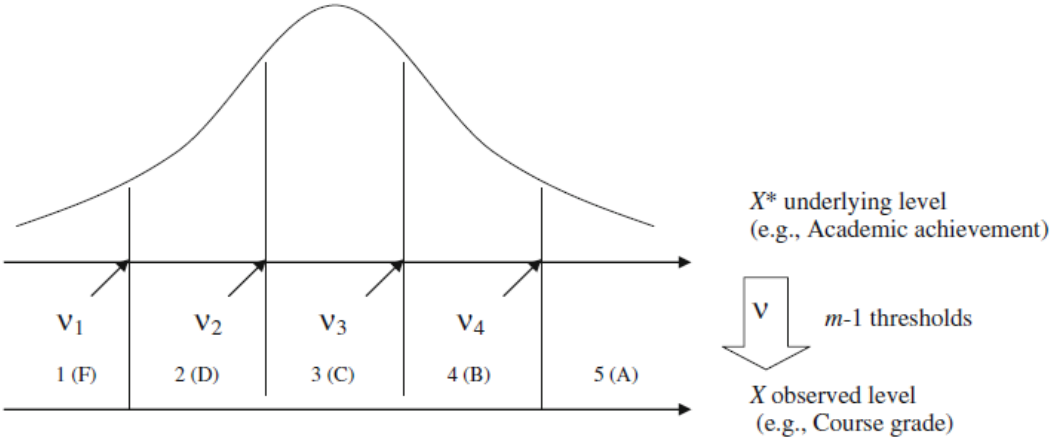

Figure 3.8: Underlying Level X* and Observed Level X, Reproduced from (Choi et al., 2010)

Another illustration by Choi and team is given in Figure 3.8. The above univariate scenario is extended to bivariate to estimate the polychoric correlation between the two metrical underlying variables(Choi et al., 2010). Polychoric correlation methods generally used are maximum likelihood (ML) and expected a posteriori (EAP). "*The traditional maximum likelihood estimation method requires large sample sizes,*

while the EAP estimation for polychoric correlations can have stable estimates of this correlation even when sample sizes are small (e.g., smaller than 30)".(Choi et al., 2010)

Ordinal Factor analysis is conducted using two software packages specifically focusing on factor analysis viz., LISREL developed by Karl Joreskog and Dag Sörbom, FACTOR64 developed by Rovirai Virgili University, Spain under the leadership of Urbano Lorenzo Seva and team. Both these software packages have Ordinal Factor analysis procedure which make use of the Polychoric correlation matrix between the variables for identifying the factors and conducting further analysis.

Due to limitations in number of variables in the free version of LISREL software and the need to analyse 27 success factors, both the packages FACTOR64 and LISREL are combined and used for Exploratory and Confirmatory Factor analyses respectively.

First, exploratory factor analysis is performed to identify critical success factors, the model validity is confirmed using confirmatory analysis. Separate factor analysis for projects in each sector is also conducted to compare the critical success factors in transport and water & sanitation sectors.

3.10.10 Sectoral and Stakeholder Comparison

Analysis of project user views for each of the study sectors viz., transport and water & sanitation is separately conducted and comparison of the results between the sectors is carried out. Results from the household survey of project users is compared with the results from the survey of project professionals to understand the similarities and differences in viewpoints. Testing of the Hypotheses is conducted using Moods Median Test and Correlation analysis.

3.11 Summary

Research Methodology involves specifying research questions and the problem statement, defining the research objectives and hypothesis to be tested with specific reference to the two infrastructure project sectors under study (viz., water& sanitation and transportation) in Thiruvananthapuram city. Research methodology involves a household survey of project users for selected projects in each sector and survey of project team members. A comparison of sectors as well as stakeholder groups is proposed.

CHAPTER IV

DATA ANALYSIS AND

INTERPRETATION

CHAPTER IV. DATA ANALYSIS AND INTERPRETATION

4.1 INTRODUCTION

Analysis of the collected data follows in line with the proposed research objectives and methodology to explore and gather insights. Data collection from the respondents is completed and the collected data is entered into the worksheets and necessary data cleaning was performed. Statistical analysis is carried out using a combination of three statistical software viz., FACTOR, JASP, and LISREL along with computation in Microsoft Excel as required. The use of different statistical packages is due to the different statistical procedures each offer as well constraints in terms of allowed number of variables for a particular analysis type under the available mode of access due to researchers' cost constraints. Description of various statistical techniques used for analysis and the analysis results are detailed in the subsequent sections.

4.2 ANALYSIS OF USER SURVEY

This section presents the analysis of household survey of project users, statistical tools and techniques used and analysis results.

4.2.1 Respondent Profile

Household survey of project users was carried out in a total of 506 households from 7 wards in Thiruvananthapuram city as explained in the sampling methodology. A total of 555 households were attempted for survey of which 525 were surveyed with a response rate of 94.6%. However, 19 responses were lost after the survey making effective usable samples as 506. The survey was conducted in interview mode. Missing details, if any, were collected over phone after the survey. Cross sectional profile of the users/respondents is presented in the following tables.

By Gender

Among the 506 respondents, 401 are males and 105 are females as in Table 4.1 below:

Table 4.1: Household survey of Project Users - Respondent Profile

Gender	**Count**
Male	401
Female	105
Total	**506**

In general, head of household responded to the survey. This explains to some extent the gender bias in responses.

By Age

Project users falling in different age groups, both young and old formed part of the survey thereby getting a good representation from various age groups. Respondent profile breakup by age is depicted in in Table 4.2 below.

Table 4.2: Project User profile by Age

Age (Years)	**Count**
Less than or Equals 30 years (<=30)	30
Between 31 and 45 years (31-45)	118
Between 46 and 60 years (46-60)	214
Between 61 and 75 years (61-75)	134
Above 75 years (>75)	9
Total	**505***

* - Age of one respondent not obtained.

Education: Based on the education level, graduates and above constituted about 40% of the sample. Breakup of respondents by level of education is included in Table 4.3.

Table 4.3: Project User profile by level of education

Level of Education	**Count**
Basic Education	98
Matriculate	111
Intermediate	88
Graduate	147
Postgraduate and above	62
Total	**506**

Profession: Project users surveyed were engaged in a variety of professions. Apart from employees, there were 53 respondents doing own business whereas 71 were housewives which are categorised under others. Table 4.4 shows the breakup.

Table 4.4: Project User profile by profession

Profession/ Type of Job	Count
Technical	28
Contractual	15
Financial	33
Legal	13
Managerial	21
Teaching/Research	25
Clerical	43
Administrative	41
Support	120
Other (includes Business -51; Housewives - 71)	167
Total	**506**

Work Experience: Users were categorised based on their years of work experience into four categories as shown in Table 4.5

Table 4.5: Project User profile by Experience

Work Experience (Years)	Count
Less than or equals 10 years (<=10)	99
Between 11 and 20 years (11-20)	147
Between 21 and 30 Years (21-30)	183
Above 30 years (>30)	78
Total	**506**

Availability of basic infrastructure in terms of transport and water &sanitation in the household was surveyed in terms of the following parameters:

- ✓ Presence of motorable road within 30m distance from household
- ✓ Presence of water supply connection
- ✓ Presence of sewerage house connection/ individual septic tank

Among the surveyed households, over 95% had access to the above basic infrastructure elements indicating high coverage of basic infrastructure in Thiruvananthapuram. Of the three parameters, while only two of the surveyed wards have sewerage networks, houses have individual septic tanks. However, the questionnaire does not distinguish between these two types and has considered both together.

4.2.2 PROJECT FAMILIARITY COMPARISON OF USERS.

Project familiarity level for individual projects for the users based on household survey has been analysed with the help of descriptive statistics. JASP 12.1 software is used for computing the statistics.

Table 4.6: Comparison of Project Familiarity Statistics of Users

	Familiarity_P1	Familiarity_P2	Familiarity_P3	Familiarity_P4	Familiarity_P5	Familiarity_P6
Valid	506	506	506	506	506	505
Mean	4.476	4.093	3.842	2.982	2.447	2.695
Median	5.000	4.000	4.000	3.000	2.000	3.000
25th percentile	4.000	4.000	3.000	2.000	2.000	1.000
50th percentile	5.000	4.000	4.000	3.000	2.000	3.000
75th percentile	5.000	5.000	5.000	4.000	3.000	4.000

Source: JASP 12.1 output

From the values of mean, median and quartiles for the projects presented in Table 4.6 above, it could be observed that in the case of transport sector projects (P1 to P3), median value is 5 for P1 and 4 for P2, P3, quartiles range between 4 to 5 for P1, P2 and 3 to 5 for P3. In the case of water and sanitation projects, median value is 3 for P4 and P6 and 2 for P5 whereas quartiles range from 2 to 4, 2 to 3 and 1 to 4 respectively for projects P4 to P6. The above results show a higher level of familiarity for transport projects among users in comparison to water and sanitation projects which is tested later.

4.2.3 SCREENING OUT LESS FAMILIAR RESPONDENTS

For each of the six selected projects in the study, respondent rating on project familiarity was obtained on 5-point Likert scale (rating from minimum 1 to maximum 5). Based on familiarity level of respondent for each project, respondents were split into two categories – 'Users with familiarity >=3' and 'Users with familiarity <3'. Project wise split-up of respondents under the two categories is shown in

Table 4.7 below:

Table 4.7: Split-up of Users based on Project Familiarity

Project Name	Respondents with Familiarity <3	Respondents with Familiarity >=3	Total Respondents
P1- Karamana-Kaliyikkavila NH project	21	485	506
P2 - Thiruvananthapuram City Roads Improvement Project	13	493	506
P3 - Thampanoor Bus Terminal	33	473	506
P4 - JICA water supply Project	163	343	506
P5 - Muttathara Sewage Treatment Plant	315	191	506
P6 - Operation Anantha	231	275	506

Users with lower project familiarity ratings less than 3 for each project were screened out from the analysis to make sure that the analysed data corresponds to users having sufficient familiarity with the projects under study. Thus, detailed analysis of user data is carried out after screening out users with lower project familiarity level

Project data for all variables except project success rating is in 5-point Likert scale while project success rating is measured in percentage. Data in 5-point Likert scale is considered to be ordinal (instead of interval scale) in the analysis. Thus, rating for each project is considered as separate response while combining the data for all the six projects under study thereby the total number of responses is 506 multiplied by 6 which is 3036. Of these total

3036 responses, those responses where project familiarity level is 3 or above, is considered for analysis while the remaining responses screened out. A total of 2260 responses from both the sectors together have project familiarity 3 or above with 1451 responses for transport projects and 809 responses for water and sanitation projects. This data is used in further analysis of project user views. Split-up of responses is shown in Table 4.8

Table 4.8: Total responses based on Project Familiarity

Project Sector	Responses with project Familiarity <3	Responses with project Familiarity >=3	Total Responses
Total for Transport Projects	67	1451	1518
Total for Water& Sanitation Projects	709	809	1518
All Projects - Total	**776**	**2260**	**3036**

4.2.4 SUCCESS RATING OF PROJECTS

Success Rating for individual projects by the users (with project familiarity >=3) as an average rating for each project is tabulated below in Table 4.9:

Table 4.9: Project Success Rating by users

Project Name	No. of Respondents (Familiarity >=3)	Project Success Rating (%)		
		Mean	Median	Standard Deviation
P1- Karamana-Kaliyikkavila NH project	485	58.25	60	12.48
P2 - Thiruvananthapuram City Roads Improvement Project	493	51.63	50	13.82
P3 - Thampanoor Bus Terminal	473	52.39	50	14.37
P4 - JICA water supply Project	343	45.90	45	15.66
P5 - Muttathara Sewage Treatment Plant	191	38.97	35	14.73
P6 - Operation Anantha	275	42.52	40	16.59

Source: Compiled by author from JASP output.

It can be observed that the three transport projects show higher success levels above 50% whereas the three water & sanitation projects have lower success ratings

Comparison of the project user success ratings for transport and water & sanitation projects is proposed for testing under Hypothesis 1.

4.2.5 DESCRIPTIVE STATISTICS

Descriptive Statistics for the project user data is computed using JASP 12.1 software. Normality check and reliability of scale verified.

4.2.5.1 TEST FOR NORMALITY

Shapiro-Wilk test is conducted to check Normality for the variables, the coefficient values are above 0.9 with significance level <0.01. The p value below 0.01 indicates deviation from normality.

4.2.5.2 RELIABILITY OF SCALE

Reliability of the used scale is checked separately for success criteria and success factors using two reliability coefficients – Cronbach α (Cronbach, 1951) and Mcdonald's ω (McDonald, 1999), value of Cronbach α coefficient is 0.762 and McDonalds ω value is 0.763. Cutoff Value of both Cronbach α and Mcdonalds ω is taken as 0.7 (Ravinder & Saraswathi, 2020; Santos, 1999), the computed coefficients are both above 0.7, scale reliability is confirmed.

4.2.6 COMPARISON OF SUCCESS RATING FOR CLUSTERS

The assumption for adopting higher samples from the core city area (wards belonging to Cluster1 area) was that the economic benefits due to the project would be felt more in the core city area in comparison to the peripheral areas. Taking this into consideration, a comparative analysis of the project success rating between core city area (Cluster1) and peripheral areas (Clusters 2 and 3 combined) is conducted as shown in Table 4.10. Testing of assumption is carried out by computing the Moods Median test, test results shown in Table 4.11.

Table 4.10: Descriptive Statistics of success rating- Core and Peripheral areas

Statistic	Core City (Cluster1)	Peripheral area (Cluster 2 + Cluster 3)
No. of responses	1369	891
Mean	54.85	42.96
Std. Deviation	14.648	14.168
Shapiro-Wilk	0.958	0.949
P-value of Shapiro-Wilk	< .001	< .001

Table 4.11: Testing of Success Rating for Clusters

Test	Statistic	df	p
Mood's Median test	217.99	1	<0.01

For Moods median test, the chi square cut-off value for df=1 and p=0.01 is 6.635, the computed value of 217.99 is very high indicating significant difference in project success rating among the clusters. The above test results show that success rating for

projects reported from core city area wards is significantly higher than that reported from peripheral areas of the city thus confirming the assumption.

4.2.7 TESTING HYPOTHESIS 1 – USER SUCCESS RATING FOR TRANSPORT VS WATER & SANITATION PROJECTS

Null Hypothesis H_1 – Success rating by users for Transport and Water projects are relatively similar.

