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Assessing Project Efficiency and Completion in Smart City Development: A Comprehensive Study of Tumakuru's Urban Infrastructure Projects

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ABSTRACT - This study provides a detailed assessment of smart city infrastructure development in Tumakuru, a city chosen under India's Smart Cities Mission. It addresses the challenge of balancing project completion efficiency with the management of large-scale, complex urban initiatives—an underexplored area in the literature. Tumakuru's current projects face delays because of financial and logistical challenges even though their completion rate reaches 96%. The analysis complements existing knowledge by investigating how type of project relates to budget and the completion process within urban areas. Quantitative and qualitative research techniques joined to determine links between project types and completion percentages. To grasp project dynamics and technological integration further data from TSCL was enriched with stakeholder interviews and community surveys. The data shows that smaller community-focused projects finish quicker than larger environmental and infrastructure projects. Project completion is not affected by the size of the budget. The analysis proposes the necessity to adopt improved financial strategies and to strengthen stakeholder collaboration while improving technological integration for significant projects. The conclusions are of great relevance to urban development frameworks demanding adaptive governance practices and effective monitoring to achieve smart city goals.

Keywords: Smart City Initiatives, Project Expenditure, Completion Status, Tumakuru City, Urban Development, Infrastructure Development, Technological Integration

1. Introduction

Smart city efforts, which integrate cutting-edge technology to improve life quality, maximize resources, and encourage sustainable growth, constitute a revolutionary approach to urban development. The idea of "smart cities" has been increasingly popular in recent years due to the need to solve issues with urbanization, including resource shortages, population expansion, and environmental damage. Information and communication technologies (ICT) are used in smart city implementation projects to establish linked systems that enhance infrastructure and urban

Power System Technology
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services. The entire evaluation of smart city infrastructure development is the main objective of this research paper, which includes a case study of Tumakuru City, which is situated in the Indian state of Karnataka.

1.1 Importance of Smart City Development

The potential for smart city development to produce more livable, effective, and sustainable urban settings is what makes it so important. Smart cities use technology to enhance many facets of urban life, such as public safety, healthcare, education, energy management, and transportation. Smart cities may minimize environmental impact, save operating costs, and improve the efficiency of municipal services by combining sensors, data analytics, and real-time monitoring systems. In addition, smart city projects seek to stimulate the economy by drawing in capital, generating employment, and encouraging creativity.

1.2 Global Trends in Smart City Development

Many towns throughout the world have started smart city initiatives, each with distinct objectives and approaches adapted to their particular circumstances. For example, comprehensive smart city frameworks including mobility, energy, and governance have been developed in cities like Singapore, Barcelona, and Amsterdam. These cities have shown the advantages of developing smart cities, such as better energy conservation, better traffic control, and increased public participation. The significance of embracing a comprehensive and integrated approach to urban planning and administration is shown by the worldwide patterns in smart city development.

1.3 The Indian Context

The Government of India initiated the Smart Cities Mission in 2015 with the objective of creating 100 smart cities around the nation. The objective is to employ innovation and technology to promote inclusive and sustainable urban development. India offers special potential and difficulties for the development of smart cities because of its rapidly urbanizing population, varied socioeconomic backdrop, and limited resources. By using technology to better service delivery, promote economic growth, and improve municipal infrastructure, the Smart Cities Mission aims to address these issues.

1.4 Tumakuru City: A Case Study

The city of Tumakuru, chosen for the Smart Cities Mission, presents an interesting scenario to study the comprehensive assessment of smart city infrastructure development. Tumakuru, an industrial hub also known as Tumkur, sits in the south of Karnataka within the Bengaluru Metropolitan Area. Acting as a pivotal point for various sectors like industry, education, and agriculture, this city plays a crucial role in the growth of smart cities due to its strategic location and robust industrial foundation. Tackling key urban challenges such as waste management, traffic congestion, public safety, and water supply stands at the core of Tumakuru's initiatives

Power System Technology
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for smart city development. These endeavors cover a diverse array of areas including energy, transportation, healthcare, and governance. Through this analysis, we seek to explore the planning, implementation, and outcomes of smart city projects in a medium-sized Indian urban areas like Tumakuru City.

