SYNOPSIS OF THE THESIS

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

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1. Introduction

Infrastructure in India

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. The Report of Taskforce National Infrastructure Pipeline notes that "*70% of the global population will be living in urban centres", that "infrastructure will determine their quality of life*" and *on* 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 (Department of Economic Affairs, 2020). 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). India's infrastructure investment is expected to be about $4.51 trillion on infrastructure by 2030 (Department of

Economic Affairs, 2020). Infrastructure statistics manual(MOSPI-GoI, 2013) classifies infrastructure broadly into five categories viz., Transport, Energy, Water & Sanitation, Communication and Social and Commercial infrastructure, each with several subheads. it is estimated that India would need to spend $ 4.5 trillion on infrastructure by 2030(Department of Economic Affairs, 2020), sector wise investment details as reproduced below as Figure 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: Infrastructure Investment Breakup
(Reproduced from (Department of Economic Affairs, 2020))

The report briefs on very ambitious infrastructure investment plans as shown below in Figure 2:

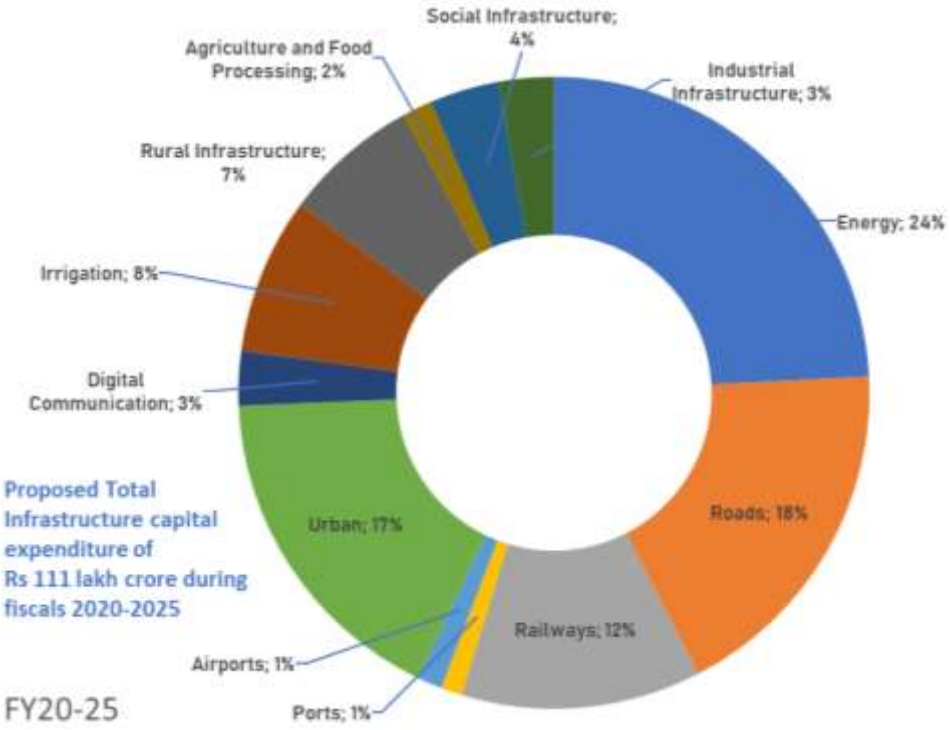

Figure 2: FY2020-25 Sector wise Infrastructure Investment
(From NIP Report (Department of Economic Affairs, 2020)

(NITI Aayog, 2019) reports 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.

Project Management in Infrastructure Projects

PMI defines 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). 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 multidimensional inputs to function satisfactorily.

2. 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. Man has 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 and this has prompted a study on success of infrastructure projects in Thiruvananthapuram to understand the stakeholder perspectives.

3. 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.

4. 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.

5. Review Of Literature

Project Life-Cycle

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. PMI defines "*The series of phases that a project passes through from initiation to closure*."(Project Management Institute, 2016).. Wu and Leifer presents project life-cycle stages proposed by various researchers reproduced here as Table 1 (Wu & Leifer, 2006)

Table 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)

Wideman presents project life-cycle giving further explanation to the phases (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). The four-phase model is generally accepted yet concentrates more on the creation of the asset whereas operation and maintenance has greater importance especially for public facilities. APMs "Extended life cycle" model includes operational phase of asset after project closure. (Archibald et al., 2012) Locatelli presents similar insights focusing on infrastructure projects through the infrastructure life cycle (Locatelli, 2020a).

For public infrastructure projects, operation phase which is generally the longest phase in the life cycle in terms of the time span involved.

Project Success and Project Management Success

Early researchers viewed project success as 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). Project management success is subordinate to product success as "*Project management success is measured in terms of internal factors (cost-time-quality) whereas achieving product success is concerned with project's external effectiveness*"(Baccarini, 1999). as illustrated in Figure 3. 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).

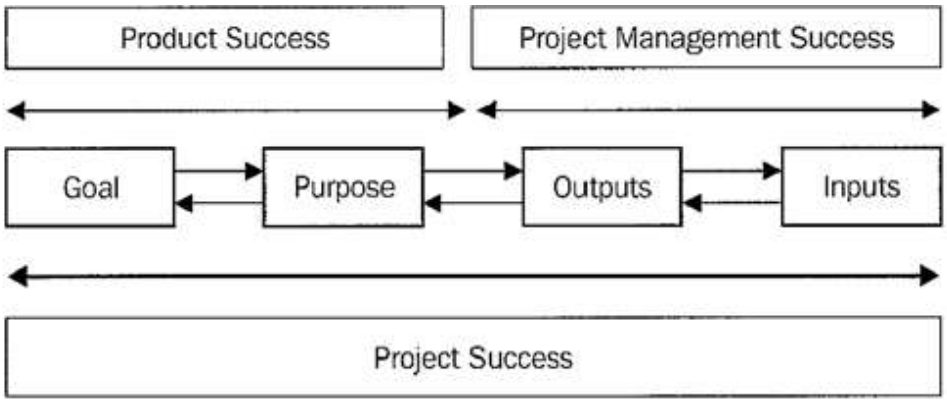

Figure 3: Link between PM Success and Project Success
Reproduced from (Baccarini, 1999)

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). 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). As per 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).. 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). Research on construction project risk in Chinese projects identifies the construction stage as the riskiest phase while risks in the front-end phase and its importance is well highlighted(Zou et al., 2012).

Infrastructure projects and performance levels

Flyvberg notes "*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".*(Flyvbjerg&Budzier, 2015). PMI states that " *only 20% of projects meet schedule, budget, and quality goals"*(PMI, 2018). *When important projects fail, the investigation is often focused on the engineering and technical reasons for the failure …in many cases*

the root cause ofthe failure is not technical, but managerial"(Sauser et al., 2009).