Descriptive Statistics for the success rating for all projects and sector wise are given in Table 4.12 below:

Table 4.12: Descriptive Statistics of success rating - Sector wise breakup

Statistic	All Projects	Transport	Water
No. of responses	2260	1451	809
Missing	1	0	1
Mean	50.16	54.09	43.11
Std. Deviation	15.58	13.88	15.99
Shapiro-Wilk	0.965	0.96	0.953
P-value of Shapiro-Wilk	< .001	< .001	< .001

From the Table above, we have observed that for the projects under study, mean success rating for transport projects is 54.09 and standard deviation 13.88 whereas in water &sanitation projects, the mean success rating and standard deviation are respectively 43.11 and 15.99. From the above values, we

hypothesise that success rating for the two sectors is different. This Hypothesis is tested using the Moods Median Test.

From Table 4.12, we can see that the independent samples have unequal sample sizes, Shapiro Wilk P value <0.01 means deviation from normality and difference in variance observed from standard deviation. For testing such a sample, Mood's Median test (Ramana PV, 2020) is among the recommended tests, the test results are shown below in Table 4.13, detailed computation sheet enclosed as Appendix 5.

Table 4.13: Hypothesis1- Testing Success Rating for sector

Test	Statistic	df	p
Mood's Median test	95.28	1	<0.01

For Moods median test, the chi square cut-off value for single degree of freedom (df=1) and p=0.01 is 6.635, the computed test statistic is 95.28 (p<0.01) which is very high compared to the cut-off value and hence significant evidence to reject the null hypothesis. User Success rating for Transport projects in Thiruvananthapuram is found to be greater than that of Water & sanitation projects.

4.2.8 PROJECT SUCCESS CRITERIA PREFERENCES AMONG USERS

Success criteria preference of users is collected on a five-point Likert scale for each of the thirteen success criteria for each

project. Comparison of level of preference for success criteria is checked by computing the Median of scores and sum of scores, details tabulated below as Table 4.14:

Table 4.14: Success Criteria Preference Levels

	Transport Projects		Water& Sanitation Projects		All Projects	
	Median	**Sum**	**Median**	**Sum**	**Median**	**Sum**
Time	3	4934	3	2266	3	7200
Budget	**3**	**5076**	3	2214	3	7290
ExpBen	3	4882	3	2168	3	7050
InfQua	**4**	**5100**	3	2268	**3**	**7368**
USatis	3	4906	**3**	**2291**	3	7197
NuTek	3	4904	3	2250	3	7154
ImpSer	3	4720	3	2099	3	6819
PuDist	3	4591	3	2124	3	6715
AdvImp	3	4518	3	2200	3	6718
PuCons	3	4761	3	2193	3	6954
EazUse	3	4627	3	2111	3	6738
UsCost	3	4583	3	2061	3	6644
SocResp	3	4390	2	2058	3	6448

From the above table, it could be deciphered that for all the studied projects, ‘Quality of Finished Infrastructure (InfQua)’ with the highest sum of scores is the most preferred success criteria among users followed by ‘Timely Completion (Time)’ and ‘Within Project budget (Budget)’.

In the case of transport projects (P1 to P3), the most preferred success criterion is ‘Quality of Finished Infrastructure (InfQua)’, the second one being ‘Timely Completion (Time)’.

And for Water &sanitation projects, ‘Good User Satisfaction (USatis)’ is viewed as the most preferred success criteria while ‘Quality of Finished Infrastructure (InfQua)’ and ‘Timely Completion (Time)’ given the next higher preference.

4.2.9 RELATION BETWEEN SUCCESS CRITERIA PREFERENCE AND SUCCESS RATING

The level of association between Success rating and each of the individual success criteria rating is analysed by computing the correlation coefficients and checking significance. Polyserial Correlation Coefficients were computed with success rating as the dependent variable and success criteria preference as independent variables.

Polyserial Correlation coefficients were computed for all the six projects together as well as independently for projects under each sector, the first set of coefficients with projects from both sectors combined are given in **Table 4.15**. Polyserial correlation coefficient is computed in LISREL.

Table 4.15: Success Criteria Preference Vs Success Rating – (All Projects)

Success Criteria	**Polyserial Correlation**	
	Coefficient	**p**
Time	0.249	< .001
Budget	0.243	< .001
ExpBen	0.238	0.009
InfQua	0.203	< .001
USatis	0.164	0.001
NuTek	0.240	0.002
ImpSer	0.182	< .001
PuDist	0.169	0.001
AdvImp	0.165	< .001
PuCons	0.190	0.014
EazUse	0.189	< .001
UsCost	0.175	< .001
SocResp	0.130	0.022

Correlation coefficients have good significance levels whereas the coefficients are below 0.25. Of the 13 success criteria, four criteria (Time, Budget, Expected Benefits and New Technology) show better correlation coefficient values between 0.2 and 0.25 indicating a stronger association with the project success levels. Nine criteria have significance level below 0.001 and the remaining four criteria show significance levels below 0.05. In short, the correlation coefficients for all success criteria are acceptable while the strength of the correlations are relatively weak.

4.2.9.1 SECTOR-WISE COMPARISON OF CORRELATION

The correlation coefficients are again computed for the sector-wise data sets for transport/ water & sanitation projects. Significance levels for Polyserial coefficient show sizeable variation. Correlation coefficients and significance levels for transport and water & sanitation sectors are shown in Table 4.16 and Table 4.17 respectively.

Table 4.16: Success Criteria Preference Vs Success Rating - (Transport Projects)

Success Criteria	**Polyserial** Correlation	
	Coefficient	**P-Value**
Time	0.138	0.232
Budget	0.11	0.659
ExpBen	0.121	0.151
InfQua	0.088	0.001
USatis	0.063	0.011
NuTek	0.105	0.671
ImpSer	0.076	0.157
PuDist	0.094	0.091
AdvImp	0.056	0.24
PuCons	0.102	0.007
EazUse	0.119	0.03
UsCost	0.018	0.002
SocResp	0.038	0.974

Weak correlation coefficient values are obtained for the transport sector, five criteria having significance below 0.03 and the remaining eight with significance level above 0.09. Correlation coefficients are relatively stronger for the water sector ranging from 0.12 to 0.26, significance levels for seven criteria are below 0.03 and balance six have level of significance above 0.075.

For transport projects, 'Ease of Use' and 'Public consultation' are having maximum relation to project success while in water projects 'Time', 'Budget', 'Usage Cost' and 'No Adverse impact' shows more relation to success.

Table 4.17: Success Criteria Preference Vs Success Rating - (Water & Sanitation Projects)

Success Criteria	**Polyserial**	
	Correlation	P-Value
Time	0.237	0.001
Budget	0.204	0.002
ExpBen	0.204	0.093
InfQua	0.145	0.126
USatis	0.14	0.474
NuTek	0.26	0.078
ImpSer	0.139	0.001
PuDist	0.124	0
AdvImp	0.226	0
PuCons	0.153	0.358
EazUse	0.124	0.028
UsCost	0.227	0.011
SocResp	0.134	0.169

4.2.10 IDENTIFICATION AND ANALYSIS OF CRITICAL SUCCESS FACTORS FOR USERS

Rating for the impact of success factors on each project is collected on a 5-point Likert scale. Of the twenty-seven factors, eight are reverse ordered variables. Ratings for reverse ordered items were separately collected and the same is combined into the data set. Factor analysis is conducted to identify inherent latent variables from the success factors. These latent variables thus identified will be subjected to confirmatory factor analysis to derive critical success factors. The study uses Ordinal Factor analysis procedure developed by Karl Joreskog and diversified by many other researchers.

4.2.10.1 Ordinal Factor Analysis – Analysis Sets

Ordinal Factor Analysis for four different sets of data are being carried out. For each of the data sets both exploratory and confirmatory factor analysis is conducted after ensuing satisfactory results in both the Kaiser-Meyer-Olikin test (KMO) and Bartler's Test of Sphericity. Different sets of analysis conducted is briefed below in Table 4.18 for ease of understanding:

Table 4.18: Ordinal Factor Analysis Sets

Analysis	Dataset	Types of Analysis
Ordinal Factor Analysis (OFA) using FACTOR64 and LISREL software for each set separately	1. User Data on success factors for all Projects combined	For each set: KMO Test Bartlet's Test of Sphericity Exploratory Ordinal Factor Analysis in FACTOR Confirmatory Factor Analysis in LISREL
	2. User Data on success factors for Transport Projects alone (P1 to P3)	
	3. User Data on success factors for Water Projects alone (P4 to P6)	
	4. Project Professional Data on success factors for all projects combined	

4.2.10.2 Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy or simply the KMO test is a statistic that indicates whether a factor analysis could be useful for the data(Kaiser, 1974; Kaiser & Rice, 1974). The coefficient indicates "the proportion of variance in variables that might be caused by underlying factors. High values (close to 1.0) generally indicate that a factor analysis may be useful"(Reddy & Kulshrestha, 2019), values less than 0.50 indicates that factor analysis may not be of much use.

4.2.10.3 Bartlett's Test of Sphericity

Bartlett's test of sphericity tests whether the correlation matrix is an identity matrix, indicating whether the variables are suitable

for structure detection. For small level of significance values (< 0.05), factor analysis could be of use(Reddy & Kulshrestha, 2019).

4.2.10.4 Exploratory Factor Analysis – All Projects

Exploratory factor analysis is attempted for the dataset comprising all the six projects. Prior to carrying out factor analysis, adequacy of the sample and polychoric correlation matrix is tested by conducting the Kaiser- Meyer -Olikin Test (KMO) and Bartlett's Test of Sphericity. Table 4.19 below shows both the test values:

Table 4.19: KMO and Bartlet's Test Statistic - All Projects

Description	Bartlett's statistic	Kaiser-Meyer-Olkin (KMO) test
Transport and Water &Sanitation projects combined (6 projects)	11334.9 (df = 351; P = 0.000010)	0.906 (very good)

The KMO test value above 0.9 confirms sampling adequacy whereas with Bartlett's test, $p<0.01$ suggesting suitability for data reduction through factor analysis.

Exploratory Factor analysis of the 27 variables (success factors) is conducted using FACTOR package. Initial analysis is run without specifying the number of factors to obtain the Eigen values and variance explained. Based on Eigen values greater than 1, number of factors is fixed and first trial is run to obtain the factor scores for each of the variables. Variables with lower factor scores (less than 0.3) are excluded systematically from the

analysis as generally followed (DiStefano et al., 2009)and factor analysis is rerun multiple trials. Analysis continued for subsequent trials by leaving out variables with lower factor scores while fixing the number of factors based on latest eigen values and rerunning the analysis. An optimised solution is obtained after several trials.

In the eighth trial, the present analysis is optimised with three factors from 10 variables. The explained variance table for the identified factors is shown in Table 4.20 and factor scores for the optimised solution is given in Table 4.21:

Table 4.20: All Projects - Explained variance Based on Eigen Values – Optimized Solution

Variable	Eigen Value	Proportion of Variance	Cumulative proportion of Variance
1	2.81	0.28	0.28
2	1.20	0.12	0.40
3	1.09	0.11	0.51
4	0.87	0.09	
5	0.79	0.08	
6	0.77	0.08	
7	0.71	0.07	
8	0.66	0.07	
9	0.60	0.06	
10	0.49	0.05	

Table 4.21: All Projects-Rotated Loading Matrix (Promax Rotation)

Variable No.	Variable	INFRA1	INFRA2	INFRA3
1	Vision	**0.55**	0.07	0.01
4	RespSha	0.03	**0.55**	-0.06
5	NdsAss	-0.03	0.08	**0.46**
10	PlanDes	**0.75**	0.00	-0.06
13	Sched	0.04	**0.44**	-0.01
14	TransProc	0.06	0.04	**0.41**
16	QCrite	-0.04	**0.48**	0.08
18	StkCo	-0.04	0.11	**0.46**
20	ChReq	**-0.64**	0.04	-0.09
25	ExtInfl	-0.04	0.14	**-0.55**

The three factors obtained from analysis are named INFRA1, INFRA2 and INFRA3, factor scores indicating variable contributions to each factor indicated in Table 4.21 above.

Determinacy and reliability of factor score estimates are verified through various indices (Ferrando& Lorenzo-Seva, 2018). Among these indices, Factor Determinacy Index' (FDI) is a common measure that gives the correlation between the factor score estimates and the levels on the estimated latent factors (Beauducel, 2011). FDI values around and above 0.8 are considered adequate for general research (Ferrando& Lorenzo-Seva, 2018).

Table 4.22: Critical Success Factors from EFA- Users-All Projects

Variables (Success Factors)	Factors (Critical Success Factors) (CSF)	Factor Determinacy Index (FDI)
Vision	**Strong Need Based Concept (INFRA1)**	0.854
Planning/Design (PlanDes)		
Change in Requirements (ChangeReq)		
ResponsibilitySharing (RespSha)	**Robust Risk Management (INFRA2)**	0.761
Schedule (Sched)		
Qualification Criteria (QualCri)		
PoliWill	**Inclusive Planning (INFRA3)**	0.791
Needs Assessment		
Transparent Procurement		
Stakeholder Coordination		
External Influence		

Table 4.22 shows the Factor determinacy indices obtained from FACTOR package for the three factors named, F1- 0.854, F2 - 0.761, and F3- 0.791 which falls within the acceptable limit. Priority level for the three factors can be fixed from FDI values with higher values indicating higher priority. Among the three factors, Strong Need Based Concept (INFRA1) has the first priority followed by Inclusive Planning (INFRA3) and Robust Risk Management (INFRA2).

4.2.10.5 Confirmatory Factor Analysis – All Projects

Confirmatory Factor Analysis of the model is run using LISREL to determine the validity of the factor scores. A path diagram is developed using the factors and corresponding variables determined from exploratory factor analysis. Analysis is run using PRELIS coding technique available in LISREL. The results are provided below:

Validity of constructs is checked by running the confirmatory factor analysis for the factor model and computing the factor loadings of variables, coefficients and fit indices. Table 4.23 shows the factor loadings, T values (Z values) and R^2 coefficients. Z values for all the variables are above the acceptable limit of 1.96 while all R^2 values are significant.