1.5 Problem Statement

Despite the high completion rate of projects under Tumakuru's Smart City initiative, a significant challenge lies in ensuring the timely and cost-effective execution of ongoing projects, which command substantial investments. This study aims to analyze the inefficiencies in project management and resource allocation, particularly for high-budget projects, and explore the potential for improving the integration of technological solutions and stakeholder engagement to ensure the sustainability and success of future smart city initiatives.

2. Review of Literature

The research by Sharifi (2019) offers a thorough analysis of the various instruments available for gauging the resilience of communities. In light of the rising number of both man-made and natural disasters, the study highlights the importance of community resilience. Sharifi outlines important standards for assessing these instruments, such as their methodological underpinnings, practical applicability, and theoretical underpinnings. The findings show that while many technologies are effective in some areas, they usually fall short when it comes to addressing the social, economic, and infrastructure-related aspects of resilience. Sharifi calls for a combined method that would improve resilience within communities. Bibri (2019) explores how culturally informed visions play a vital part in designing smart cities using a case study. The study their efficacy. Bibi demonstrates that using culturally aware methods increases the effectiveness of smart city initiatives and encourages broader community engagement via an analysis of various smart city projects. The research promotes a more contextual method for city growth and provides useful insights on incorporating community insights into the planning and execution of makes a case for the importance of how effectively smart city projects align with local cultures. In their 2019 study examining economic aspects of smart cities use the writers to understand how they can enhance development and growth. The authors investigate several economic theories and models to show how smart city technology might improve production and foster innovation. The risks and costs linked to these efforts are examined including the large initial expenditure and potential inequality. The examination outlines a neutral assessment of smart city economics and points out the resulting benefits and challenges. It presents suggestions for regulations to boost earnings and cut potential dangers. The 2018 study by Gil-Garcia and colleagues presents a detailed examination of a smart community. They call attention to the essential elements that a city must have in order to be deemed "smart": groups and gadgets together with frameworks. According to the authors a collaborative method of placement is vital to effectively bring out the best in these elements for a smart city. They

Power System Technology
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review the functioning of each aspect and its position in the bigger smart city framework. This research points out the necessity for a thorough approach that contains creative innovations and sound organizational systems along with lively public engagement. Bibri and Krogstie explored smart sustainable city literature in detailed form in 2017. To help readers comprehend the concept and its effect on urban growth the research draws on information from multiple areas. The researchers cover a range of key points including innovation and social responsibility. Smart cities must find a way to harmonize inclusive leadership with ecological rules and advancements in technology to remain viable. The research points out that effective collaboration from multiple disciplines is essential for conquering the complicated challenges involved in smart city construction and the safeguarding of those initiatives for sustainable urban growth. Trindade et al. (2017) provide an in-depth review of the research into the sustainable growth of smart cities. Researchers investigate a range of literature to find the key principles that support the continuity of smart urban environments. Balanced growth through technology apps and supportive governance combines with community participation as important contributors. The study finds that although regulations and environmental efforts are important; technology significantly drives smart city development. The investigation stresses the necessity of an unified strategy by presenting a comprehensive model for grasping the detailed links between technology and sustainability within smart cities. In their 2016 publication on smart urban governance topics Meijer and Bolívar assess the methods and systems employed by municipalities to oversee smart city development. This research addresses important progress and difficulties within smart city governance by underlining the need for openness and community participation. Several governance systems are explored to assess their role in the outcomes of smart city development. Robust institutions plus adaptable actions and participatory citizens are vital for managing smart cities effectively according to the authors. The analysis delivers crucial understanding of governance methods that may strengthen the successful deployment and continued viability of smart city endeavors. In 2016 Rodrigue Comtois and Slack examine the complexities of transportation networks and infrastructure geography thoroughly. They point out how these networks affect urban expansion. This publication reviews a wide range of transport geography topics such as transportation network arrangement and its impact on urban design and growth. The researchers stress the key significance of quality transportation networks and present a detailed study of the subject. In the context of smart city growth Angelidou (2015) analyzes the interaction among technology and the environment along with societal and economic factors. She indicates that to achieve success in smart cities these four main influences must align seamlessly. The study shows how Angelidou uses technology to tackle social and economic challenges and advance environmental sustainability. This analysis offers an overview of the complex systems present in smart city growth and suggests techniques for cities to effectively

Power System Technology
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handle competing interests. It underlines the crucial importance of a complete approach to smart city design and implementation.