Project Stakeholders and multiple views on success

Projects usually have multiple stakeholders with different points of view who perceive project success differently (Andersen et al 2006; Davis 2013).(Davis, 2018)(Di Maddaloni& Davis, 2017)(Shenhar et al., 2001)(Aaltonen&Kujala, 2010)(Lloyd-walker et al., 2014). 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). 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.

Success Factors and Success Criteria

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 refer to the measurement of project success whereas success factors refer to those inputs to management system that lead directly/ indirectly to the success of project/ business*"(Cooke-Davies, 2002). "*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). "*Success criteria will differ from project to project depending on a number of issues, for example, size, uniqueness and complexity*"(Wateridge, 1998). Muller and Turner from survey of Australian project managers modelled a relation between importance assigned to success criteria against success rating to obtain a link between these variables(Müller & Turner, 2007).

6. Research Gap

Studies on critical success factors (CSF) for PPP projects focussed 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. 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, less importance given to subjective success criteria. 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. Comparative study of different infrastructure sectors with respect to either success criteria or critical success factors is rare. The present study focuses on planning of select infrastructure projects (Water & Sanitation and Transportation) in Thiruvananthapuram city based on the users and professionals' viewpoint of 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 and between stakeholders adds a new aspect in the analysis.

7. 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 sectors, success criteria for these projects and critical success

factors impacting these projects. In line with the above 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 validate/ compare with that from project professionals.
4. To compare the critical success factors between the project sectors

8. Hypothesis Formulation

Hypothesis 1 and Hypothesis 2 are in line with the first objective while Hypothesis 3 aligns with the second objective.

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

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.

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

9. 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 Corporation is the urban local body with 100 administrative wards and total population of 9,57,691. (Thiruvananthapuram Corporation & Department of Town and Country Planning, 2012).

10. Research Methodology

A descriptive research design is followed as shown in **Figure 4**:

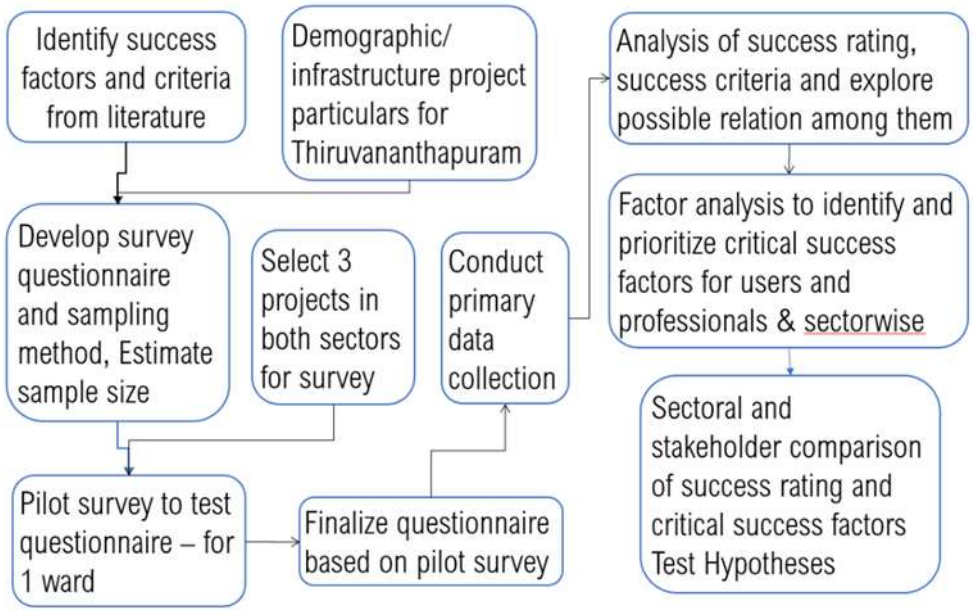

Figure 4: Research Methodology Flow Diagram
(Compiled by Researcher)

Success criteria and Success factors from literature

A set of 13 success criteria and 27 success factors are finalised for the study from literature as tabulated below in Table 2 and Table 3.

Table 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)(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)

S. No	Project Success Criteria and Corresponding (Variable name)	Reference Source
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)

Table 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)

SNo	Symbol	Variable Name	Success Factor	Literature reference
8.	V8	SocEnv	Social and Environmental Assessment	(Silvius et al., 2013; Silvius & Schipper, 2015)
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)
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)

SNo	Symbol	Variable Name	Success Factor	Literature reference
25.	V25	ExtInfl	External influences on project	(Hadipriono & Chang, 1988; Jha & Iyer, 2007; 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)

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.

Population

The study focuses on infrastructure project users in Thiruvananthapuram as the main respondents and project professionals as the secondary respondents. From ward wise total population, respondent population is taken as 9.57 lakh persons.

Sample Size Estimation

Sample size computed using Cochran's formula (Israel, 1992) (95% confidence level and p = 0.5) is 385 and checked using formula by Yamane (Israel, 1992) which gives 400, a sample size of 400 is fixed.

Sampling Method

Mult-stage clustered sampling technique is used for household survey. due to reasons of large population, operational efficiency and

cost for household surveys and has the advantage of concentrating the sample in a limited number of areas, (Valliant et al., 2015)(Cochran, 1977), illustrated in Figure 5 below

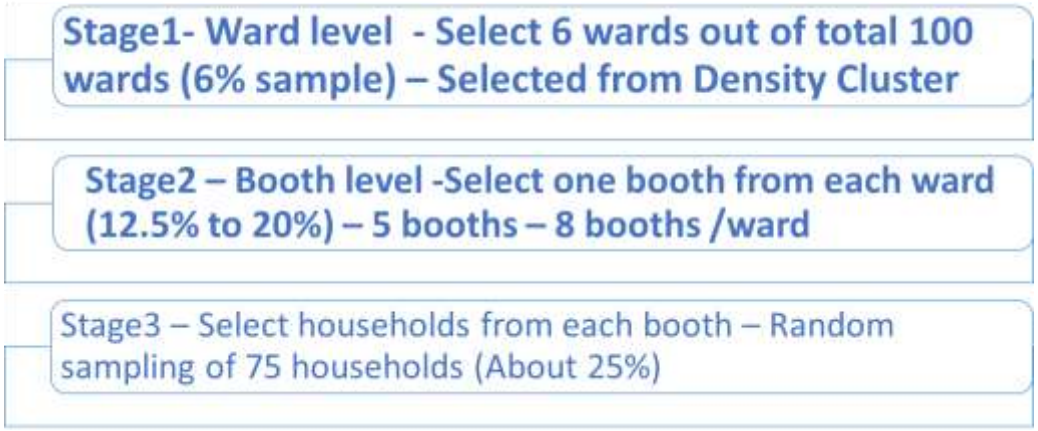

Figure 5: Multistage Cluster Sampling – Methodology

Density 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). Density clusters for the city area (100 wards) is developed using QGIS software by dividing the 100 wards into clusters based on population density and administrative ward boundaries. Three density clusters are developed – HIGH DENSITY, MEDIUM DENSITY and LOW DENSITY, the 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). Map of density clusters is included below as Figure 6 and cluster wise details included in Table 4:

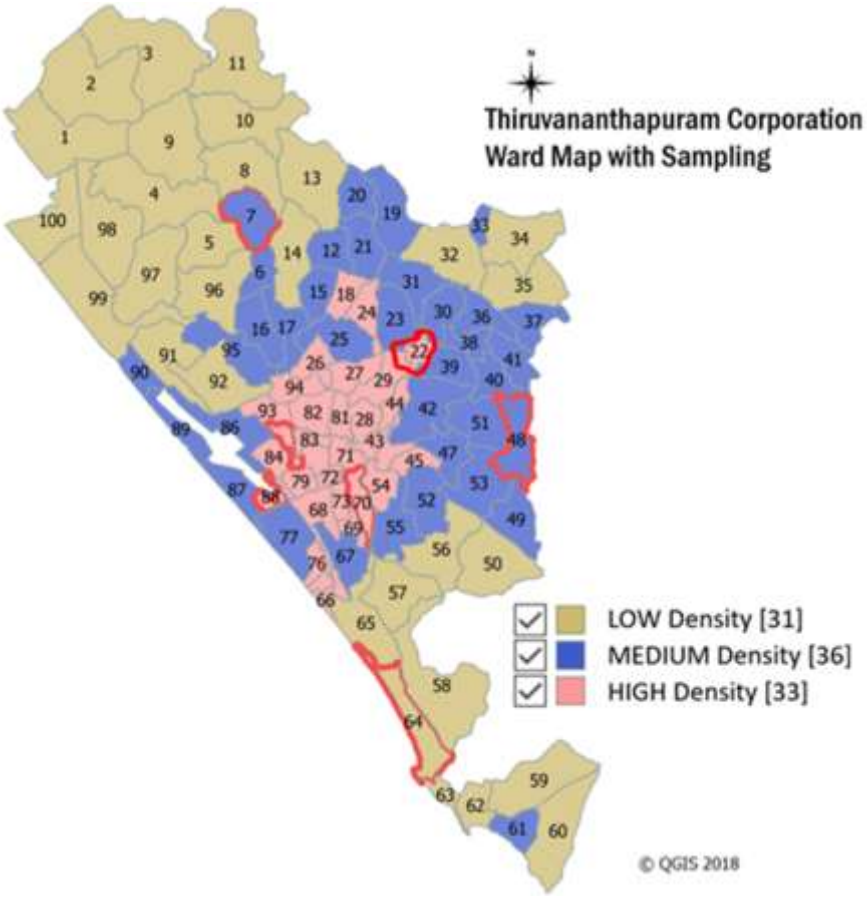

Figure 6: Thiruvananthapuram City Map with Density Clusters and Sample Wards

Table 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%**	

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

Selecting projects under both sectors

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. Transport projects are coded from P1 to P3 whereas water& sanitation projects have codes P4 to P6. The projects studied are :

P1 - Karamana- Kaliyikkavila NH project

P2 - Thiruvananthapuram City Roads Improvement Project

P3 - Thampanoor Bus Terminal

P4 - JICA water supply Project

P5 – Muttathara STP

P6 – Operation Anantha

Survey Questionnaire and Pilot Survey

A household survey questionnaire was initially developed and the same underwent few rounds of revisions based on review comments and the pilot survey conducted for 75 households in Sasthamangalam ward to test questionnaire for content and respondent understanding as well as explore additional factors. Important comments were on Including specific projects, collecting rating for project familiarity, performance level for each project, collection of success criteria preference for each project rating, impact of success factors, separating reverse ordered items into a new question, Additional

question on infrastructure service availability in household, including a survey of project professionals for comparison/ validation, Changing scale from three-point to five-point Likert scale. These comments were addressed questionnaire was finalised Survey questionnaire was translated into the local language Malayalam by providing side by side Malayalam version for the questions.

11. Data Analysis

User Profile

Among the 506 respondents, 401 are males and 105 are females. Maximum respondents were in the age group of 46 to 60, about 40%; by education level, graduates and above constituted over 40% of the sample. All the 10 job types were well represented with 13 respondents at least. Almost half the respondents had more than 20 years' experience. Availability of basic infrastructure in terms of transport and water &sanitation in the household was surveyed, over 95% had access to the basic infrastructure elements.

Screening out less familiar Respondents

Respondent rating on project familiarity was obtained on 5-point Likert scale (minimum 1 to maximum 5) which 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 3036 (506 x 6). Users with project familiarity ratings below 3 for each project are screened out from the analysis to make sure that the analysed data corresponds to users having sufficient familiarity with the projects under study

After screening, a total of 2260 responses with 1451 responses for transport projects and 809 responses for water and sanitation projects.

Success Rating of Projects

Average Success Rating for transport projects are above 50% while water & sanitation projects have lower success ratings. Hypothesis 1 tests similarity of success rating between the sectors.

Shapiro-Wilk tests Normality for the variables, coefficient above 0.9, significance level <0.01. indicating deviation from normality.

Reliability of scale is checked, Cronbach α value is 0.762 and McDonalds ω value is 0.763. Both values above cut-off of 0.7 (Ravinder & Saraswathi, 2020.), scale reliability is confirmed.

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.

Mean success rating is 54.09 and standard deviation 13.88 for transport projects; 43.11 and 15.99 respectively for water &sanitation projects. Independent samples have unequal sample sizes, data is not normal and standard deviation is different. Mood's

Median test (Ramana PV, 2020) is recommended for such sample, test results shown in Table 5.

Table 5: Hypothesis1- Testing Success Rating for sector

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

The computed test statistic (95.28) is above the chi square cut-off value for single degree of freedom (6.635 cut-off for p=0.01hence 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.

Relation of Success Criteria Preference and Success Rating

Association between a continuous and a categorical (ordinal) variable can be measured using Polyserial correlation (Olsson et al., 1982). With success rating as the dependent variable and success criteria preference as independent variables, Polyserial Correlation coefficients are computed in LISREL software (Jöreskog, K.G. & Sörbom, 2018). for all the six projects together as well as independently for each sector, the coefficients are given in **Table 6**.. For all projects combined, Correlation coefficients are below 0.25 while some have good significance levels below 0.05. 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. Correlation coefficients for all success criteria are acceptable while some of the coefficients are weak.