Maximum Likelihood (ML) fitting function is used for CFA. Though ML assumes multivariate normality assumption, ML is reported to be robust during violation of the normality assumption as well. ML parameter estimates were found consistent under severe nonnormality in some simulations(Schermelleh-Engel et al., 2003) Chi-square value from CFA is traditionally considered as indicative of good model-data fit while its sensitivity to model size and non-normality is reported (Hox &Bechger, 2015). Other indices like Goodness of Fit Index (GFI), chi-square, Root Mean Square Residual (RMSR), or the Standardized Root Mean Square Residual (SRMR) measure overall fit of the model. The Root Mean

Square Residual index (RMR) based on the fitted residuals; values close to zero indicate good fit. RMR is scale dependent whereas SRMR avoids this problem (Schermelleh-Engel et al., 2003) SRMR values below 0.10 indicate an acceptable fit while values less than 0.05 is indicative of good fit(Cangur, 2015; Hu L.-T. &Bentler P. M., 1999; Schermelleh-Engel et al., 2003) . RMSEA (Steiger, 1998) is a measure of approximate fit in the population and is therefore concerned with the discrepancy due to approximation (Schermelleh-Engel et al., 2003). RMSEA can be interpreted as the indicator of good fit when it produces a value lower than 0.05 while values between 0.05 and 0.08 are acceptable (Hu L.-T. & Bentler P. M., 1999; Kim et al., 2016; Schermelleh-Engel et al., 2003). In the case of GFI, values above 0.95 can be considered as good fit(Hu L.-T. &Bentler P. M., 1999).

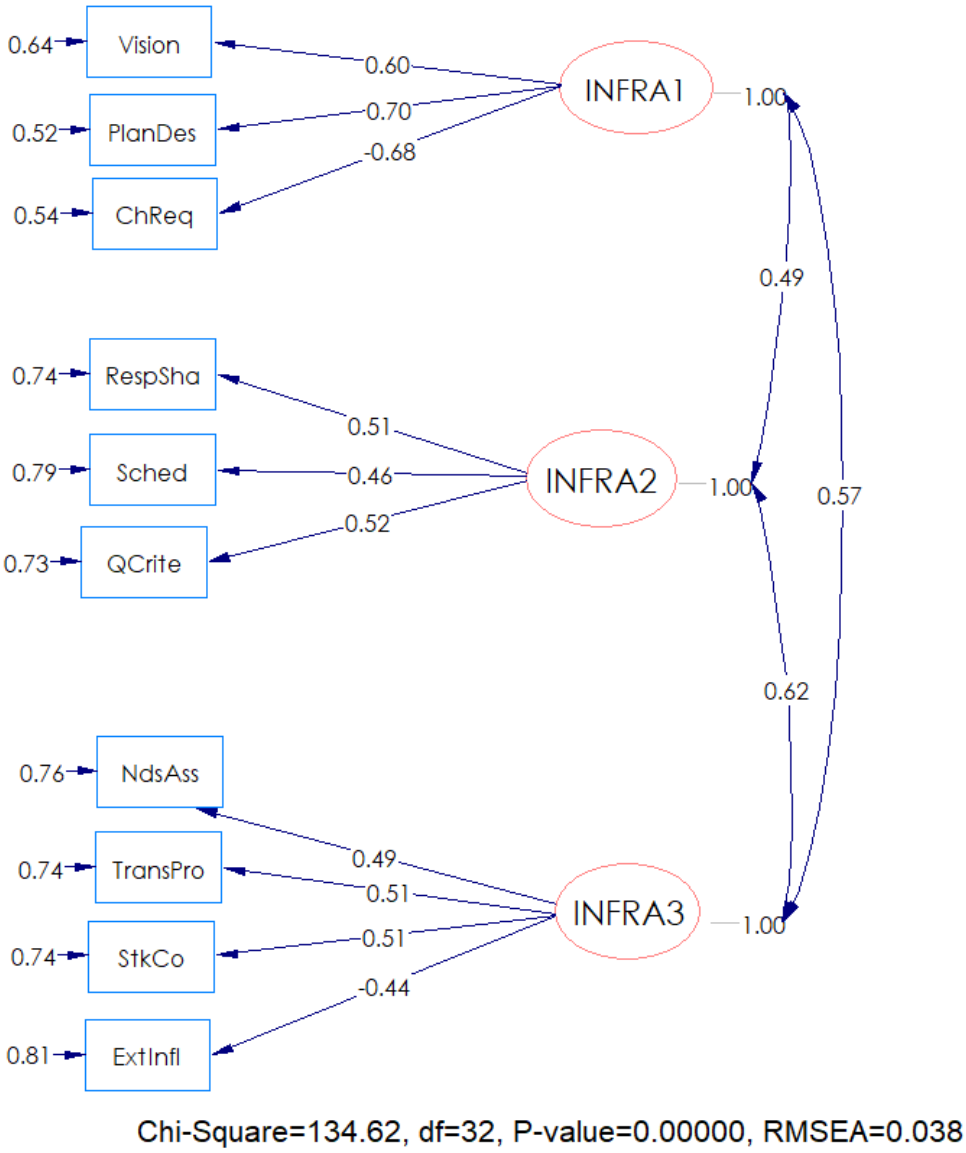

Figure 4.1: CFA Model with Standardised Solution - All Projects

Path diagram from CFA showing the standard solution is presented in Figure 4.**1**. Factor loading of variables is given in Table 4.23 and goodness of fit statistics for the CFA model provided as Table 4.24.

Table 4.23: Coefficients from CFA- Users-All Projects

Variables (Success Factors)	Factor loading	T values (Z value)	R^2	P
Strong Need Based Concept (INFRA1)				
Vision	0.60	26.13	0.36	0.00
Planning and Design	0.70	30.21	0.48	0.00
Change in Requirements	-0.68	-29.63	0.47	0.00
Robust Risk Management (INFRA2)				
Responsibility Sharing	0.51	18.13	0.26	0.00
Schedule	0.46	16.54	0.21	0.00
Qualification Criteria	0.52	18.40	0.27	0.00
Inclusive Planning (INFRA3)				
Needs Assessment	0.49	19.20	0.24	0.00
Transparent Procurement	0.51	19.70	0.26	0.00
Stakeholder Coordination	0.51	19.81	0.26	0.00
External Influence	-0.44	-17.03	0.19	0.00

Table 4.24: Goodness of Fit Indices - Users

Fit Index	Value
Goodness of Fit Index (GFI)	0.988
Comparative Fit Index (CFI)	0.965
Standard Root Mean Square Residual (SRMR)	**0.0253**
Root Mean Square Error of Approximation (RMSEA)	0.038

The three critical success factors (CSF) for infrastructure projects combining project data for transport and water & sanitation sectors are **Strong Need Based Concept (INFRA1), Inclusive Planning (INFRA3) and Robust Risk Management (INFRA2)**. Priority levels for the CSFs are understood by comparing their variance values as well as determinacy indices. **Strong Need**

Based Concept gets first priority**, Inclusive Planning** the second and **Robust Risk Management** the third priority.

4.2.10.6 Exploratory Factor Analysis– Transport Projects

As in the case of the dataset for all projects, Kaiser- Meyer- Olkin (KMO) test and Bartlett's test of sphericity was conducted for the segregated data for transport projects, results are given below in Table 4.25:

Table 4.25: KMO and Bartlett's Test Statistic - Transport Projects

Description	Bartlett's statistic	Kaiser-Meyer-Olkin (KMO) test
Transport Projects (P1, P2,P3)	4892.3 (df = 351; P = 0.000010)	0.791 (fair)

Exploratory Factor analysis for the three transport projects with the 27 variables (success factors) is conducted using FACTOR package. Systematic optimisation of the factors by excluding variables with low factor values less than 0.3 as recommended in other studies (Samuels, 2016) yielded an optimised solution after seven trials with three factors, details tabulated in

Table 4.26:

Table 4.26: Transport Projects - Explained variance Based on Eigen Values

Variable	Eigen Value	Proportion of Variance	Cumulative proportion of Variance
1	2.01	0.22	0.22
2	1.49	0.17	0.39
3	1.10	0.12	0.51
4	0.92	0.10	
5	0.82	0.09	
6	0.72	0.08	
7	0.69	0.08	
8	0.64	0.07	
9	0.60	0.07	

The factors are named TP1, TP2 and TP3. The factor scores obtained for the variables and alignment to the factors is indicated in the Table 4.27 below:

Table 4.27: Transport Projects-Rotated Loading Matrix (Promax Rotation)

Variable No.	Variable	TP1	TP2	TP3
1	VisionTP	**0.54**	-0.08	0.10
3	ComSuppT	0.00	**0.57**	-0.11
4	RespShaT	0.03	-0.07	**0.71**
5	NdsAssTP	0.14	**0.33**	-0.10
8	SocEnvTP	-0.13	**0.44**	0.19
10	PlanDesT	**0.59**	0.02	0.00
16	QCriteTP	0.04	0.19	**0.30**
18	StkCoTP	0.04	**0.44**	0.02
20	ChReqTP	**-0.60**	-0.03	0.04

Table 4.28: Critical Success Factors from EFA- Transport projects

Variables (Success Factors)	Factors (Critical Success Factors) (CSF)	Factor Determinacy Index (FDI)
Vision	**Strong Need Based Concept (TP1)**	0.78
PlanDesign		
ChangeReq		
Responsibility Sharing	**Risk Action (TP3)**	0.76
Qualification Criteria		
Community Support	**Safeguards Action (TP2)**	0.74
NeedsAssess		
SocEnvTP		
StkCoTP		

4.2.10.7 Confirmatory Factor Analysis – Transport Projects

From the above table, it can be seen that a total of 3 factors are identified for transport projects –**Strong Need Based Concept, Risk Action and Safeguards Action.** Among the three factors, Strong Need Based Concept has higher FDI. The three factors and corresponding variables are used to develop the network model which is subjected to confirmatory analysis in LISREL, results of analysis tabulated below.

Based on higher FDI values, Stronger Need Based Concept gets the highest priority followed by Risk Action and Safeguards Action respectively as the second and third important factors.

Confirmatory factor analysis (CFA) is conducted, CFA model path diagram with solution is illustrated in Figure 4.2.

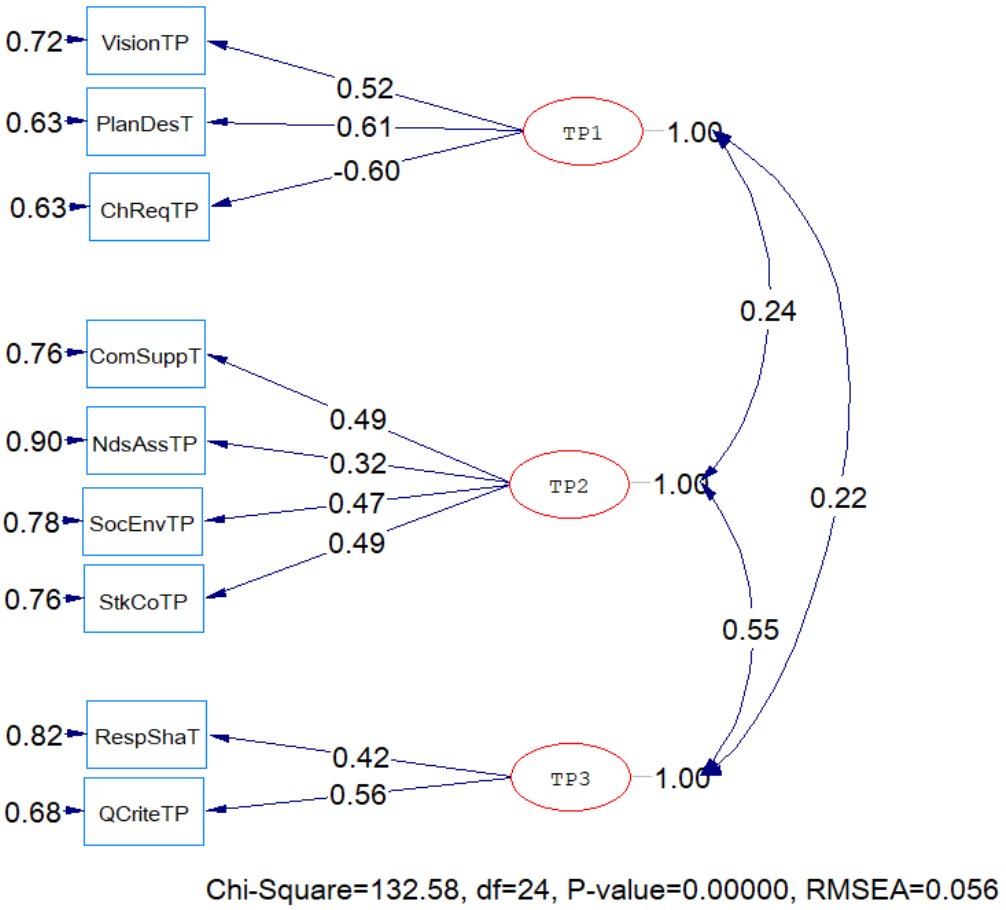

Figure 4.2: CFA Model with Standardised Solution - Transport Projects

Path diagram from CFA showing the standard solution is presented in Figure 4.2. Factor loading of variables is given in Table 4.29 and goodness of fit statistics for the CFA model provided as Table 4.30.