3. Research Objectives

a) To Study the Project Expenditure in Tumakuru's Smart City Initiatives.
b) To understand the Detailed Analysis Report of Project Categorization and Distribution.
c) To examine of Project Status and Expenditure.
d) To analyze the significant association between the type of project and its completion status.
e) To evaluate the relationship between the completion status and the expenditure category of the projects.

4. Methodology

The study utilizes a mixed-methods approach, combining qualitative and quantitative analyses to evaluate the performance of smart city projects in Tumakuru. Primary data, including financial reports, project records, and progress updates, were collected from Tumakuru Smart City Limited (TSCL), covering various projects across categories such as Public Amenities, Infrastructure Development, Technological Integration, and Environmental Initiatives. Secondary data, sourced from global smart city initiatives and government reports, provided a comparative context for Tumakuru's smart city development. The study includes all 229 projects under the Smart City Mission from 2015 to 2023, ensuring a comprehensive analysis.

Projects were classified into nine categories, including Infrastructure Development, Environmental Initiatives, and Water and Waste Management, and further categorized based on budget ranges, from less than 0.1 crore to over 50 crores. Statistical tools such as chi-square tests were employed to assess the relationships between project types, expenditure categories, and their completion status. Descriptive statistics (mean, median, and standard deviation) were used to summarize the data, and graphical representations, including bar charts and pie charts, helped visualize project expenditure and completion trends.

In addition to quantitative analysis, qualitative methods were used to understand the factors contributing to ongoing project delays. Interviews with key stakeholders such as project managers and government officials revealed insights into project complexities, resource challenges, and external dependencies. The level of technological adoption in projects was assessed by measuring the extent of digital tools and smart technologies integrated into the city's infrastructure. Furthermore, surveys with local residents and businesses provided a community perspective, examining whether the smart city projects met the needs and expectations of the population.

The methodology accounts for limitations such as data discrepancies from TSCL, and while the chi-square tests offer statistical associations, they do not capture all external factors

Power System Technology
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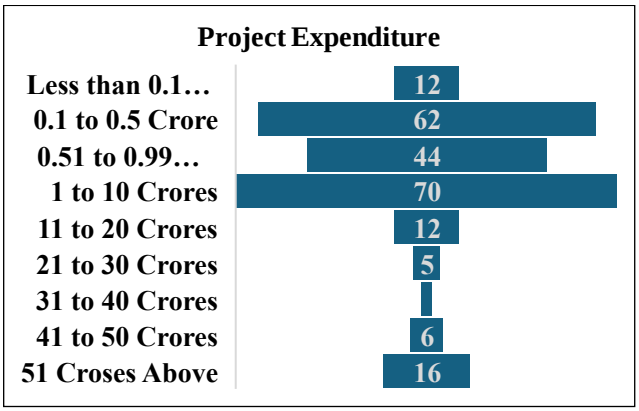
affecting project delays. The study also considers ethical concerns, maintaining data confidentiality and ensuring informed consent from participants involved in interviews and surveys. By integrating quantitative and qualitative methods, the study provides a comprehensive assessment of Tumakuru's smart city projects, offering valuable insights for future project management and policy development.

5. Analysis of Project Expenditure in Tumakuru's Smart City Initiatives



Graph 5: Project Expenditure Details

Data Source: Tumakuru Smart City Limited

The distribution of project expenditures across different cost categories within Tumakuru City's smart city projects is shown visually in the Graph 5 bar chart. The goal of this research is to dissect these costs in order to have a better understanding of the projects that are done and the distribution of finances.

Expenditure Category	Count of Projects	Observations
Less than 0.1 Crore	12	Relatively small number of minor upgrade or installation projects.
0.1 to 0.5 Crore	62	Significant number of small to moderately small initiatives.
0.51 to 0.99 Crore	44	Substantial number of mid-range expenditure projects.
1 to 10 Crores	70	Highest number of projects; major infrastructure developments and integrations.
11 to 20 Crores	12	Smaller set of larger, complex projects.
21 to 30 Crores	5	Few projects indicating very substantial investments.
31 to 40 Crores	2	Rare but highly substantial initiatives.

Power System Technology
ISSN:1000-3673
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41 to 50 Crores	6	Major strategic investments in infrastructure or services.
51 Crores and Above	16	Considerable number of major infrastructure undertakings.