Table 6: Success Criteria Preference Vs Success Rating – Polyserial Correlation

Success Criteria	All Projects		Transport		Water & Sanitation	
	Coefficient	p	Coefficient	P-Value	Coefficient	P-Value
Time	**0.249**	**< .001**	0.138	0.232	**0.237**	**0.001**
Budget	**0.243**	**< .001**	0.11	0.659	**0.204**	**0.002**
ExpBen	**0.238**	**0.009**	0.121	0.151	0.204	0.093
InfQua	0.203	< .001	0.088	0.001	0.145	0.126
USatis	0.164	0.001	0.063	0.011	0.14	0.474
NuTek	**0.240**	**0.002**	0.105	0.671	0.26	0.078
ImpSer	0.182	< .001	0.076	0.157	0.139	0.001
PuDist	0.169	0.001	0.094	0.091	0.124	0
AdvImp	0.165	< .001	0.056	0.24	**0.226**	**0**
PuCons	0.190	0.014	**0.102**	**0.007**	0.153	0.358
EazUse	0.189	< .001	**0.119**	**0.03**	0.124	0.028
UsCost	0.175	< .001	0.018	0.002	**0.227**	**0.011**
SocResp	0.130	0.022	0.038	0.974	0.134	0.169

Weak correlation coefficient values are obtained for the transport projects, 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.

Analysis of Critical Success Factors for users

Ordinal Factor Analysis methodology is used for analysis as "*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 Factor analysis is conducted using both LISREL and FACTOR64 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 are combined and used for Exploratory and Confirmatory Factor analyses respectively.

Ordinal Factor Analysis – Analysis Sets

Ordinal Factor Analysis conducted for four different sets of data after ensuing satisfactory results in both the Kaiser-Meyer-Olikin test (KMO) and Bartler's Test of Sphericity, as in Table 7:

Table 7: 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	

Kaiser-Meyer-Olikin Measure of Sampling Adequacy (KMO)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO test) indicates whether a factor analysis could be useful for the data(Kaiser, 1974).(Kaiser & Rice, 1974) , higher values show indicate better results.

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(IBM, n.d.).

Exploratory Factor Analysis – All Projects

KMO test value of 0.91 and Bartlet's $p<0.01$ suggests suitability for data reduction through factor analysis. Exploratory Factor analysis) is conducted using FACTOR package. Variables with lower factor scores (less than 0.3) are excluded systematically from the analysis (DiStefano et al., 2009) (Samuels, 2016)and factor analysis is rerun by leaving out variables with lower factor scores while fixing the number of factors based on latest eigen values. The optimised solution has three factors from 10 variables with total cumulative variance explained at 51%, The three factors are designated INFRA1, INFRA2 and INFRA3. Factor Determinacy Index' (FDI) gives the correlation between the factor scores and the levels on the latent factors (Beauducel, 2011). FDI values around and above 0.8 are adequate for general research (Ferrando& Lorenzo-Seva, 2018).

Table 8: 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)		
Responsibility Sharing (RespSha)	**Robust Risk Management (INFRA2)**	0.761
Schedule (Sched)		
Qualification Criteria (QualCri)		
Political Will and Govt. support (PoliWill)	**Inclusive Planning (INFRA3)**	0.791
Needs Assessment (NdsAss)		
Transparent Procurement (tTansPro)		
Stakeholder Coordination (StkCo)		
External Influence (ExtInf)		

From Table 8, Strong Need Based Concept (INFRA1) has the first priority followed by Inclusive Planning (INFRA3) and Robust Risk Management (INFRA2).

Confirmatory Factor Analysis – All Projects

Confirmatory Factor Analysis of the three-factor model is run using LISREL to determine the validity of the construct and factor scores, Table 9 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.

Table 9: 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

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). 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 lower than 0.05 indicates good fit (Hu L.-T. &Bentler P. M., 1999; 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). Goodness of fit statistics for the CFA model provided as Table 10.

Table 10: 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**

Exploratory Factor Analysis– Transport Projects

For transport projects, KMO test value is 0.791(fair) and Bartlett's statistic 4892; $p<0.01$ Exploratory Factor analysis yielded an optimised solution with three factors with total cumulative variance of 51%, The factors are named TP1, TP2 and TP3, see Table 10.

Table 11: 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		

Confirmatory Factor Analysis – Transport Projects

Confirmatory factor analysis is conducted for the three-factor model.

Table 12: 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**

Factor loading of variables is given in Table 12 and goodness of fit statistics for the CFA model provided as Table 13.

Table 13: 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

Exploratory Factor Analysis– Water & Sanitation Projects

For water& sanitation projects, KMO test statistic is 0.877 (good) Exploratory Factor analysis identified 4 factors with 15 variables and total cumulative variance explained as 51%. The factors are named WS1, WS2, WS3 and WS4; CSF with FDI values in Table 14

Table 14: 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		

Confirmatory Factor Analysis– Water & Sanitation Projects

Confirmatory Factor analysis for the four-factor model is carried out, Factor loadings, T and R^2 values shown in Table **15**. and goodness of fit statistics given in Table **16**

Table 15: Factor loadings from CFA- Water 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**

Table 16: 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

Comparison of CSF for Transport and Water &Sanitation sectors

Table 17: 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)

Analysis On Survey Of Project Professionals

A total of 47 professionals involved in Thiruvananthapuram infrastructure projects were surveyed. Responses for more than one project were received from many professionals, 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. Over 90% of the professionals have experience above 10 years upto 60 years. Shapiro-Wilk test coefficient value is above 0.9 with significance level <0.01 indicating a clear deviation from normality. Reliability of scale is checked, Cronbach α is 0.872 and McDonalds ω is 0.867, hence scale reliability is confirmed.

Testing Hypothesis 2 –Success Rating for Users Vs Professionals

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

Average project success rating by professionals is higher than user rating for five out of the six projects, hence we test Hypothesis2 using Moods Median test, results in Table 18.

Table 18: Hypothesis2 - Success Rating of Users Vs Professionals

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

The computed test statistic is 0.068 ($p<0.01$) which is very low compared to the cut-off value (6.635) 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.

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 assessment, details shown in Table 19

Table 19: Hypothesis2 - Success Rating of Retired Vs In Service Professionals

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

Test results above could not show evidence for any difference in success rating between retired and in-service professionals.

Exploratory Factor Analysis– Professionals

KMO test statistic is 0.785 (fair) and Bartlett's statistic is 985.7, $p<0.01$. EFA yielded four factors with 16 variables and 66% total cumulative variance explained, factors named PRO1, PRO2, PRO3 and PRO4. Factors and FDI values given in Table **20**

Table 20: 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		

Confirmatory Factor Analysis– Professionals

The four-factor model was run and found to converge to an optimal solution, factor loadings for variables is provided in Table 21 below: Model Fit indices are given in Table **22.** Model fit indices obtained for 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.

Table 21: 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**

Table 22: 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)	0.131

Comparison of Critical success factors by Users and Professionals

Comparison of critical success factors from users and project professionals is shown in Table **23** below:

Table 23: 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)

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.

12. Results and Discussions

Users more familiar with Transport Projects

Project familiarity ratings show evidence for more familiarity on Transport projects than water & sanitation projects. Contrary to common expectation that 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 (P3 and 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 lane 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.