Table 4.29: Factor loadings from CFA - Transport Projects

Variables (Success Factors)	Factor Loading	T Values	R^2	P
Strong Need Based Concept (TP1)				
Vision	**0.52**	**15.54**	**0.28**	**0.000**
PlanDesign	**0.61**	**17.00**	**0.37**	**0.000**
ChangeReq	**-0.60**	**-16.98**	**0.37**	**0.000**
Risk Action (TP3)				
Responsibility Sharing	**0.42**	**9.45**	**0.18**	**0.000**
Qualification Criteria	**0.56**	**10.26**	**0.32**	**0.000**
Safeguards Action (TP2)				
Community Support	**0.49**	**13.27**	**0.24**	**0.000**
NeedsAssess	**0.32**	**8.99**	**0.10**	**0.000**
SocEnvTP	**0.47**	**12.86**	**0.22**	**0.000**
StkCoTP	**0.49**	**13.18**	**0.24**	**0.000**

Table 4.30: Goodness of Fit indices - Transport Projects

Fit Index	Value
Goodness of Fit Index (GFI)	0.980
Comparative Fit Index (CFI)	0.895
Standard Root Mean Square Residual (SRMR)	**0.041**
Root Mean Square Error of Approximation (RMSEA)	0.056

4.2.10.8 Exploratory Factor Analysis– Water & Sanitation Projects

Test results for KMO test and Bartlett's Test of Sphericity in the case of water& sanitation projects is given in Table 4.31 below:

Table 4.31: KMO and Bartlett's Test – Water & sanitation Projects

Statistic	Bartlett's statistic	Kaiser-Meyer-Olkin (KMO) test
Water & Sanitation Projects (P4,P5,P6)	4596.7 (df = 351; P = 0.000010)	0.877 (good)

Exploratory Factor analysis of the 27 variables (success factors) is conducted using FACTOR package. Variables with lower factor scores are excluded systematically from the analysis and factor analysis is rerun multiple trials after which an optimised solution is obtained. The optimised solution with factor scores and cumulative variance explained is provided below in Table 4.32:

Table 4.32: Water &Sanitation Projects - Explained variance based on eigenvalues

Variable	Eigen Value	Proportion of Variance	Cumulative proportion of Variance
1	3.72	0.25	0.25
2	1.52	0.10	0.35
3	1.20	0.08	0.45
4	1.13	0.08	0.51
5	0.87	0.06	
6	0.83	0.06	
7	0.79	0.05	
8	0.75	0.05	
9	0.72	0.05	
10	0.66	0.04	
11	0.63	0.04	
12	0.59	0.04	
13	0.58	0.04	
14	0.56	0.04	
15	0.47	0.03	

The optimized solution identifies four factors as per above table

Table 4.33: Water &Sanitation Projects- Rotated Loading Matrix

Variable No	Variable	F1	F2	F3	F4
1	Vision	0.05	-0.02	**0.50**	0.09
3	Community Support	-0.01	**0.42**	0.19	-0.04
4	Responsibility Sharing	**-0.41**	0.13	-0.07	0.12
5	Needs Assessment	0.05	-0.05	-0.09	**0.67**
7	Cost Benefit Assessment (CBA)	-0.10	**0.48**	0.02	-0.04
9	Client Involvement	-0.01	-0.06	0.04	**0.60**
10	Planning and Design	-0.09	-0.08	**0.79**	-0.06
12	Funding Plan	-0.11	0.02	-0.04	**0.47**
16	Qualification Criteria	0.02	**0.57**	-0.06	-0.00
19	Clear Rules	0.01	0.11	-0.02	**0.47**
20	Change in Requirements	-0.02	-0.08	**-0.58**	0.03
21	Delay in Approvals	-0.18	-0.13	-0.21	**-0.48**
23	Staff Changes	**0.62**	-0.01	-0.07	0.07
26	Omissions	0.26	0.10	-0.05	**-0.46**
27	Corruption	0.04	**-0.43**	0.05	-0.14

Thus, from above Table 4.33, four factors are identified which are named WS1, WS2, WS3 and WS4. The factor names and corresponding contributing variables are included in Table 4.34 below:

Table 4.34: Critical Success Factors from EFA- Water & sanitation Projects

Variables (Success Factors)	**Factors (Critical Success Factors) (CSF)**	**Factor Determinacy Index (FDI)**
Needs Assessment	**WS2 – Focussed Client Action**	**0.869**
Client Involvement		
Funding Plan		
Clear Rules		
Delay in Approvals		
Omissions		
Vision	**WS1 – Strong Need based Concept**	0.861
Planning and Design		
Change in Requirements		
Community Support	**WS4 – Public Accountability**	0.805
Cost Benefit Assessment (CBA)		
Qualification Criteria		
Corruption		
Responsibility Sharing	**WS3 – Responsible Governance**	0.758
Staff Changes		

4.2.10.9 Confirmatory Factor Analysis– Water & Sanitation Projects

Based on the factors identified from exploratory analysis above, network model is prepared by pairing the variables to the respective factors to conduct confirmatory factor analysis. Confirmatory Factor analysis is conducted in LISREL software package which includes additional coding capabilities through the PRELIS interface. Confirmatory factor analysis results are presented below in Figure 4.**3**:

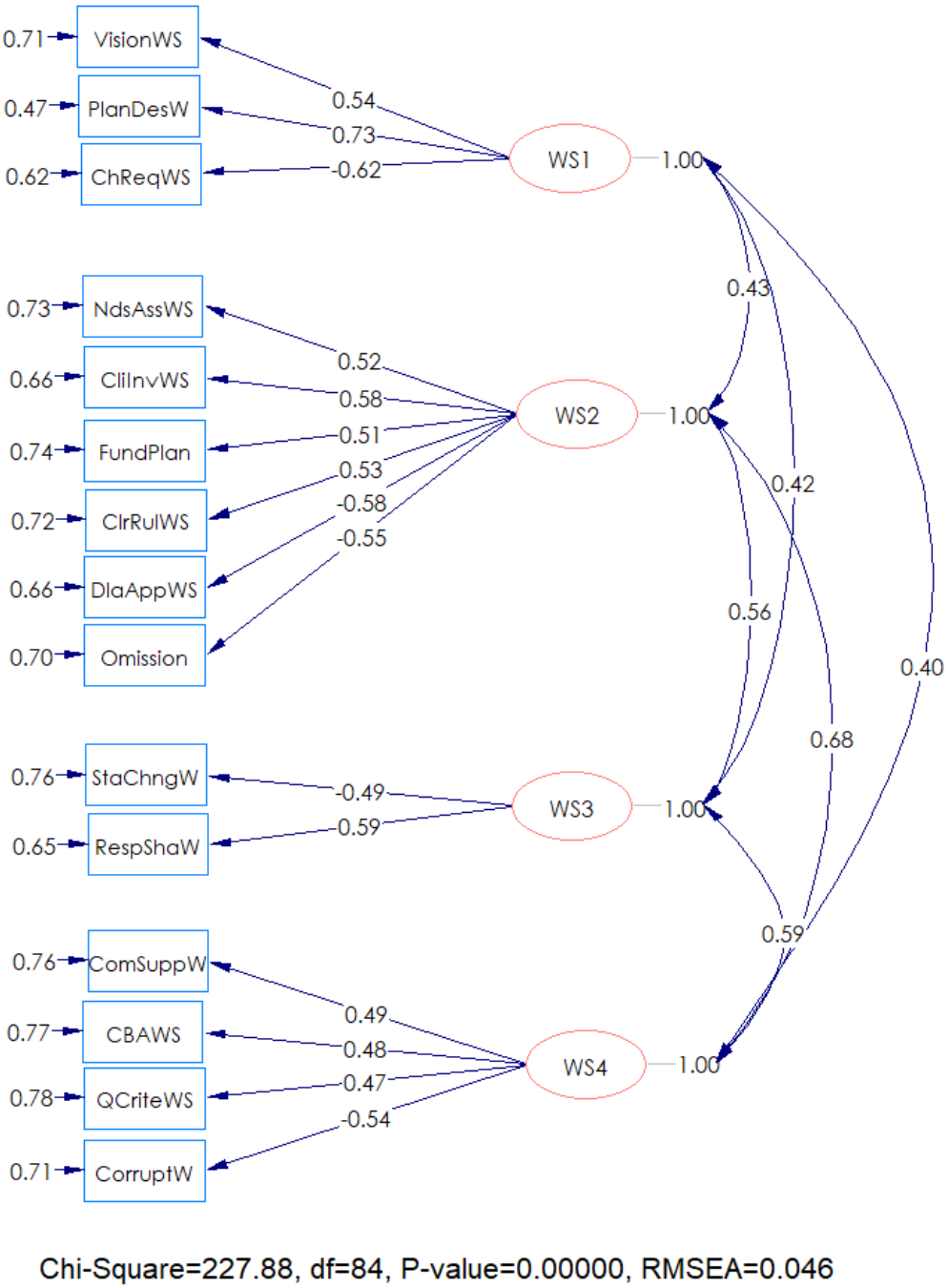

Figure 4.3: CFA Model with Standardised Solution - Water & Sanitation Projects

The four critical success factor (CSF) construct with the contributing variables and their respective factor scores are

tabulated below in Table 4.35 along with the T scores and R^2 values obtained from Confirmatory Factor analysis.

Table 4.35:Factor loadings from CFA- Water & sanitation Projects

Variables (Success Factors)	**Factor loading**	**T values**	**R^2**	**P**
WS2 –Focussed Client Action				
Needs Assessment	**0.52**	**13.79**	**0.27**	**0.000**
Client Involvement	**0.58**	**15.64**	**0.34**	**0.000**
Funding Plan	**0.51**	**13.41**	**0.26**	**0.000**
Clear Rules	**0.53**	**13.95**	**0.28**	**0.000**
Delay in Approvals	**-0.58**	**-15.70**	**0.34**	**0.000**
Omissions	**-0.55**	**-14.66**	**0.30**	**0.000**
WS1 –Strong Need based Concept				
Vision	**0.54**	**13.49**	**0.29**	**0.000**
Planning and Design	**0.73**	**17.59**	**0.53**	**0.000**
Change in Requirements	**-0.62**	**-15.26**	**0.38**	**0.000**
WS4 –Public Accountability				
Community Support	**0.49**	**11.66**	**0.24**	**0.000**
Cost Benefit Assessment (CBA)	**0.48**	**11.63**	**0.23**	**0.000**
Qualification Criteria	0.47	11.35	0.22	**0.000**
Corruption	-0.54	-13.05	0.29	**0.000**
WS3 –Responsible Governance				
Responsibility Sharing	**0.59**	**11.22**	**0.35**	**0.000**
Staff Changes	0.49	10.19	0.24	**0.000**

Model validity is checked from the goodness of fit statistics tabulated below in Table 4.36, the coefficients show good level of fit for the CFA model.

Table 4.36: Goodness of fit indices-Water& Sanitation Projects

Fit Index	**Value**
Goodness of Fit Index (GFI)	0.963
Comparative Fit Index (CFI)	0.923
Standard Root Mean Square Residual (SRMR)	**0.041**
Root Mean Square Error of Approximation (RMSEA)	0.046

4.2.10.10Comparison of CSF for Transport and Water &Sanitation sectors

Sectoral comparison of critical success factors between transport projects and water projects is carried out and tabulated as Table 4.**37**below:

Table 4.37: Critical Success Factors (Transport Vs Water & sanitation)

Critical Success Factor (CSF) with (Determinacy Index)	
Transport Sector	**Water & Sanitation Sector**
Strong Need Based Concept (TP1) (0.791)	Focused Client Action (WS2) (0.869)
Risk Action (TP3) (0.760)	Strong Need based Concept (WS1) (0.861)
Safeguards Action (TP2) (0.740)	Public Accountability (WS4) (0.805)
	Responsible Governance (WS3) (0.758)

From Table 4.33**,** similarity among the factors and comparison of the priority levels of these factors under each sector is analysed. 'Strong Need Based Concept' has emerged as an important factor for both the sectors whereas other factors are different among the sectors. FDI values show that the critical success factors derived for water & sanitation sector projects are relatively stronger in terms of the indices in comparison to transport projects.

4.3 ANALYSIS ON SURVEY OF PROJECT PROFESSIONALS

Data for project professionals includes both responses from professionals within the city area as well as professionals located in other geographies who worked in infrastructure projects in Thiruvananthapuram. A total of 47 professionals from different parts of the city as well as from outside locations formed part of the survey which included persons in service as well as retired persons. Responses for more than one project were received in cases where professionals were involved in multiple projects. Thus, combining the responses for all projects, a total of 134 useful samples are considered in the analysis of which 96 were for transport projects and 38 responses on water and sanitation projects. Descriptive Statistics for the project user data is computed using JASP 12.1 software, details presented in Table 4.**39**. Normality check and reliability of scale verified.

Work Experience: Profile of Professionals categorised based on their years of work experience is shown in Table 4.**38**

Table 4.38: Project professional profile by profession

Work Experience (Years)	**Count**
Less than or equals 10 years (<=10)	2
Between 11 and 20 years (11-20)	10
Between 21 and 30 Years (21-30)	20
Above 30 years (>30)	15
Total	**47**

Table 4.39: Project Success Rating- Professionals

Statistic	All Projects
Sample Size	134
Mean Success Rating – All Projects (%)	55.49
Std. Deviation	17.10
Shapiro-Wilk	0.918
P-value of Shapiro-Wilk	< .001

4.3.1 TEST FOR NORMALITY

Shapiro-Wilk test is conducted to check Normality for the variables, the coefficient values are above 0.9 with significance level <0.01. As in the case of household survey sample, Shapiro-Wilk test significance level is less than 0.01 indicating a clear deviation from normality.

4.3.2 RELIABILITY OF SCALE

Reliability of the used scale is checked for success criteria and success factors, value of Cronbach α coefficient is 0.872 and McDonalds ω value is is 0.867, the values are satisfactory and hence scale reliability is confirmed.

4.3.3 TESTING HYPOTHESIS 2 –SUCCESS RATING FOR USERS VS PROFESSIONALS

Null Hypothesis H_2 – Success rating for projects by Users and project professionals are similar.

Mean Success Rating by users and professionals for each of the six projects is tabulated below:

Table 4.40: Comparison of Project Success Rating by Users and Professionals

Project Name	**Mean Project Success Rating – Users (%)**	**Mean Project Success Rating – Professionals (%)**
P1- Karamana- Kaliyikkavila NH project	58.24	60.74
P2 - Thiruvananthapuram City Roads Improvement Project	51.63	58.94
P3 - Thampanoor Bus Terminal	52.39	53.83
P4 - JICA water supply Project	45.90	49.47
P5 - Muttathara Sewage Treatment Plant	38.97	55.00
P6 - Operation Anantha	42.52	39.37

It could be observed from Table 4.**40** above that for five out of the six projects, average project success rating by professionals is higher than user rating whereas for the sixth project, user rating is slightly higher. We test the hypothesis that success rating by users and professionals are similar as detailed below. Mean success rating by professionals for all the six projects combined is 55.49% with standard deviation 17.10 as indicated in Table 4.**40** whereas for users it is respectively 50.16% and

15.58. From the above values, we hypothesise that success rating for professionals could be higher than that for users. Testing of this hypothesis is carried out using Moods Median Test as in the case of Hypothesis1 for sectors.

From Table 4.**40**, we can see that the independent samples have unequal sample sizes, Shapiro Wilk P value <0.01 means deviation from normality and difference in variance observed from standard deviation. For testing such a sample, Mood's Median test (Ramana, 2020) is the most preferred test, the test results are shown below in Table 4.41, detailed computation sheet enclosed as Appendix3.

Table 4.41: Hypothesis2 - Success Rating of Users Vs Professionals

Test	**Statistic**	**df**	**p**
Mood's Median test	0.068	1	>0.1

For Moods median test, the chi square cut-off value for single degree of freedom (df=1) and p=0.01 is 6.635, the computed test statistic is 0.068 (p<0.01) which is very low compared to the cut-off value and hence does not show sufficient and significant evidence to reject the null hypothesis. Success rating of Infrastructure projects in Thiruvananthapuram by users and project professionals are similar.