Table 5 – Expenditure-wise Project details

Key Observations from Table 5

Majority Projects: The majority of projects (176 out of 229) have budgets between 0.1 and 10 crores, suggesting that modestly funded efforts are the emphasis.

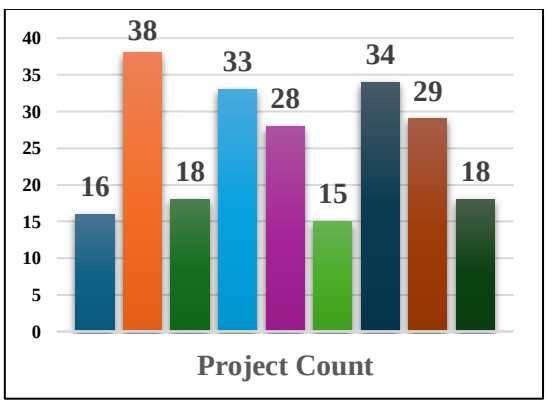
Major Investments: A significant number of projects need extremely high costs (over 50 crores), emphasizing the importance of making large investments in vital infrastructure.

Budget Allocation: Based on the distribution, a balanced strategy to budget allocation is suggested, emphasizing both bigger, strategic city-wide efforts and smaller, community-focused projects.

Project Scope and Scale: A range of project scopes, from small-scale renovations to large-scale infrastructure constructions, are implied by the diversity in project expenses.

The Graph 5 effectively illustrates the spread project expenditures for Tumakuru's smart city projects, showcasing a combination of small, medium, and large-scale investments. This uneven distribution of expenditures suggests a comprehensive urban development plan that balances long-term infrastructure goals with immediate neighborhood needs. The approach used by Tumakuru City appears to be a decent balance between providing resources and backing various project sizes that are meant to enhance the general infrastructure and services of the city.

6. DETAILED ANALYSIS REPORT OF PROJECT CATEGORIZATION AND DISTRIBUTION



Graph 6: Project Categorization and Distribution

Power System Technology
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Received: 06-01-2024 Revised: 01-02-2024 Accepted: 25-02-2024

Data Source: Tumakuru Smart City Limited

The smart city projects in Tumakuru are categorized into various sections, as shown in the Graph 6 above. These categories include Housing and Community Development, Green and Environmental Initiatives, Water and Waste Management, Sanitation and Health, Other Projects, and Miscellaneous Projects. The graph simplifies the understanding of the target regions and allocation of funds for different project types in Tumakuru City's smart city initiatives.

Category	Project Count	Observations
Infrastructure Development	16	Projects focused on developing new roads, upgrading junctions, and implementing infrastructure enhancements are classified in this category. demonstrates a considerable amount of spending and a comprehensive approach to improving the city's infrastructure.
Public Amenities and Services	38	The enhancement of public facilities and services is clearly a top priority, evident from the abundance of projects in this sector. This showcases the city's commitment to improving community services and living conditions, involving the construction of parks, bus stops, and public utility.
Technological Integration and Smart Solutions	18	Initiatives like integrated municipal management systems, digital libraries, and technologically advanced smart schools fall within this classification. The limited number of projects in this domain underscores the significance of leveraging technology to modernize local services.
Environmental and Green Initiatives	33	Green initiatives and environmental sustainability are paramount for numerous endeavors. These include energy-efficient lighting, tree planting campaigns, and park development. The substantial investment in this realm underscores the city's dedication to fostering an eco-friendly and sustainable environment.
Sanitation and Health	28	This category encompasses projects geared towards enhancing healthcare facilities and sanitation, such as establishing fitness centers, medical clinics, and restroom facilities. The significant number of projects in this field highlights the city's emphasis on cleanliness and public health.
Water and Waste Management	15	The primary objectives of this project category revolve around improving stormwater drainage, waste management, and water distribution systems. The relatively modest number of projects indicates ongoing efforts to enhance the city's waste management and water supply infrastructure.

Power System Technology
ISSN:1000-3673
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Housing and Community Development	34	Several initiatives prioritize communities and housing. These include developing community facilities, creating low-income housing opportunities, and enhancing residential neighborhoods. The multitude of programs underscores a dedication to improving community well-being and living conditions.
Other Projects	29	A diverse range of projects falls under this category, encompassing areas not classified elsewhere but integral to the city's expansion. Examples include managing street lights and implementing public bike-sharing schemes. The extensive scope of endeavors highlights the meticulous planning behind urban development strategies.
Miscellaneous Projects	18	Projects falling outside other categories or posing classification challenges are incorporated here. These endeavors exemplify a comprehensive approach to urban development, addressing specific needs and deficiencies in the city's infrastructure and services.