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 P1 and P2, project readiness level in terms of social safeguards is higher than in water & sanitation projects. Moreover, quick execution was observed for both P1 and P2 whereas P4 and P5 had their share of lags during execution. 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 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 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.

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.

Testing Success Criteria relation to Success Rating

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.

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. 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(Tabish & Jha, 2011)(Jha &Iyer, 2006). 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)(Osei-Kyei& Chan, 2015)(Liu et al., 2014). 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.

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.

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; Shenhar et al., 2001). While it is generally accepted from previous research that project success meaning varies across stakeholders (Andersen et al 2006; Davis 2013).(Davis, 2018)(Di Maddaloni& Davis, 2017)(Shenhar et al., 2001)(Aaltonen&Kujala, 2010)(Lloyd-walker et al., 2014) 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 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; 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 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. Important CSFs point towards apt identification of stakeholder needs and inclusive approach by engaging all parties affected by the project.

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.

Implications (Social and Managerial)

The need to address project success more holistically taking into consideration the views of various stakeholders, 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. 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. 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 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.

13. 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) , thus puts 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; 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.

14. 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.

15. References

Books

1. Baker, B. N., Fischer, D., & Murphy, D. C. (1974). Multiple Determinants of Project Success and Failure.
2. Cochran, W. G. (1977). Sampling Techniques (Third). John Wiley and Sons.
3. Dvir, D., & Shenhar, A. (2007). Reinventing Project Management: The Diamond Approach to Succesful Growth and Innovation., Harvard University Press, 1-276
4. Department of Economic Affairs, MoF. GoI. (2020). Report of National Infrastructure Pipeline: the Task Force . New Delhi.
5. Dunham B, R. (1984). Organizational Behavior: People and Processes in Management. Irwin.
6. IPMA. (2015). IPMA Individual Competence Baseline (ICB), Version 4.0.
7. PMI. (2017). PMBOK 6th Edition (6th ed.).
8. Narayan, D, Chambers, R, Shah, M K & Petesch, P (2015). Voices of the Poor: Crying Out for Change, January 2000, World Bank.
9. Serrador, P. (2012). The importance of the planning phase to project success. 2008, CRC Press 1–9.
10. Teplitz, Charles. (2007). Making Optimal Use of the Matrix Organization. 10.1002/9780470172346.ch16.
11. Thiruvananthapuram Corporation, & Department of Town and Country Planning, Govt. of Kerala. (2012). Thiruvananthapuram Masterplan (Draft). Thiruvananthapuram.

Conference Papers

1. Bannerman, P. L. (2008). Defining Project Success: A Multi-Level Framework. July 2008.
2. Hussein, B., Ramazani, S., & Kazemi, S. H. (2011). Preliminary investigation of project success criteria in Norway. Proceedings of the 6th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications, IDAACS'2011, 2(March 2015), 915–918. https://doi.org/10.1109/IDAACS.2011.6072906
3. Rafindadi, A. D., Mikić, M., Kovačić, I., & Cekić, Z. (2014). Global Perception of Sustainable Construction Project Risks. Procedia - Social and Behavioral Sciences, 119(Williams 1995), 456–465. https://doi.org/10.1016/j.sbspro.2014.03.051
4. Samset, K. F., Berg, P., & Klakegg, O. J. (2006). Front end governance of major public projects. EURAM 2006 Conference in Oslo, May, 18(1), 8.
5. Schwartz, J. Z., Ruiz-nuñez, F., & Chelsky, J. (2014). Closing the Infrastructure Finance Gap : Addressing Risk. Conference Volume, 2006, 141–156.
6. Shenhar, A. J., & Wideman, R. M. (1996). Improving PM: Linking Success Criteria to Project Type, Proceedings of Creating Canadian Advantage through Project Management, 25(3). https://doi.org/10.1007/BF00043865
7. Xia, B., Zuo, J., Skitmore, M., & Chan, A. (2014). Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate. Proceedings of the 17th International Symposium on

Advancement of Construction Management and Real Estate, July, 99–106. https://doi.org/10.1007/978-3-642-35548-6

Journal Articles

1. Aaltonen, K., & Kujala, J. (2010). A project lifecycle perspective on stakeholder influence strategies in global projects. *Scandinavian Journal of Management*, 26(4), 381–397. https://doi.org/10.1016/j.scaman.2010.09.001
2. Ameyaw, E., & Chan, A. (2016). A Fuzzy Approach for the Allocation of Risks in Public Private Partnership Water-Infrastructure Projects in Developing Countries. *Journal of Infrastructure Systems*, 22, 4016016.
3. Archibald, R. D., Filippo, I. Di, & Filippo, D. Di. (2012). The Six-Phase Comprehensive Project Life Cycle Model Including the Project Incubation / Feasibility Phase and the Post-Project Evaluation Phase. *PM World Journal*, 2012, 1–33.
4. Atkinson, R. (1999). Project management: cost time and quality two best guesses and a phenomenon, it's time to accept other success criteria. *International Journal of Project Management*, 17(6), 337–342. https://doi.org/10.1016/S0263-7863(98)00069-6
5. Babu, S. S., & Sudhakar. (2015). Critical Success Factors Influencing Performance of Construction Projects. *International Journal of Innovative Research in Science, Engineering and Technology*, 4(5), 3285–3292. https://doi.org/10.15680/IJIRSET.2015.0405048

6. Baccarini, D. (1996). The concept of project complexity - A review. *International Journal of Project Management*, 14(4), 201–204. https://doi.org/10.1016/0263-7863(95)00093-3

7. Baccarini, D. (1999). The Logical Framework Method for Defining Project Success. *Project Management Journal*, Volume 30(Issue 4), 25–32. https://doi.org/10.1086/250095

8. Baggett, S., Jeffrey, P., & Jefferson, B. (2006). Risk perception in participatory planning for water reuse. *Desalination*, 187(1–3), 149–158. https://doi.org/10.1016/j.desal.2005.04.075

9. Bayiley, Y. T., & Teklu, G. K. (2016). Success factors and criteria in the management of international development projects. *International Journal of Managing Projects in Business*, 9(3), 562–582. https://doi.org/10.1108/IJMPB-06-2015-0046

10. Beauducel, A. (2011). Indeterminacy of factor score estimates in slightly misspecified confirmatory factor models. *Journal of Modern Applied Statistical Methods*, 10(2), 583–598. https://doi.org/10.22237/jmasm/1320120900

11. Bing, L., Akintoye, A., Edwards, P. J., Hardcastle, C., Li, B., Akintoye, A., Edwards, P. J., & Hardcastle, C. (2005). Critical success factors for PPP/PFI projects in the UK construction industry. *Construction Management and Economics*, 23(5), 459–471. https://doi.org/10.1080/01446190500041537

12. Bryde, D. J., & Robinson, L. (2005). Client versus contractor perspectives on project success criteria. *International Journal of Project Management*, 23(8), 622–629. https://doi.org/10.1016/j.ijproman.2005.05.003

13. Bulsara, H. P., Kumar, A., Kumar, R., & Chauhan, K. A. (2016). Principle factors for success of traditional vs. ppp road projects in India. International Journal of Applied Business and Economic Research, 14(6), 3575–3590.