4.3.4 SUCCESS RATING – COMPARISON OF IN-SERVICE VS RETIRED PROFESSIONALS

A comparison of success ratings by in-service professionals and retired professionals was carried out to understand any differences in their assessments on the success of projects. Though designations of respondents are collected, taking into account the retirement age of state and central governments, professionals above 60 years of age are considered retired while carrying out the assessment.

Table 4.42: Descriptive Statistics - Retired Vs In-service Professionals

Statistic	Retired	In-service
Sample	78	56
Mean	53.735	58.089
Median	50.000	50.000
Std. Deviation	16.227	18.173

As in the Table 4.42 above, it was expected that project success rating by retired professionals would be lower than those in service. The same is tested, the test results given in Table 4.43:

Table 4.43: Hypothesis2 - Success Rating of Retired Vs In Service Professionals

Test	Statistic	df	p
Mood's Median test	1.47	1	>0.1

Moods median test statistic of 1.47 is lower than cut-off value of 6.635. Hence, contrary to expectations, the test results above could not show sufficient evidence for any difference in success rating between retired and in-service professionals.

4.3.5 EXPLORATORY FACTOR ANALYSIS– PROFESSIONALS

Test results for KMO test and Bartlett's Test of Sphericity conducted for the data on professionals is included in Table 4.44 below:

Table 4.44: KMO and Bartlett's Test– Professionals

Bartlett's statistic	Kaiser-Meyer-Olkin (KMO) test
985.7 (df = 105; P = 0.000010)	0.785 (fair)

Exploratory Factor analysis of the 27 variables (success factors) is conducted using FACTOR package.

As for the previous analyses, variables are systematically excluded based on lower factor scores and an optimised solution with four factors is arrived. Table 4.45 showing explained variance for the optimised solution is given below:

Table 4.45: Professionals- Explained variance based on eigenvalues – Optimized Solution

Variable	Eigen Value	Proportion of Variance	Cumulative proportion of Variance
1	6.65	0.42	0.42
2	1.83	0.11	0.53
3	1.11	0.07	0.60
4	0.97	0.06	0.66
5	0.87	0.05	
6	0.69	0.04	
7	0.64	0.04	
8	0.59	0.04	
9	0.51	0.03	
10	0.44	0.03	
11	0.39	0.02	
12	0.38	0.02	
13	0.30	0.02	
14	0.25	0.02	
15	0.20	0.01	
16	0.17	0.01	

Four factors were obtained as tabulated below in Table 4.46. A major observation in the present analysis is that KMO test recommended removal of 4 variables from analysis, these variables were removed from analysis set while conducting further trials to identify factors. The four critical success factors thus identified are shown in Table 4.47, the respective contributing variables and factor determinacy indices are provided in Table 4.47 below:

Table 4.46: Professionals - Rotated Loading Matrix

Variable No.	Variable	F1	F2	F3	F4
2	PolWill	**0.55**	0.02	-0.03	-0.14
3	ComSupp	0.14	**0.47**	-0.24	0.12
4	RespSha	**0.65**	0.06	-0.10	0.04
6	Feasi	**0.78**	-0.18	0.21	-0.05
7	CBA	**0.53**	0.36	-0.21	0.15
8	SocEnv	0.24	**0.48**	-0.09	0.05
12	FundPlan	0.00	**0.77**	-0.08	0.03
16	QCrite	**0.47**	0.17	0.03	-0.09
17	CommAge	**0.57**	0.30	0.05	-0.07
18	StkCo	-0.20	**0.99**	0.13	0.03
19	ClrRul	0.16	**0.66**	0.33	-0.22
20	ChReq	-0.01	0.18	**0.86**	0.07
21	DlaApp	0.29	-0.26	**0.45**	0.33
22	InexTm	-0.12	0.04	0.20	**0.60**
23	StaChng	-0.07	0.05	0.05	**0.70**
26	Omission	-0.01	-0.01	0.06	**0.69**

Table 4.47: Critical Success Factors from EFA- Professionals

Variables (Success Factors)	**Factors (Critical Success Factors) (CSF)**	**Factor Determinacy Index**
Political Will (PolWill)	**PRO1 – Strong Project Governance**	**0.933**
Responsibility Sharing (RespSha)		
Feasibility (Feasi)		
Cost Benefit Analysis (CBA)		
Qualification Criteria (QCrite)		
Committed Agency (CommAge)		
Community Support (ComSupp)	**PRO2 – Safeguards Due diligence**	**0.948**
Social and Environmental (SocEnv)		
Funding Plan (FundPlan)		
Stakeholder Coordination (StkCo)		
Clear Rules (ClrRul)		
Change in Requirements (ChReq)	**PRO3 – Unclear Scope**	0.893
Delay in Approvals (DlaApp)		
Inexperienced Team (InexTm)	**PRO4 – Resource Crunch**	0.896
Staff Changes (StaChng)		
Omission		

4.3.6 CONFIRMATORY FACTOR ANALYSIS– PROFESSIONALS

Confirmatory factor analysis of the model is carried out using LISREL. The four-factor model was run and found to converge to an optimal solution. The network model and standardised solution from confirmatory analysis are given in Figure 4.4 below:

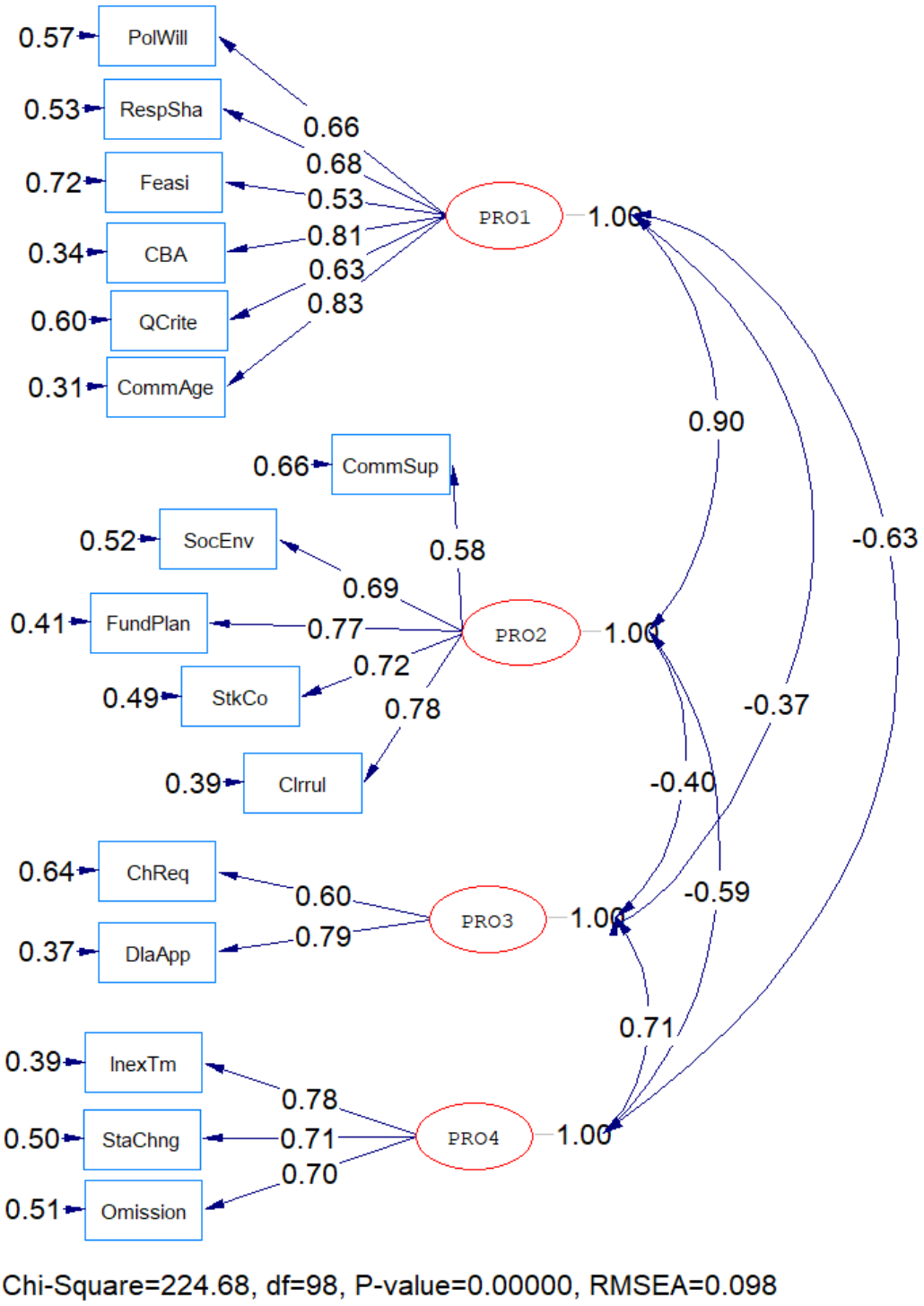

Figure 4.4: CFA Model and Standardised solution- Professionals

Factor loadings for variables under each critical success factor as per confirmatory factor analysis is provided in Table 4.48 below:

Table 4.48: Factor Loadings from CFA – Professionals

Variables (Success Factors)	**Factor Loading**	T Values	R^2	P
PRO1 -Strong Project Governance				
Political Will (PolWill)	**0.66**	**8.25**	**0.43**	**0.000**
Responsibility Sharing (RespSha)	**0.68**	**8.69**	**0.47**	**0.000**
Feasibility (Feasi)	**0.53**	**6.33**	**0.28**	**0.000**
Cost Benefit Analysis (CBA)	**0.81**	**11.09**	**0.66**	**0.000**
Qualification Criteria (QCrite)	**0.63**	**7.81**	**0.40**	**0.000**
Committed Agency (CommAge)	**0.83**	**11.45**	**0.69**	**0.000**
PRO2 – Safeguards Due diligence				
Community Support (ComSupp)	**0.58**	**7.03**	**0.34**	**0.000**
Social and Environmental (SocEnv)	**0.69**	**8.74**	**0.48**	**0.000**
Funding Plan (FundPlan)	**0.77**	**10.13**	**0.59**	**0.000**
Stakeholder Coordination (StkCo)	**0.72**	**9.14**	**0.51**	**0.000**
Clear Rules (ClrRul)	**0.78**	**10.30**	**0.60**	**0.000**
PRO3 –Unclear Scope				
Change in Requirements (ChReq)	**0.60**	**6.26**	**0.36**	**0.000**
Delay in Approvals (DlaApp)	**0.79**	**7.72**	**0.63**	**0.000**
PRO4 –Resource Crunch				
Inexperienced Team (InexTm)	**0.78**	**9.77**	**0.61**	**0.000**
Staff Changes (StaChng)	**0.71**	**8.60**	**0.50**	**0.000**
Omission	**0.70**	**8.43**	**0.49**	**0.000**

Model Fit indices are checked for model validation, the values given in Table 4.49. below:

Table 4.49: Goodness of Fit Indices for CFA- Professionals

Goodness of Fit Index (GFI)	0.847
Comparative Fit Index (CFI)	0.872
Standard Root Mean Square Residual (SRMR)	0.062
Root Mean Square Error of Approximation (RMSEA)	0.098

It is observed that the model fit indices obtained in the present analysis of project professionals are not as strong (GFI and CFI around 0.85 as against above 0.9 in previous analyses, SRMR above 0.05 and RMSEA 0.098) in comparison with the previous three analysis cases of users, the values are in the border line region for a satisfactory model. These analyses were based on 134 samples for overall 27 variables. Taking into account the moderate KMO statistic, limitation in the sample size with respect to number of variables could be a major reason for the weaker parameters and relatively lower model fit for professionals.

4.3.7 COMPARISON OF CRITICAL SUCCESS FACTORS BY USERS AND PROFESSIONALS

Comparison of critical success factors from users and project professionals is carried out. As in the case of comparison of sectors, the critical success factors are compared for similarity as well as the priority level for each factor based on their variance and determinacy indices, the results are shown in Table 4.**50** below:

Table 4.50: Comparison of CSF for Stakeholder groups

Critical Success Factors (CSF) with (Determinacy Index)	
Users	**Project Professionals**
(INFRA1) Strong Need Based Concept (0.854)	PRO1 – Strong Project Governance 0.933
(INFRA3) Inclusive Planning 0.791	PRO2 – **Safeguards Due diligence** 0.948
(INFRA2) Robust Risk Management (0.761)	PRO3 – Unclear Scope) 0.893
	PRO4 – Resource Crunch 0.896

From the above table, it could be observed that there is lack of similarity among the users and project professionals with respect to the critical success factors. Strong Need Based Concept emerged as an important critical success factor for users while Strong Project Governance and Safeguards Due diligence are important for professionals. Inclusive Planning and robust Risk management gains importance among users as the second and third factors while professionals assign more focus to Unclear scope and Resource crunch as the third and fourth CSFs. Determinacy indices obtained from analysis of professionals is generally found higher than that of users.

4.4 SUMMARY

This chapter details on the various sets of data analysed, data analysis techniques used and the analysis outputs. Data for analysis comprised Household survey data of project users and project professional survey data, separate analysis conducted for each set. Analysis of user data on project familiarity trends overall and project sector wise comparison, project success ratings with comparison of sectors and clusters, project success criteria preferences and its relation to the success ratings overall and sector wise, project success factors and determination of critical success factors through factor analysis independently for all projects and each project sector. Data from professionals is analysed in a similar manner, comparison of success rating and critical success factors between users and professionals is carried out. Statistical testing of the three Hypothesis conducted.