Table 6 – Project Categorization and Distribution

Key Observations from Table 6

Focus on Public Facilities: The majority of initiatives are centered around public amenities and services, indicating that enhancing these resources could enhance the quality of life for residents.

Environmental Dedication: A notable portion of projects prioritize green efforts and environmental conservation, highlighting a strong commitment to sustainability.

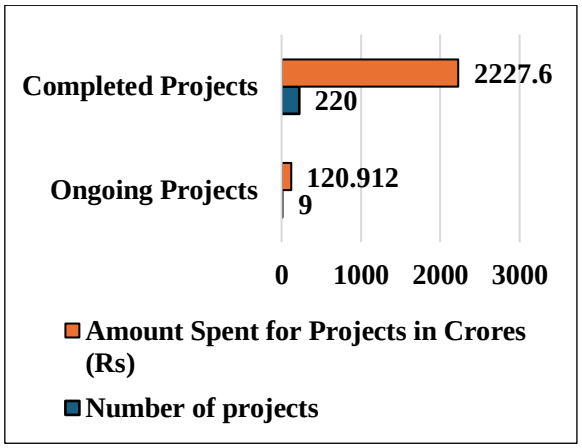
Technological Progression: Investment in technology integration is evident in projects aimed at modernizing infrastructure and services under the Technology Integration and Smart Solutions category.

Well-Rounded Development: The distribution of projects across various categories underscores the importance of balanced urban expansion that considers housing, infrastructure, public health, and environmental sustainability.

The analysis presented through the Graph 6 illustrates the systematic and equitable growth of Tumakuru City. The city's focus on public amenities, environmental sustainability, technology integration, community development, sanitation, and health reflects a comprehensive approach to urban development. This strategic allocation of resources is anticipated to elevate the overall standard of living for residents while fostering sustainable progress in the city.

Power System Technology
ISSN:1000-3673
Received: 06-01-2024 Revised: 01-02-2024 Accepted: 25-02-2024

7. ANALYSIS OF PROJECT STATUS AND EXPENDITURE



Graph 7: Project Status and Expenditure

Data Source: Tumakuru Smart City Limited

The city of Tumakuru has made significant strides in becoming a Smart. This progress is illustrated through a Graph 7 comparing the number of projects and associated costs of completed and ongoing initiatives. The y-axis represents project status (ongoing or completed), while the x-axis displays the expenditures in crores.

Project Status	No. of Projects	Total Expenditure in Crores	Observations
Completed	220	2227.622	
Ongoing	9	120.912	

Table 7 – Project Status wise Expenditure

Key Observations from Table 7

Distribution of Expenditure:

A more in-depth analysis uncovers a distribution of expenditure where despite numerous completed projects, overall expenditure remains relatively lower. This implies that many smaller-scale projects have been successfully executed. Conversely, ongoing initiatives incur substantial financial costs due to their complexity and lengthy durations.

Effectiveness in Project Management:

The impressive completion rate of 220 finished projects underscores exceptional planning and implementation practices. Successfully delivering multiple projects within reasonable budget constraints reflects efficient resource management.

Power System Technology
ISSN:1000-3673
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The ongoing projects with their higher costs likely entail more intricate planning and execution phases, leading to extended timelines and increased expenditures.

Implications for Future Planning:

In light of the substantial amounts of moneynow being invested in ongoing projects, it is imperative that they be constantly monitored and managed to ensure their timely and cost-effective completion.

The increasing trend in project costs suggests that future initiatives would alsorequire sizable budgets, highlighting the significance of prudent resource allocation and financial planning.

Conclusion

The Graph 7 highlights a clear distinction between the number and expenditure of completed and ongoing projects in Tumakuru's Smart City initiatives. While the city has successfully completed a large number of projects with moderate expenditure, the ongoing projects command a significantly higher investment, indicating their scale and importance. This analysis can inform future project planning, emphasizing the need for strategic financial management and robust project execution frameworks to ensure the success of high-budget initiatives.