14. Cangur, S. (2015). Comparison of Model Fit Indices Used in Structural Equation Modeling Under Multivariate Normality. 14(1). https://doi.org/10.22237/jmasm/1430453580

15. Chan, D. W. M., Chan, A. P. C., Lam, P. T. I., & Wong, J. M. W. (2010). Identifying the critical success factors for target cost contracts in the construction industry. *Journal of Facilities Management*, 8(3), 179–201. https://doi.org/10.1108/14725961011058820

16. Chou, J. S., & Pramudawardhani, D. (2015). Cross-country comparisons of key drivers, critical success factors and risk allocation for public-private partnership projects. International Journal of Project Management, 33(5), 1136–1150. https://doi.org/10.1016/J.IJPROMAN.2014.12.003

17. Chua, J. H. , C. J. J. and S. P. (1999). Defining the Family Business by Behavior. *Entrepreneurship Theory and Practice*, 19–39.

18. Cleveland, S. (2017). On Developing Project Complexity Framework *Emergent Research Forum Paper*.

19. Cooke-Davies, T. (2002). The “real” success factors on projects. *International Journal of Project Management*, 20(3), 185–190. https://doi.org/10.1016/S0263-7863(01)00067-9

20. Davis, K. (2017). An empirical investigation into different stakeholder groups perception of project success. International Journal of Project Management, 35(4). https://doi.org/10.1016/j.ijproman.2017.02.004

21. Davis, K. (2018). Reconciling the Views of Project Success: A Multiple Stakeholder Model. *Project Management Journal*, 49(5), 38–47. https://doi.org/10.1177/8756972818786663

22. de Wit, A. (1988). Measurement of project success. *International Journal of Project Management*, 6(3), 164–170. https://doi.org/10.1016/0263-7863(88)90043-9

23. Di Maddaloni, F., & Davis, K. (2017). The influence of local community stakeholders in megaprojects: Rethinking their inclusiveness to improve project performance. *International Journal of Project Management*, 35(8). https://doi.org/10.1016/j.ijproman.2017.08.011

24. Dimitriou, H. T., Ward, E. J., & Wright, P. G. (2013). Mega transport projects-Beyond the "iron triangle": Findings from the OMEGA research programme. Progress in Planning, 86. https://doi.org/10.1016/j.progress.2013.03.001

25. DiStefano, C., Zhu, M., & Mîndrilă, D. (2009). Understanding and using factor scores: Considerations for the applied researcher. *Practical Assessment, Research and Evaluation*, 14(20).

26. Dosumu, O. S., & Onukwube, H. N. (2013). Analysis of Project Success Criteria in the Nigerian. *International Journal of Sustainable Construction Engineering & Technology* (ISSN: 2180-3242), 4(1), 31–47.

27. Elkington, P., & Smallman, C. (2001). Managing project risks: A case study from the utilities sector. *International Journal of Project Management*, 20(1), 49–57. https://doi.org/10.1016/S0263-7863(00)00034-X

28. Ferrando, P. J., & Lorenzo-Seva, U. (2018). Assessing the Quality and Appropriateness of Factor Solutions and Factor Score Estimates in

Exploratory Item Factor Analysis. *Educational and Psychological Measurement*, 78(5), 762–780. https://doi.org/10.1177/0013164417719308

29. Flyvbjerg, B. (2013). Quality control and due diligence in project management: Getting decisions right by taking the outside view. *International Journal of Project Management*, 31(5), 760–774. https://doi.org/10.1016/j.ijproman.2012.10.007
30. Hox, J. J., & Bechger, T. M. (2015). An introduction to structural equation models. Studies in Systems, Decision and Control, 22, 1–8. https://doi.org/10.1007/978-3-319-16507-3_1
31. Hu L.-T., & Bentler P. M. (1999). 103. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling*, 6(July 2012), 1–55.
32. Ika, L. A., & Pinto, J. K. (2022). The "re-meaning" of project success: Updating and recalibrating for a modern project management. *International Journal of Project Management*, 40(7), 835–848. https://doi.org/10.1016/j.ijproman.2022.08.001
33. Jefferies, M., Gameson, R., & Rowlinson, S. (2002). Critical success factors of the BOOT procurement system: Reflections from the Stadium Australia case study. Engineering, *Construction and Architectural Management*, 9(4), 352–361. https://doi.org/10.1108/eb021230
34. Jha, K. N., & Iyer, K. C. (2007). Commitment, coordination, competence and the iron triangle. *International Journal of Project Management*, 25(5), 527–540. https://doi.org/10.1016/j.ijproman.2006.11.009
35. Jha, Kumar. Neeraj., & Iyer, K. C. (2006). Critical Factors Affecting Schedule Performance: Evidence from Indian Constrcution Projects. *Journal*

of Construction Engineering and Management, 132(November 2016), 871–881. https://doi.org/10.1061/(ASCE)0733-9364(2006)132

36. Jöreskog, K. G. (1994a). Structural equation modeling with ordinal variables. January 1994, 297–310. https://doi.org/10.1214/lnms/1215463803

37. Jöreskog, K. G. (1994b). Structural equation modeling with ordinal variables. January 1994, 297–310. https://doi.org/10.1214/lnms/1215463803

38. Joslin, R., & Müller, R. (2015). Relationships between a project management methodology and project success in different project governance contexts. *International Journal of Project Management*, 33(6), 1377–1392. https://doi.org/10.1016/j.ijproman.2015.03.005

39. Joslin, R., & Müller, R. (2016). The relationship between project governance and project success. *International Journal of Project Management*, 34(4), 613–626. https://doi.org/10.1016/j.ijproman.2016.01.008

40. Jugdev, K., & Thomas, J. (2001). Rethinking Project Management: Old Truths and New Insights. 7(1), International *Project Management Journal*.

41. Kaiser, H. F. (1974). An Index of Factorial Simplicity, *Psychometrika*,39,31-36

42. Kaiser, H. F., & Rice, J. (1974). Little Jiffy, Mark Iv. Educational and *Psychological Measurement*, 34(1). https://doi.org/10.1177/001316447403400115

43. Kassel, D. S. (2008). Public Administration Review Public Administration Review Performance, Accountability, and the Debate over Rules. *Public Administration Review*, 68(2), 241–252.