CHAPTER V

RESULT, DISCUSSIONS &

CONCLUSIONS

CHAPTER V. RESULT, DISCUSSIONS & CONCLUSION

5.1 RESULTS AND DISCUSSIONS

5.1.1 Users more familiar with Transport Projects

User ratings for project familiarity shows that transport projects are more familiar to users in Thiruvananthapuram than water & sanitation projects. Out of the 506 user responses analysed, over 95% respondents showed a familiarity level of 3 and above on a five-point scale whereas for Water & sanitation projects, the range varied between 39% and 69% (averaging to about 55%) for different projects. Contrary to common expectation than water and sanitation being basic needs would find more familiarity among the users, results show otherwise. This is possibly due to the fact that transport project assets being road and associated facilities are all above ground and readily visible whereas water& sanitation system assets are mostly underground or located at an isolated facility out of public reach thereby causing less familiarity. Another observation is that road projects have specific reaches where work is undertaken and the impact of works is readily experienced in the same area along with its effect on other areas. Whereas in water & sanitation projects, the system is highly interconnected and most times projects involve improvements to part of the system and users need not be clearly aware of the cause and effects of a particular project. Another important fact is that transport projects in general have higher costs

in comparison to water& sanitation projects of same areal coverage. The higher investment may possibly be a reason for more public awareness in the sector. In the projects studied, one project each in transport and water & sanitation sectors involve facility development in an enclosed area (Thampanoor Bus stand (P3) and Muttathara STP (P5)) and remaining two projects in each sector involve linear development passing through different areas of the city. However, when we examine the project familiarity for the first set of projects (P3 and P5), we can see that P3 has higher familiarity among the users. The same is true for the remaining two projects also. Upon comparing the characteristics of the selected projects in each sector, Transport project P1 involves an important National Highway reach being converted to four lanes whereas P2 involves improvement to several urban road reaches with unique design elements and higher levels of user consultation while P3 is development of the central bus stand in the heart of the city. In water and sanitation, P4 involves works both within and outside city limits, P5 is located in a concentrated site with very limited public access and P6 was of shorter duration and implemented under special provisions of disaster management. These factors possibly could also have resulted in higher familiarity level observed for transport projects in comparison to water & sanitation projects.

5.1.2 Transport Projects' success rated higher by Users

Project Success rating by users for Transport projects in Thiruvananthapuram city is found to be higher than for Water &Sanitation projects. The same trend is found to be true for success rating assessments by project professionals also though not tested significantly. Success rating for transport projects by users averaged in the range of 51 to 58% while water& sanitation project success ratings range between 38 to 45%. Rating by professionals for transport and water & sanitation projects are between 53 to 60% and 39 to 55% respectively. The intrinsic difference in projects under the two sectors could be a reason. Apart from this, project familiarity levels for transport projects are significantly higher than water & sanitation projects which could have resulted in a higher success rating. Project complexity levels for transport projects are expected to be higher than water & sanitation projects which is possibly another reason. On further examination of the studied projects in the two sectors, an observation was that all the transport projects studied were executed through local contractors whereas in the case of water & sanitation projects, Contractors were from other geographies. In transport project studied especially Karamana Kaliyikkavila NH (P1) and Thiruvananthapuram City Roads project (P2), project readiness level in terms of social safeguards is higher than in water & sanitation projects. Moreover, quick execution was observed for both the above transport projects whereas JICA water supply project (P4)

and Muttathara STP (P5) had their share of lags during execution. Projects P1 and P2 involved land acquisition which could have raised the awareness level and interest among the local population. P1 is an important National Highway stretch whereas P2 alignments were through many important city roads and Thampanoor Bus Stand (P3) is the central bus terminus facility. P2 was also unique in many ways by its user-friendly design, sustainable approach, being the first PPP project in the city, consultative approach during execution etc. While for water and sanitation projects, P4 had facilities outside municipal limits, P5 was a concentrated facility in the city with limited public access and Operation Anantha (P6) was a project with short tenure. All these reasons could have contributed to the higher awareness and success level for transport projects in comparison to water and sanitation projects.

5.1.3 Similar Success rating by different stakeholders.

Success Rating assessments by users and professionals for the studied projects showed a similar trend, the hypothesis test failed to identify any significant differences. Success rating for transport projects by users averaged in the range of 51 to 58% and that by professionals between 53 to 60% while water & sanitation project success rating range between 38 to 45%. and 39 to 55% for users and professionals respectively. This could be considered as good level of awareness and involvement among project users in infrastructure

development related works of the city. This was mostly expected of Thiruvananthapuram where a significant fraction of the city population comprises public officials both from the state and union governments as well as other public sector undertakings.

5.1.4 Testing Success Criteria relation to Success Rating

Relation of project success rating with success criteria chosen is reported in earlier studies on project managers (Müller & Turner, 2007) and multisectoral survey of professionals ((Kothandath, 2020). Preference level for project success criterion among users in Thiruvananthapuram shows a weak yet significant relation to success rating, in particular for water & sanitation projects. ‘Ease of Use’ and ‘Public consultation’ are having maximum relation to project success in transport projects whereas ‘Time’, ‘Budget’, ‘Usage Cost’ and ‘No Adverse impact’ shows more relation to success in water & sanitation projects.

5.1.5 Different CSF by Users and Professionals

Critical success factors (CSF) in planning of infrastructure projects as per users and as per project professionals shows no similarities. The three CSFs for users and the four CSFs for professionals show clear difference in viewpoints of both these stakeholders, Need Based Concept is the first important factor for users while Inclusive Planning and Robust Risk Management are the other CSFs. Success

factors for Professionals are Strong Project Governance, Safeguards Due diligence, Unclear Scope and Resource Crunch. Comparison of the two CSF sets shows that there is clear difference among the critical factors in line with previous research(Muhammad et al., 2022).

Studies on critical success factors for public construction projects in India have similar views with some stressing the importance of pre-project planning(Tabish & Jha, 2011), effective partnering/commitment among project participants(Jha & Iyer, 2007; Tabish & Jha, 2011). Analysis of PPP projects in water and other infrastructure sectors have identified the importance of risk allocation/ risk sharing and management as key to success(Ameyaw & Chan, 2016; Liu et al., 2014; Osei-Kyei & Chan, 2015). Users have identified 'Robust risk management' as a success factor in our study as well. Difference in success perspectives among stakeholders is a generally accepted viewpoint in project management research.

5.1.6 CSF differs with project sector

Critical success factors (CSF) in planning of transport projects and water & sanitation projects showed similarity with respect to one factor viz., Need based concept whereas other factors are found to be different. Priority level for this factor is more in transport projects and less for water & sanitation projects. The common factor Need Based Concept combines the three variables 'Project vision and

clarity of goals', 'Planning and Design' and 'Change in Requirements'. Critical factors identified for public construction projects under a study by IIT Delhi researchers identifies 'pre-project planning and clarity in scope' as a critical success factor (Tabish & Jha, 2011) which bears true similarity to the Need Based Concept factor.

In addition to the common factor viz., Strong Need Based Concept, other critical success factors for transport projects are, Implementation Planning, Stakeholder Engagement and Committed Project Agency. In water & sanitation projects, Focussed Client Action, Public Accountability and Responsible Governance are the other CSFs.

5.2 THEORETICAL IMPLICATIONS

Project success levels among the two analysed infrastructure project sectors in Thiruvananthapuram are different with transport projects showing higher success levels as tested in Hypothesis1. This observation is in line with previous research studies where variations in project success level based on type of project is reported(de Wit, 1988; Ghaffar et al., 2022; Shenhar et al., 2001). While it is generally accepted from previous research that project success meaning varies across stakeholders (Aaltonen & Kujala, 2010; Davis, 2017, 2018; di Maddaloni & Davis, 2018; Lloyd-walker et al., 2014; Shenhar et al., 2001) and so is success criteria, the present analysis finds success levels reported by users and project professionals to be relatively

similar. This similarity in success rating for select projects by two sets of stakeholders is not sufficient to conclude any serious deviation from the widely accepted finding on variation in views among stakeholders. However, reasons for this similarity among stakeholders in Thiruvananthapuram needs further detailed exploration through comprehensive analysis of all project stakeholders.

Success criteria as metrices that define how success of projects are evaluated (Cooke-Davies, 2002; Joslin & Müller, 2014) and the need to define these early on in the project. Apart from studying success criteria for different project types(Bayiley & Teklu, 2016; Kušljić & Marenjak, 2017; Shenhar & Wideman, 1996), multiple project stakeholders(Bryde & Robinson, 2005; Wai et al., 2012) and geographies(Dosumu & Onukwube, 2013; B. Hussein et al., 2011), some studies also focused on find a relation of success criteria to project parameters like project type(Shenhar & Wideman, 1996) , relation between importance assigned to success criteria against success rating (Kothandath, 2020; Müller & Turner, 2007) and relation between project governance and success(Joslin & Müller, 2016) in projects. The present analysis adds on to develop relation between importance assigned to success criteria and success rating specific to infrastructure projects in Thiruvananthapuram with evidence of relation between success criteria preference and success rating for at least some of the criterion.

This inference is in line with a broader study where modelling the relationship between importance assigned to success criteria and reported project success against these criteria showed a link between importance and actual achievements(Müller & Turner, 2007). A more detailed study on the aspect in multiple geographies and project sectors will help arrive at a more generalised relation. While the need to consider project performance under intangibles (like customer satisfaction, ease of use etc.) in addition to tangible elements (cost, time, quality) have been cited in multiple studies (Atkinson, 1999; Jha & Iyer, 2007; Pinto & Slevin, 1988; Tabish & Jha, 2012) at both Indian and global level, the present study through an analysis of user feedback identifies inclusive project planning as a CSF. Analysis of transport project identified Safeguards Action as a CSF while water and sanitation projects has Public Accountability and Responsible Governance among the CSFs. These inferences further reinforce need to address increased project stakeholder expectation in India as well as in other geographies(Selim & ElGohary, 2020). Important CSFs point towards apt identification of stakeholder needs and inclusive approach by engaging all parties affected by the project for better success(Prieto, 2021). User awareness in public infrastructure projects in Thiruvananthapuram is higher and relates to that of internal stakeholders while inclusive project planning emerged as a critical success factor. Public infrastructure programs should include social impact and public accountability indices in the project monitoring framework.

5.3 PRACTICAL IMPLICATIONS

Analysis of user responses and comparison with project professional viewpoint shows similarities in terms of project success rating. This possibly points towards a high level of awareness and involvement among infrastructure project users in Thiruvananthapuram. Executing agencies/ utility departments and contractors could gain by leveraging the local knowledge and preferences of project users during planning and execution of projects. In comparison to water and sanitation projects in Thiruvananthapuram, users are more familiar with transport projects and are assigning higher success levels to transport projects. This inference will be of use while carrying out social evaluation of multisectoral infrastructure programs. Importance assigned to success criteria bears some relation to success rating. This aspect can be put in use in different situations like defining success criteria for projects based on stakeholder strategy, weighing out responses from multiple stakeholders during performance analysis of projects and developing a balanced success criteria for projects. The above aspects will be handy when planning impact parameters for multisectoral infrastructure programs results. In addition, these are expected to guide advisory on public policy with respect to governance of public infrastructure projects with particular emphasis on the studied sectors.

5.4 IMPLICATIONS (SOCIAL AND MANAGERIAL)

The need to address project success more holistically, especially in public projects, taking into consideration the varying views of different stakeholders(Volden & Welde, 2022), project users in particular, across the project timeframe is gaining importance. Necessity for adequate stakeholder engagement in projects is widely recognised as leading to more successful projects(Basten et al., 2016; Manavasi Ramesh, 2020; Oliver & Miller, 2015). Projects need to have a stakeholder engagement strategy firmed up early on in the project initiation phase itself with attention to engage newer stakeholders as the project moves ahead(N. H. Nguyen et al., 2009). Users form a very important stakeholder class whose importance and power upsurges in public infrastructure projects where they demand accountability from the project as public resources are expended. This study shows the higher level of awareness among users and their intent to involve in development projects. The study results are in line with previous research that emphasize the importance of subjective factors in the project process.

More focus towards the critical success factors during infrastructure project planning will help achieve more successful projects. Front-end planning phase being the riskiest phase in projects need special attention. Importance of planning efforts as a success factor is

reported in construction projects(Jha &Iyer, 2007; Tabish & Jha, 2011). Additional resources as time or efforts put into the project front-end helps in firming up the project model and ensures aversion/ management of many risks and controls their escalation during future project phases. In terms of overall project investments, these additional inputs may be mostly trivial whereas their contribution to success would eventually be much larger.

5.5 STUDY LIMITATIONS

- The study relies on the findings from select projects in transport and water & sanitation sectors in Thiruvananthapuram while success parameters vary with project type(Müller & Turner, 2007; Shenhar & Wideman, 2002), project geography(Chou & Pramudawardhani, 2015), type of implementation(Bulsara et al., 2016; Raisbeck et al., 2010; Yalegama et al., 2016), cultural factors(Dyer, 2017; Koops et al., 2015) and so on which puts a limitation on the findings.
- Due to the limitation in number of projects studied as well as the diverse nature of the study sectors, focus was mainly into projects of more common nature which limits the scope of generalising the results as for a comprehensive sectoral assessment. In the case of transport projects, the focus was into road and surface transport projects; infrastructure like

airports, railways and metro/ monorail projects and non-motorised transport systems are not covered. In the case of water & sanitation projects, water supply, sewage treatment and urban drainage projects are covered whereas dams, groundwater and marine works does not find a place. Multidisciplinary works like inland water transport, ports and freight management are also excluded.

- Stakeholder views on projects are studied based on user and project professional views, other important stakeholders such as Contractor, project funding agency, regulatory agencies, city administration etc are not studied. While multiple stakeholders and varying project success views is normal (Davis, 2017; L. A. Ika & Pinto, 2022; Muhammad et al., 2022), there is need to bring alignment of multiple stakeholder views(Scheepers et al., 2022).
- Project planning was concentrated in this study which would give maximum impetus to the front-end phase and it will not give a complete picture of project success which is another limitation.

5.6 FUTURE SCOPE

Project success as an area of research as well as the present study offers various avenues for future research by building upon/ improving the present results and inferences as below:

- Current study inferences prompt further investigation into project avenues like understanding relation between success criteria preference and success level as well as provide support to furthering analysis on multiple stakeholders for public infrastructure projects.
- Present study methodology will support qualitative and empirical analysis for a comprehensive infrastructure sectoral study for similar cities in India.
- Project Complexity is an important aspect with respect to success of project (Podgórska, 2017)which needs attention in an Indian scenario. Project Complexity and influence on project success would be a fresh dimension to focus on in a Kerala/ city specific context.
- Project success assessed mostly technically while more people focus sought after (Dimitriou et al., 2013; Scheepers et al., 2022). Comparative analysis of the effects of systemic elements and subjective elements in infrastructure projects in Kerala could be furthered taking clues from the present study considering the higher level of project stakeholder involvement.
- Detailed study on limitations of infrastructure project management offices in Kerala and scope for capacity building is another area for further research.

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APPENDIX 1 – HOUSEHOLD SURVEY QUESTIONNAIRE

Success Factors in Planning for Infrastructure Projects -Questionnaire

1. Basic Details of Respondent (പ്രാധമിക വിവരങ്ങൾ)

Name (പേര്)					
Address (മേൽവിലാസം)			**Ward No & House No.** (വാർഡ് നമ്പർ/ വീട്നമ്പർ)		
Age (വയസ്സ്)			**Gender** (ലിംഗം)	**M** (പു)	**F** (സ്ത്രീ)
Organization & Designation (if retired, last position held) സ്ഥാപനം/ തസ്തിക (വിരമിച്ചവർ അവസാനം വഹിച്ചതസ്തിക)			**Total Work Exp (Years)** ആകെ പ്രവൃത്തിപരിചയം (വർഷം)		
Nature of Work (Tick wherever applicable) പ്രവൃത്തി മേഖല	**Technical** സാങ്കേതികം	**Contractual**(കരാർ സംബന്ധം)	**Financial** (സാമ്പത്തികം)	**Legal** (നിയമസംബന്ധം)	**Managerial** (മാനേജർ)
	Research (ഗവേഷണം)	**Clerical** (ഗുമസ്തം)	**Administrative** (പൊതുഭരണം)	**Support**(സഹായി)	**Any Other** (മറ്റ്മേഖല)
Email Address (ഇ-മെയിൽ)			**Telephone** (ഫോൺ)		

2. Personal Profile

Education Level (വിദ്യാഭ്യാസം)	**Basic Education (< 10th Std.)** പ്രാധമികം(പത്താം തരത്തിൽ താഴെ)	**SSLC/Matriculate** പത്താം ക്ലാസ്	**Predegree /+2/ Diploma** പ്രീഡിഗ്രീ/+2/ഡിപ്ലൊമ	**Graduate** ബിരുദം	**Post-graduate & above** ബിരുദാനന്തരബിരുദം
Position in Family (കുടുംബത്തിൽ സ്ഥാനം)	**Head of Family** കുടുംബനാഥ(ൻ)		**Other Family Member** (മറ്റ് കുടുംബാംഗം)		

3.	**Whether house located near motorable road (Distance < 30m to Tar road)?** വീടിനടുത്ത് ഗതാഗതയോഗ്യമായ റോഡ് ഉണ്ടോ?		**YES** ഉവ്വ്	**NO** ഇല്ല
4.	**Whether house has water supply connection? If NO, distance to nearest stand post (m)** _____ വീട്ടിൽ കുടിവെള്ള കണക്ഷൻ ഉണ്ടോ?, ഇല്ലെങ്കിൽ പൊതു ടാപ്പിലേക്കുള്ള ദൂരം?		**YES** ഉവ്വ്	**NO** ഇല്ല
5.	**Whether house is connected to sewerage network? If Not, Is there septic tank in house?** വീട്ടിൽ മലിനജല കണക്ഷൻ ഉണ്ടോ?, ഇല്ലെങ്കിൽവീട്ടിൽ സെപ്റ്റിക്ക് ടാങ്ക് ഉണ്ടോ?	**YES** ഉവ്വ് / **NO** ഇല്ല	**YES** ഉവ്വ്	**NO** ഇല്ല
6.	**Have you heard of infrastructure projects implemented in Thiruvananthapuram city?** തിരുവനന്തപുരത്ത് നടപ്പിലാക്കുന്ന അടിസ്ഥാനസൌകര്യ വികസന പദ്ധതികളെക്കുറിച്ച് കേട്ടിട്ടുണ്ടോ?		**YES** ഉവ്വ്	**NO** ഇല്ല

7. If YES to Qn.6. above, your level of awareness on Infrastructure Development Projects in Thiruvananthapuram? (Tick multiple options, if applicable)
ഉണ്ടെങ്കിൽ,തിരുവനന്തപുരത്ത് നടപ്പിലാക്കുന്ന അടിസ്ഥാനസൌകര്യ വികസന പദ്ധതികളെക്കുറിച്ച് ഏത് നിലക്ക് അധവാ ഏത് രീതിക്ക് അറിയാം? (ഉചിതമായവ അടയാളപ്പെടുത്തുക)

	User level ഉപഭോക്താവ്	**Execution Level** പദ്ധതിനിർവഹണം	**Management Level** പദ്ധതിനേതൃത്വം	**Policy Level** നയപരം	**None of these but aware** മറ്റ് നിലക്ക്
Transportation Projects (Road, Rail, Air, Water transport etc.) ഗതാഗതപദ്ധതികൾ (റോഡ്/ റെയിൽ/ വിമാനം/ ജലഗതാഗതം)					
Water and Sanitation Projects (water supply, sewage, flood management, drainage etc.) ജലവിഭവപദ്ധതികൾ (കുടിവെള്ളം, ശുചിത്വം, പ്രളയദുരിതാശ്വാസം മുതലായവ)					
Other Projects (Describe) മറ്റുവികസനപദ്ധതികൾ (വിവരിക്കുക)					

8. Please specify your nature of participation in infrastructure development projects in Thiruvananthapuram? (Tick multiple options, if applicable)
പദ്ധതിനിർവഹണത്തിൽ പങ്കുവഹിച്ചുവെങ്കിൽ ഏത്/ഏതെല്ലാം നിലക്ക് എന്ന് അടയാളപ്പെടുത്തുക?

	Project Manager/ Work Supervisor	**Other Project Official**	**Contractor/ Subcontractor**	**Consultant/ Advisor**	**Others**
Transportation Projects (ഗതാഗതപദ്ധതികൾ)					
Water & Sanitation Projects ജലവിഭവപദ്ധതികൾ					
Other Projects (Describe) മറ്റുവികസനപദ്ധതികൾ (വിവരിക്കുക)					

9. **How much successful were the following projects, Rate the importance of each of the below criteria in assessing project performance?**
താഴെ പട്ടികയിൽ പറഞ്ഞ പദ്ധതികളുടെ വിജയം/ സാഫല്യം അഥവാ ഈപദ്ധതികളുടെ ക്ഷമത/ഗുണം സംബന്ധിച്ച് താങ്കളുടെ വിലയിരുത്തൽ? പദ്ധതികളുടെപ്രകടനം വിലയിരുത്തുന്നതിൽ താഴെ പറഞ്ഞ ഓരോ മാനദണ്ഡത്തിനുള്ള പ്രാധാന്യം ?

Success Factors (Rate each 1 to 5) **(Not Important 1; Most Important 5)**	**Karamana- Kaliyikkavila NH project** കരമന-കളിയിക്കാവിള ദേശീയപാത	**Thiruvananthapuram City Roads Project** തിരുവനന്തപുരം സിറ്റി റോഡ്സ് പദ്ധതി	**Thampanoor Bus Terminal (KTDFC)** തമ്പാനൂർ ബസ്സ് സ്റ്റാൻറ്	**JICA water supply project (KWA)** ജൈകാ കുടിവെള്ള പദ്ധതി	**Muttathara STP (KSUDP/KWA)** മുട്ടത്തറ മലിനജല സംസ്കരണശാല	**Operation ANANTHA Flood Mitigation Programme**
Project Familiarity (Not Familiar /Low/ Medium/ High)						
Performance Level (%) REF: (0-20%-Project Failed; 21-40%- Minimal Success; 41-60%-Moderately Successful; 61-80% - Successful81-100% - Exceeded Expectation)						
Timely completion **സമയബന്ധിതമായ പൂർത്തീകരണം**						
Within Budget ബജറ്റിനുള്ളിൽ						
Meets/ Exceeds expected benefits **പ്രതീക്ഷക്കൊത്ത് പദ്ധതിഗുണങ്ങൾ**						
Quality of Finished infrastructure **പൂർത്തീകരിച്ച നിർമാണത്തിൻ ഗുണനിലവാരം**						
Good User Satisfaction **നല്ല ഉപയോക്തൃ സംതൃപ്തി**						
Use of new/ better/innovative technology **മികച്ച / നൂതന സാങ്കേതിക വിദ്യയുടെ ഉപയോഗം**						
Improved service delivery after project **പദ്ധതിമൂലം മെച്ചപ്പെട്ട സേവനം**						
Less Public Disturbance during work **ജോലിസമയത്തെ പൊതുശല്യം**						
Does not have any adverse impacts **പ്രതികൂലമായ ആഘാതം ഇല്ല**						
Good Public interaction during project **പദ്ധതിവേളയിൽ നല്ല പൊതുജന സമ്പർക്കം**						
Ease of Access/ Use ഉപയോഗിക്കാൻ എളുപ്പം						
Lower Usage Cost **കുറഞ്ഞ ഉപയോഗ ചെലവ്**						
Socially Responsible Initiative **പദ്ധതിയുടെസാമൂഹിക ഉത്തരവാദിത്തം**						

10. **For each of the below projects, Rate each of the following factors below (on a scale of 1 to 5) on the basis of how each factor impacts the success of project**
താഴെയുള്ള ഓരോ പദ്ധതിയുടെയും വിജയത്തെ എങ്ങനെ സ്വാധീനിക്കുന്നു എന്ന അടിസ്ഥാനത്തിൽ ഓരോ ഘടകങ്ങളെ (1 മുതൽ 5 വരെ) വിലയിരുത്തുക**(No Impact -1; Very High Impact -5)**

Success Factors (Rate each 1 to 5) **(No Impact -1; Very High Impact -5)**	Karamana- Kaliyikkavila NH projectകരമന-കളിയിക്കാവിള ദേശീയപാത	Thiruvananthapuram City Roads Project തിരുവനന്തപുരം സിറ്റി റോഡ്സ് പദ്ധതി	Thampanoor Bus Terminal തമ്പാനൂർ ബസ്സ് സ്റ്റാൻറ്	JICA water supply project (KWA) ജൈകാ കുടിവെള്ള പദ്ധതി	Muttathara STPമുട്ടത്തറ മലിനജല സംസ്കരണശാല	Operation ANANTHA Flood Mitigation Programme
Project Vision and Clarity of project Goals പദ്ധതിവീക്ഷണം/പദ്ധതിലക്ഷ്യങ്ങളിൽ വ്യക്തത						
Political will and Government support പദ്ധതിക്കുള്ള സർക്കാർ പിന്തുണ						
Local Community Involvement and Support പദ്ധതിക്കുള്ളപൊതുജനപിന്തുണ						
Collective Responsibility/ Risk Sharing among project stakeholders പദ്ധതി പങ്കാളികൾക്കുള്ള കൂട്ടുത്തരവാദിത്വം						
Proper Needs Assessment in project plan പദ്ധതി ആസൂത്രണത്തിൽ ശരിയായ ആവശ്യങ്ങൾ വിലയിരുത്തൽ						
Thorough Project Feasibility Study സമഗ്രസാഹചര്യപഠനം/ സാദ്ധ്യതാപഠനം						
Diligent Cost- Benefit Assessment കണിശമായ പദ്ധതിഗുണം-ചിലവ് വിലയിരുത്തൽ						
Detailed Social/ Environmental Study വിശദമായ സാമൂഹ്യവും പാരിസ്ഥിതിക വിലയിരുത്തലും						
Client Involvement/ Control in Project പദ്ധതി ആസൂത്രണത്തിൽ ഉടമസ്ഥ പങ്കാളിത്തം/ നിയന്ത്രണം						
Detailed Project Planning and Design വിശദമായ പദ്ധതി ആസൂത്രണവും രൂപകൽപ്പനയും						
Quality Assurance/ Control in project പദ്ധതി ആസൂത്രണത്തിൽ ഗുണനിലവാര നിയന്ത്രണം						
Project Funding Plan പദ്ധതിയുടെ ധനകാര്യപ്ലാൻ						
Realistic Program Schedule/Milestones യാഥാർത്ഥ്യമായ പദ്ധതിസമയക്രമവും/ നാഴികക്കല്ലുകളും						
Mode and Transparency of Procurement കരാർ രീതിയും കരാർ പ്രക്രീയയിലെ സുതാര്യതയും						
Clear Scope and Work Definition in Tender കരാറിൽ വ്യക്തമായ ജോലി നിർവ്വചനം						

Success Factors (Rate each 1 to 5) **(No Impact -1; Very High Impact -5)**	Karamana- Kaliyikkavila NH projectകരമന-കളിയിക്കാവിള ദേശീയപാത	Thiruvananthapuram City Roads Project തിരുവനന്തപുരം സിറ്റി റോഡ്സ് പദ്ധതി	Thampanoor Bus Terminal തമ്പാനൂർ ബസ്സ് സ്റ്റാൻറ്	JICA water supply project (KWA) ജൈകാ കുടിവെള്ള പദ്ധതി	Muttathara STPമുട്ടത്തറ മലിനജല സംസ്കരണശാല	Operation ANANTHA Flood Mitigation Programme
Effective Qualification/ Selection Criteria in Tender കരാർ പ്രക്രീയയിൽഫലപ്രദമായ യോഗ്യത/ തിരഞ്ഞെടുപ്പ് മാനദണ്ഡം						
Well organized and committed project agency സംഘടിതമായപ്രതിബദ്ധതയുള്ള പദ്ധതിആസൂത്രണ സംഘടന						
Effective Communication & stakeholder coordination പദ്ധതിപങ്കാളികൾതമ്മിൽ ഫലപ്രദമായ ആശയവിനിമയവും ഏകോപനവും						
Clear cut rules and responsibilities പ്രവർത്തികൾക്ക് വ്യക്തമായ നയങ്ങളും ഉത്തരവാദിത്തങ്ങളും						

11. **For each of the below projects, Rate each of the following factors below (on a scale of 1 to 5) on the basis of how each factor impacted the <u>NEGATIVE PERFORMANCE</u> of the project?** താഴെയുള്ള ഓരോ പദ്ധതിയുടെയും പ്രകടനത്തെ എങ്ങനെ പ്രതികൂലമായിസ്വാധീനിക്കുന്നു എന്ന അടിസ്ഥാനത്തിൽ ഓരോ ഘടകങ്ങളെ(1 മുതൽ 5 വരെ) വിലയിരുത്തുക**(No Impact -1; Very High Impact -5)**