44. Khanani, R. S., Adugbila, E. J., Martinez, J. A., & Pfeffer, K. (2021). The Impact of Road Infrastructure Development Projects on Local Communities

in Peri-Urban Areas: the Case of Kisumu, Kenya and Accra, Ghana. *International Journal of Community Well-Being*, 4(1), 33–53. https://doi.org/10.1007/s42413-020-00077-4

45. Khona, A. C., Jayshinmure, A. G., Nagare, M. R., & Narkhede, B. E. (2016). Reduction of Delays in Infrastructure Projects. *International Journal of Advanced Research in Management, Architecture, Technology and Engineering*, 2(7).

46. Kothandath, S. (2020). Exploring the role of perceived level of difficulty in preference for project success criteria among professionals. *IUJ Journal of Management*, 8(1), 1–12. https://doi.org/10.11224/IUJ.08.01.01

47. Liu, J., Love, P., & Smith, J. (2014). Life Cycle Critical Success Factors for Public-Private Partnership Infrastructure Projects. *Journal of Management …*, JUNE, 1–7. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000307.

48. Lloyd-walker, B. M., Mills, A. J., & Walker, D. H. T. (2014). Enabling construction innovation: The role of a no-blame culture as a collaboration behavioural driver in project alliances. *Construction Management and Economics*, 32(3), 229–245. https://doi.org/10.1080/01446193.2014.892629

49. Muhammad, S., Alasan, I. I., & Ali, W. (2022). Stakeholders have a different perspective in the identification and ranking of Success factors: Empirical evidence from PSDP projects., *Academy of Strategic Management Journal* (Vol. 21, Issue S6).

50. Müller, R., & Turner, R. (2007). The Influence of Project Managers on Project Success Criteria and Project Success by Type of Project. *European Management Journal*, 25(4), 298–309. https://doi.org/10.1016/j.emj.2007.06.003

51. Munns, A. K., & Bjeirmi, B. F. (1996). The role of project management in achieving project success. *International Journal of Project Management*, 14(2), 81–87. https://doi.org/http://dx.doi.org/10.1016/0263-7863(95)00057-7

52. Nguyen, T. H. D., Chileshe, N., Rameezdeen, R., & Wood, A. (2019). Stakeholder influence strategies in construction projects. International *Journal of Managing Projects in Business*, 2008, IJMPB-05-2018-0093. https://doi.org/10.1108/IJMPB-05-2018-0093

53. Nicolini, D. (2002). In search of "project chemistry." *Construction Management and Economics*, 20(2), 167–177.

54. Olsson, U., Drasgow, F., & Dorans, N. J. (1982). The polyserial correlation coefficient. *Psychometrika*, 47(3), 337–347. https://doi.org/10.1007/BF02294164

55. Osei-Kyei, R., & Chan, A. P. C. (2015). Review of studies on the critical success factors for public-private partnership (PPP) projects from 1990 to 2013. *International Journal of Project Management*, 33(6), 1335–1346. https://doi.org/10.1016/j.ijproman.2015.02.008

56. Pawar, C. S., Jain, S. S., & Patil, J. R. (2015). Risk Management in Infrastructure Projects in India. *International Journal of Innovative Research in Advanced Engineering*, 4(2), 2349–2163.

57. Pinto, J. K., & Slevin, D. P. (1988). Project success: Definition and Measurement Techniques. *Project Management Journal*, 19(3), 67–73.

58. Pinto, J. K., & Prescott, J. E. (1990). Planning and Tactical Factors in the Project Implementation Process. *Journal of Management Studies*, 27(3), 305–327. https://doi.org/10.1111/j.1467-6486.1990.tb00249.x

59. Pinto, & Prescott. (1988). Variations in Critical Success Factors Over the Stages in the Project Life Cycle. *Journal of Management*, 14(1), 5–18. https://doi.org/10.1177/014920638801400102

60. Qiao, L., Wang, S. Q., Tiong, R. L. K., & Chan, T.-S. (2001). Framework for Critical Success Factors of BOT Projects in China. *The Journal of Structured Finance*, 7(1), 53–61. https://doi.org/10.3905/jsf.2001.320244

61. Raisbeck, P., Duffield, C., & Xu, M. (2010). Comparative performance of PPPs and traditional procurement in Australia. Construction Management and Economics, 28(4), 345–359. https://doi.org/10.1080/01446190903582731

62. Rajkumar, K., Anandakumar, S.., Krishnamoorthy, V. M., & Phil, M. (2013). A Study on Critical Factors Influencing The Infrastructure Development Projects Under Public Private Partnership. 3(12), 328–334.

63. Samset, K., & Volden, G. H. (2016). Front-end definition of projects: Ten paradoxes and some reflections regarding project management and project governance. *International Journal of Project Management*, 34(2). https://doi.org/10.1016/j.ijproman.2015.01.014

64. Sanvido, V. , G. F. , P. K. , G. M. , & C. M. (1992). Critical Success Factors for Construction Projects. *Journal of Construction Engineering and Management*, , 118, 94-111.

65. Sauser, B. J., Reilly, R. R., & Shenhar, A. J. (2009). Why projects fail? How contingency theory can provide new insights - A comparative analysis of NASA's Mars Climate Orbiter loss. *International Journal of Project Management*, 27(7), 665–679. https://doi.org/10.1016/j.ijproman.2009.01.004

66. Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *MPR-Online*, 8(May 2003), 23–74.

67. Shen, L. Y., Wu, G. W. C., & Ng, C. S. K. (2001). Risk Assessment for. Construction Joint ventures in China, *ASCE Journal of Construction Engineering and Management*, 127(February), 76–81.

68. Shenhar, A. J., Dvir, D., Levy, O., & Maltz, A. C. (2001). Project Success: A Multidimensional Strategic Concept. *Long Range Planning*, 34(6), 699–725. https://doi.org/10.1016/S0024-6301(01)00097-8

69. Silvius, A. J. G., Schipper, R., & Nedeski, S. (2013). Sustainability in Project Management: Reality Bites. *PM World Journal*, 2(2), 1–183. https://doi.org/10.1002/pmj

70. Silvius, A. J. G., & Schipper, R. P. J. (2015). Exploring the relationship between sustainability and project success -conceptual model and expected relationships. 00. https://doi.org/10.12821/ijispm040301

71. Songer, A. D., & Molenaar, K. R. (1997). Project Characteristics for Successful Public-Sector Design-Build. *Journal of Construction Engineering and Management*, 123(1), 34–40. https://doi.org/10.1061/(ASCE)0733-9364(1997)123:1(34)

72. Subiyakto, A., Ahlan, A. R., Kartiwi, M., & Sukmana, H. T. (2015). Measurement of information system project success based on perceptions of the internal stakeholders. *International Journal of Electrical and Computer Engineering*, 5(2), 271–279.