Failure Factors (Rate each 1 to 5) **(No Impact -1; Very High Impact -5)**	Karamana- Kaliyikkavila NH project കരമന-കളിയിക്കാവിള ദേശീയപാത	Thiruvananthapuram City Roads Project തിരുവനന്തപുരം സിറ്റി റോഡ്സ്	Thampanoor Bus Terminal തമ്പാനൂർ ബസ്സ് സ്റ്റാൻറ്	JICA water supply project ജൈകാ കുടിവെള്ള പദ്ധതി	Muttathara STP മുട്ടത്തറ മലിനജല സംസ്കരണശാല	Operation ANANTHA ood Mitigation Programme
Change in Requirements/Design പദ്ധതി രൂപകൽപ്പനയിലും ആവശ്യകതയിലും ഇടക്കിടെമാറ്റം						
Incomplete Approvals/ Delay in Approvals അപൂർണ്ണമായ/ വൈകിയ അംഗീകാരങ്ങൾ						
Lack of experienced project team പ്രോജക്ട് ടീമിൽ പരിചയക്കുറവ്						
Frequent changes to project staff ഉദ്യോഗസ്ഥർക്ക് ഇടയ്ക്കിടെ മാറ്റം						
Major policy level changes പ്രധാന നയപരമായ മാറ്റങ്ങൾ						
External influences on project പദ്ധതിയിലെ ബാഹ്യ സ്വാധീനം						
Errors/ Omissions in the project പദ്ധതി ആസൂത്രണത്തിൽ വരുന്ന പിശക്/ ഒഴിവാക്കൽ						
Corruption in the project പദ്ധതിയിലുള്ള അഴിമതി						

12. **Any other factor that you feel affected the success of infrastructure projects in Thiruvananthapuram?** മറ്റ്ഘടകങ്ങൾ**?**

Transportation Projects	**Water Projects**

APPENDIX 2 – SURVEY OF PROFESSIONALS QUESTIONNAIRE

1. Basic Details of Respondent

Name					
Email Address			**Phone**		
Age			**Gender** (ലിംഗം)	**M** (പു)	**F** (സ്ത്രീ)
Designation			**Total Work Exp (Years)**		
Education Level (	**Basic Education (< 10th Std.)**	**SSLC/ Matriculate**	**Predegree /+2/ Diploma**	**Graduate**	**Post-graduate & above**

2. Please specify your nature of participation in infrastructure Transport /Water & Sanitation projects in Thiruvananthapuram? (Tick multiple options, if applicable)

Project Manager/ Project In charge	
Other Project Official	
Contractor/ Subcontractor	
Consultant/ Advisor	
Statutory/ Regulatory Agency	
Administrative Head	
Others, please specify	

3. From the list of Transport and Water projects in Trivandrum below, Select the project where you are/were involved? Please assess the success level of your project in percentage?

Project Name	**Tick your project(s)**	**Success Rating (%)**
Karamana- Kaliyikkavila NH project		
Thiruvananthapuram City Roads Project		
Thampanoor Bus Terminal (KTDFC)		
JICA water supply project (KWA)		
Muttathara STP (KSUDP/KWA)		
Operation ANANTHA		
Other (Please specify		

4. **How much successful were the following projects, Rate the importance of each of the below criteria in assessing project performance?**

താഴെ പട്ടികയിൽ പറഞ്ഞ പദ്ധതികളുടെ വിജയം/ സാഫല്യം അഥവാ ഈപദ്ധതികളുടെ ക്ഷമത/ഗുണം സംബന്ധിച്ച് താങ്കളുടെ വിലയിരുത്തുന്നതിൽ

താഴെ പറഞ്ഞ ഓരോ മാനദണ്ഡത്തിനുള്ള പ്രാധാന്യം ?

Success Factors (Rate each 1 to 5) **(Not Important 1; Most Important 5)**	**Karamana-Kaliyikkavila NH project**	**Thiruvananthapuram City Roads Project**	**Thampanoor Bus Terminal (KTDFC)**	**JICA water supply project (KWA)**	**Muttathara STP (KSUDP/KWA)**	**Operation ANANTHA Flood Mitigation Programme**
Timely completion						
Within Budget						
Meets/ Exceeds expected benefits						
Quality of Finished infrastructure						
Good User Satisfaction						
Use of new/ better/innovative technology						
Improved service delivery after project						
Less Public Disturbance during work						
Does not have any adverse impacts						
Good Public interaction during project						
Ease of Access/ Use						
Lower Usage Cost						
Socially Responsible Initiative						

5. **For each of the below projects, Rate each of the following factors below (on a scale of 1 to 5) on the basis of how each factor impacts the success of project (No Impact -1; Very High Impact -5)**

Success Factors (Rate each 1 to 5) **(No Impact -1; Very High Impact -5**	Karamana-Kaliyikkavila NH project	Thiruvananthapuram City Roads Project	Thampanoor Bus Terminal	JICA water supply project (KWA)	Muttathara STP	Operation ANANTHA Flood Mitigation Programme
Project Vision and Clarity of project Goals						
Political will and Government support						
Local Community Involvement and Support						
Collective Responsibility/ Risk Sharing among project stakeholders						
Proper Needs Assessment in project plan						
Thorough Project Feasibility Study						
Diligent Cost- Benefit Assessment						
Detailed Social/ Environmental Study						
Client Involvement/ Control in Project						
Detailed Project Planning and Design						

Success Factors (Rate each 1 to 5) **(No Impact -1; Very High Impact -5**	Karamana-Kaliyikkavila NH project	Thiruvananthapuram City Roads Project	Thampanoor Bus Terminal	JICA water supply project (KWA)	Muttathara STP	Operation ANANTHA Flood Mitigation Programme
Quality Assurance/ Control in project						
Project Funding Plan						
Realistic Program Schedule/Milestones						
Mode and Transparency of Procurement						
Clear Scope and Work Definition in Tender						
Effective Qualification/ Selection Criteria in Tender						
Well organized and committed project agency						
Effective Communication & stakeholder coordination						
Clear cut rules and responsibilities						

6. **For each of the below projects, Rate each of the following factors below (on a scale of 1 to 5) on the basis of how each factor impacted the <u>NEGATIVE PERFORMANCE</u> of the project? (No Impact -1; Very High Impact -5)**

Failure Factors (Rate each 1 to 5) **(No Impact -1; Very High Impact -5)**	Karamana-Kaliyikkavila NH project	Thiruvananthapuram City Roads Project	Thampanoor Bus Terminal	JICA water supply project	Muttathara STP	Operation ANANTHA ood Mitigation Programme
Change in Requirements/Design						
Incomplete Approvals/ Delay in Approvals						
Lack of experienced project team						
Frequent changes to project staff						
Major policy level changes						
External influences on project						
Errors/ Omissions in the project						
Corruption in the project						

APPENDIX 3 - – MOODS MEDIAN TEST – SAMPLE COMPUTATION SHEET

Moods Median Test

Comparison of Success Rating between Transport and Water Sectors

1 Overall Median 50

2

	TP	WS	
>Median	696	218	914
<= Media	755	591	1346
	1451	809	2260

3 Obseerved Frequency

	TP	WS	Total
A1	696	218	914
A2	755	591	1346
Total	1451	809	2260

Expected Frequency

	TP	WS	Total
A1	586.82	327.18	914
A2	864.18	481.82	1346
Total	1451	809	2260

Chi Square Test

X2	20.3132	36.4332	
	13.7937	24.7399	95.2799

Step 4: Compute the degrees of freedom = (2-1)*(2-1) =1

Critical value of $\chi 2$ (0.05, 1) = 3.841

Critical value of $\chi 2$ (0.01, 1) = 6.635

Step 5: Calculated $\chi 2$ value is greater than the critical value of $\chi 2$ for a 0.01 significance level, hence we have evidence to reject the null hypothesis
So, the data are consistent with the alternate hypothesis

Critical Values of Chi-Square Distribution

	0.990	0.975	0.950	0.900	0.100	0.050	0.025	0.010
1	0.000	0.001	0.004	0.016	2.706	3.841	5.024	6.635
2	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210
3	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345
4	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277
5	0.554	0.831	1.145	1.610	9.236	11.070	12.833	15.086
6	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812
7	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475
8	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090
9	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666

APPENDIX 4 - DENSITY CLUSTER – WARDWISE PARTICULARS

Cluster	Ward No	Cluster	Ward Name	Area (km^2)	Population
Cluster 1 – HIGH DENSITY	18	1	Muttada	1.28	10020
	22	1	Shasthamangalam	0.92	10490
	24	1	Kuravankonam	1.5	9840
	26	1	Kunnukuzhy	1.41	9512
	27	1	Palayam	1.63	9761
	28	1	Thycaud	1.25	10399
	29	1	Vazhuthacaud	1.98	9676
	43	1	Valiyasala	0.82	8774
	44	1	Jagathy	0.95	9872
	45	1	Karamana	0.96	8856
	46	1	Arannoor	0.78	10004
	54	1	Neducaud	1.39	10528
	66	1	Poonthura	0.43	8659
	68	1	Kamaleswaram	1.58	8675
	69	1	Kalippankulam	0.57	8708
	70	1	Attukal	1.53	8699
	71	1	Chalai	1.15	8692
	72	1	Manacaud	0.46	8660
	73	1	Kuriyathy	0.79	9266
	74	1	Puthanpally	0.57	8692
	75	1	Manikyavilakam	0.39	8315
	76	1	Beemapally East	0.77	8790
	78	1	Muttathara	0.17	10528
	79	1	Sreevaraham	0.92	8659
	80	1	Fort	0.92	8888
	81	1	Thampanoor	0.99	9184
	82	1	Vanchiyoor	1.82	9498
	83	1	Sreekandeswaram	0.57	9676
	84	1	Perumthanni	1.22	9790
	85	1	Palkulangara	0.81	8941
	88	1	Vallakadavu	0.69	8790
	93	1	Pettah	1.23	10089
	94	1	Kannanmoola	1.42	9955
Cluster 2 – MEDIUM DENSITY	6	2	Ulloor	1.45	9102
	7	2	Edavacode	2.73	8659
	12	2	Kinavoor	1.9	10545
	15	2	Kesavadasapuram	1.82	9856
	16	2	Medical College	2.49	10528
	17	2	Pattom	2.18	10545
	19	2	Kudappanakunnu	3.29	9951
	20	2	Pathirapally	1.85	8659
	21	2	Chettivilakam	2.23	10496
	23	2	Kowdiar	2.65	10069
	25	2	Nanthankode	2.7	9512
	30	2	Kanjirampara	2.02	10004
	31	2	Peroorkada	2.66	9184
	33	2	Nettayam	0.64	10509
	36	2	Vattiyoorkavu	2.12	9807
	37	2	Koduganoor	1.98	10348
	38	2	PTP Nagar	1.2	10250
	39	2	Pangode	1.92	10200
	40	2	Thirumala	1.76	9905
	41	2	Valiyavila	1.87	9348
	42	2	Poojappura	3.89	8644
	47	2	Mudavanmugal	1.99	9020
	48	2	Thrikkannapuram	2.83	9856
	49	2	Nemom	2.75	9950
	51	2	Punnakkamugal	2.93	10168
	52	2	Pappanamcode	2.86	9872
	53	2	Estate	3.4	9856
	55	2	Kalady	2.69	8659
	61	2	Kottappuram	1.64	10610
	67	2	Ambalathara	2.13	8659
	77	2	Beemapally	2.99	8642
	86	2	Chakai	2.8	9754

Cluster	Ward No	Cluster	Ward Name	Area (km^2)	Population
	87	2	Valiyathura	1.91	8856
	89	2	Shangumugham	1.51	10171
	90	2	Vettucaud	1.3	10351
	95	2	Anamugham	3.24	9872
Cluster 3 – LOW DENSITY	1	3	Kazhakuttom	6.77	10528
	2	3	Chanthavila	7.88	9351
	3	3	Kattaikonam	8.03	9229
	4	3	Sreekariyam	6.56	10455
	5	3	Cheruvaikkal	3.31	9357
	8	3	Chellamangalam	4.32	10036
	9	3	Chempazhanthy	6.05	10184
	10	3	Powdikonam	5.38	9676
	11	3	Njadoorkonam	6.57	8501
	13	3	Mannanthala	5.54	9525
	14	3	Nalanchira	3.9	8777
	32	3	Thuruthummoola	4.18	10027
	34	3	Kachani	4.24	9328
	35	3	Vazhottukonam	3.77	10371
	50	3	Ponnumangalam	4.72	10007
	56	3	Melamcode	4.09	10384
	57	3	Punchakkari	3.73	10168
	58	3	Poonkulam	6.9	10250
	59	3	Venganoor	4.88	9696
	60	3	Mulloor	4.72	9778
	62	3	Vizhinjam	2.42	8724
	63	3	Harbour	2.75	8692
	64	3	Vellar	3.71	9758
	65	3	Thiruvallam	3.77	10332
	91	3	Karikkakam	3.65	9761
	92	3	Kadakampally	3.85	9908
	96	3	Akkulam	4.47	8856
	97	3	Kulathoor	5.33	8938
	98	3	Attipra	5.66	8741
	99	3	Poundukadavu	6.65	9004
	100	3	Pallithura	4.01	10046

APPENDIX 5 - LIST OF PUBLICATION

Papers Published

1. Kothandath.S ,"Success Factors in Planning of Infrastructure projects and associated risks - A study of User Perceptions" in "IUJ Journal of Management" (ISSN 2347- 5080) Vol 5. No.1, May-17 , Pages 34-38
2. Kothandath.S ,"Project Success Criteria Preferences" in "IUJ Journal of Management" (ISSN 2347- 5080) Vol.6 No.2, Nov-18, Pages 73-77.
3. Kothandath.S ,"Exploring the role of perceived level of difficulty in preference for project success criteria among professionals" in "IUJ Journal of Management" (ISSN 2347- 5080) Vol.8 No.1, Jun 2020, Pages 1 to 12.
4. Kothandath.S and Hari Haran,"Study of success levels and success criteria for infrastructure projects in Thiruvananthapuram" in "International Journal of Innovative Technology and Exploring Engineering (IJITEE)" ISSN (2278-3075) Vol. 9, Issue 9S July 2020 Pages 30-36. (Scopus Indexed)

Conferences:

1. Attended presented paper titled 'Success Factors in Planning of Infrastructure projects and associated risks - A study of User Perceptions' at National Doctoral Conference 2017 on Trends in Management Research at ICFAI University Jharkhand, Mar 2017.
2. Attended and presented paper "Study of success levels and success criteria for infrastructure projects in Thiruvananthapuram" at International Conference on Sustainable Technology Applications for Green Engineering Solutions (STAGE 2020, 17-18 July 2020. Paper published in proceedings with ISBN: 978-93-5406-794-5, by NSS College of Engineering, Palakkad, Kerala. (Jointly authored with Dr. Hari Haran)