73. Tabish, S. Z. S., & Jha, K. N. (2011). Identification and evaluation of success factors for public construction projects. *Construction Management and Economics*, 29(8), 809–823. https://doi.org/10.1080/01446193.2011.611152

74. Tabish, S. Z. S., & Jha, K. N. (2012). Success Traits for a Construction Project. *Journal of Construction Engineering and Management*, 138(10), 1131–1138. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000538

75. Valliant, R., Dever, J. A., & Kreuter, F. (2015). Effects of Cluster Sizes on Variance Components in Two-Stage Sampling. *Journal of Official Statistics*, 31(4). https://doi.org/10.1515/jos-2015-0044

76. Wai, S. H., Yusof, A. M., & Ismail, S. (2012). Exploring success criteria from the developers' perspective in Malaysia. *International Journal of Engineering Business Management*, 4(1), 1–9. https://doi.org/10.5772/51096

77. Wai, S. H., Yusof, A. M., Ismail, S., & Ng, C. A. (2013). Exploring success factors of social infrastructure projects in Malaysia. *International Journal of Engineering Business Management*, 5(1), 1–9. https://doi.org/10.5772/55659

78. Wateridge, J. (1998). How can IS/IT projects be measured for success? *International Journal of Project Management*, 16(1), 59–63. https://doi.org/10.1016/S0263-7863(97)00022-7

79. Węgrzyn, J. (2016). The Perception of Critical Success Factors for PPP Projects in Different Stakeholder Groups. *Entrepreneurial Business*, 4(2), 81–92. https://doi.org/http://dx.doi.org/10.15678/EBER.2016.040207

80. Williams, T., Vo, H., Samset, K., & Edkins, A. (2019). The front-end of projects: a systematic literature review and structuring. *Production Planning and Control*, 30(14), 1137–1169, https://doi.org/10.1080/09537287.2019.1594429

81. Yalegama, S., Chileshe, N., & Ma, T. (2016). Critical success factors for community-driven development projects: A Sri Lankan community perspective. *International Journal of Project Management*, 34(4), 643–659. https://doi.org/10.1016/j.ijproman.2016.02.006

Others/Website

1. Chan, A. P. C. (2001). Framework for Measuring Success of Construction Projects.
2. Department of Economic Affairs, M. of F. G. of I. (2020). Report of National Infrastructure Pipeline: the Task Force.
3. Flyvbjerg, B., & Budzier, A. (2015). Why do projects fail? Project.Magazine
4. Gao, J., & Buffalo, S. (n.d.). Clustering Lecture 4: Density-based Methods. Retrieved November 7, 2022, from https://cse.buffalo.edu/~jing/cse601/fa12/materials/clustering_density.pdf
5. Haarmeyer, D., & Mody, A. (1998). Pooling water projects to move beyond project finance. Private Sector Viewpoint Note, 152. http://scholar.google.com/scholar?as_q=%22project+finance%22&num=100&btnG=Search+Scholar&as_epq=&as_oq=&as_eq=&as_occt=title&as_sauthors=&as_publication=&as_ylo=&as_yhi=&as_sdt=1&as_subj=bus&as_subj=soc&as_sdtf=&as_sdts=5&hl=en#80
6. Hadipriono, F. C., & Chang, K.-S. (1988). Knowledge base development for international construction operations. Civil Engineering Systems, 5(4), 220–227. https://doi.org/10.1080/02630258808970532

7. IBM. (n.d.). KMO and Bartlett's Test. Retrieved February 1, 2021, from https://www.ibm.com/support/knowledgecenter/SSLVMB_26.0.0/statistics_casestudies_project_ddita/spss/tutorials/fac_telco_kmo_01.html
8. Israel, G. D. (1992). Determining Sample Size. University of Florida, IFAS Extension, PE0D6(April 2009), 1–5. https://doi.org/10.4039/Ent85108-3
9. Jöreskog, K.G. & Sörbom, D. (2018). LISREL 10 for Windows [Computer software]. Skokie, IL: Scientific Software International, Inc.
10. Khavari, B., Korkovelos, A., Sahlberg, A., Howells, M., & Fuso Nerini, F. (2021). Population cluster data to assess the urban-rural split and electrification in Sub-Saharan Africa. Scientific Data, 8(1), 1–11. https://doi.org/10.1038/s41597-021-00897-9
11. Kušljić, D., & Marenjak, S. (2017). Critical PPP / PFI project success criteria for public sector clients. December 20, 2013, Tehnicki Vjesnik-technical Gazette.
12. Laroche, L., Ph, D., & Eng, P. (1998). Managing Cross-Cultural Differences in International Projects. Engineering Dimensions.
13. Locatelli, G. (2020a). The phases of the infrastructure life cycle. 2020.
14. Locatelli, G. (2020b). Types of project life cycles. https://www.coursera.org/learn/major-engineering-project-performance/supplement/h2h9P/types-of-project-life-cycles
15. Mannan Adnan, T. (2018). Stakeholder Management in Complex Projects: an Empirical Case Study. Thesis, Aug 2018, Faculty of Technology, University of Oulu.
16. Morris, A., & Wilkinson, S. J. (2016). 13 . Public Sector Management and Not-for-Profit Email : Sara.Wilkinson@uts.edu.au Faculty of Information

Technology , Monash University , VIC , Australia Email : Chivonne.algeo@monash.edu School of Communication and Creative Industries , Charles Sturt Un. December.

17. MOSPI-GoI. (2013). Infrastructure Statistics 2013: Vol. I.
18. PMI. (2018, December 8). Why do Projects fail and how can we measure the success of a Project? https://www.solusinformatics.com/why-do-projects-fail-and-how-can-we-measure-the-success-of-a-project/
19. Podgórska, M. (2017). Dependency the project success on the project complexity. Scientific Papers of Silesian University of Technology. Organization and Management Series, 2017(101), 391–399. https://doi.org/10.29119/1641-3466.2017.101.29
20. Project Management Institute. (2016). PMI Lexicon of Project Management Terms–Version 3.1.
21. Project Management Institute. (2019). Exposure Draft -The Standard for Project Management 7th Edition (7th ed.). Project Management Institute.
22. Ramana PV. (2020). Mood 's Median Non-Parametric Hypothesis Test. https://sixsigmastudyguide.com/moods-median-non-parametric-hypothesis-test/
23. Ravinder, E. B., & Saraswathi, A. B. (n.d.). Literature Review Of Cronbach alpha coefficient (A) And Mcdonald's Omega Coefficient (Ω).
24. Shenhar, A. J., & Wideman, R. M. (1996). Improving PM: Linking Success Criteria to Project Type. Creating Canadian Advantage through Project Management, 25(3).
25. Thiruvananthapuram Corporation, & Department of Town and Country Planning, Govt. of K. (2012). Thiruvananthapuram Masterplan (Draft).

26. Wu, J., & Leifer, D. (2006). Learning from Projects: A Life-Cycle Perspective. (2003), 1–15.

27. Zou, Patrick. X. W. W., Zhang, G., & Wang, J. (2012). Identifying Key Risks in Construction Projects: Life Cycle and Stakeholder Perspectives. University of New South Wales, Sydney, 9(1), 1–14. https://doi.org/10.1080/15623599.2009.10773122