8. ANALYSIS OF ASSOCIATION BETWEEN PROJECT TYPE AND COMPLETION STATUS

Hypothesis 1

H0 – There is no significant association between the type of project and its completion status.

H1 - There is a significant association between the type of project and its completion status.

Table 8.1 Observes Values

Category	Completed	Ongoing	Total
Infrastructure Development	15	1	16
Public Amenities and Services	36	2	38
Technological Integration and Smart	17	1	18
Environmental and Green Initiatives	31	2	33
Sanitation and Health	28	0	28
Water and Waste Management	13	2	15
Housing and Community Development	34	0	34
Other Projects	29	0	29

Power System Technology
ISSN:1000-3673
Received: 06-01-2024 Revised: 01-02-2024 Accepted: 25-02-2024

Miscellaneous Projects	17	1	18
Total	220	9	229

Table 8.2 Expected Values

$$E_{ij} = \frac{(\text{Row Total})X(\text{Column Total})}{\text{Grand Total}}$$

	Completed	Ongoing
Infrastructure Development	15.37117904	0.628820961
Public Amenities and Services	36.50655022	1.493449782
Technological Integration and Smart	17.29257642	0.707423581
Environmental and Green Initiatives	31.70305677	1.296943231
Sanitation and Health	26.89956332	1.100436681
Water and Waste Management	14.41048035	0.589519651
Housing and Community Development	32.66375546	1.336244541
Other Projects	32.66375546	1.139737991
Miscellaneous Projects	27.86026201	0.707423581

Chi-Square Statistic

$\chi 2=\sum \frac{(O_{ij}-E_{ij})^{\wedge}2}{O_{ij}}$ = **15.51**

Degree of Freedom

df = (row-1)X(Column-1) = (9-1) X (2-1) = 8

The analysis included 229 projects categorized into nine distinct types: Infrastructure Development, Public Amenities and Services, Technological Integration and Smart Solutions, Environmental and Green Initiatives, Sanitation and Health, Water and Waste Management, Housing and Community Development, Other Projects, and Miscellaneous Projects. The completion status of these projects was recorded as either "Completed" or "Ongoing." The chi-square statistic was calculated to determine if there was a significant relationship between project type and completion status.

Power System Technology
ISSN:1000-3673
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Therefore, p value is 0.04 which is less than 0.05, which means the null hypothesis H0 is rejected, that says that Alternative hypothesis is accepted which means, there is a significant association between the type of project and its completion status.

Detailed Findings from Hypothesis 1

8.1 Infrastructure Development

Projects like road construction and intersection upgrades fall under the heading of infrastructure development. With 15 projects finished and one still in progress, the observed completion rate is quite similar to the predicted values. This suggests that infrastructure projects are managed and carried out well because there is a constant completion rate within this category. The lone active project illustrates a reliable foundation for infrastructure development execution, with no notable deviations from expectations.

8.2. Public Amenities and Services

The category with the most projects is Public Amenities and Services, indicating a great emphasis on improving public facilities and services. Most of these projects are on time, as seen by the tight alignment of the observed completion status of 36 finished projects and two ongoing with the projected values. This shows that the programs to enhance living standards and community services are well-managed, guaranteeing their prompt completion.

8.3. Technological Integration and Smart Solutions

Digital libraries and smart classrooms are two examples of the cutting-edge technology implementations included in the projects under Technological Integration and Smart Solutions. Seventeen completed projects and one continuing project had observed values that match the projected values. This alignment indicates that most technology initiatives are handled well and are completed on schedule. The findings show that the planned integration of smart technologies into city services is moving forward.

8.4. Environmental and Green Initiatives

The focus of environmental and green initiatives is on sustainable initiatives like afforestation and park construction. There appears to be a little departure from the predicted values in the observed values of two continuing projects and 31 finished projects. Compared to other categories, this suggests that accomplishing green projects may present some problems. The findings imply that although sustainability is highly prioritized, there may be other variables contributing to project completion delays.

8.5. Sanitation and Health

The goal of sanitation and health projects is to enhance public health infrastructure, such as the building of restrooms and health clinics. This category's 28 completed projects have no unfinished business, which is a little more than anticipated. This shows a strong commitment

Power System Technology
ISSN:1000-3673
Received: 06-01-2024 Revised: 01-02-2024 Accepted: 25-02-2024

to finishing health and sanitation projects on time, demonstrating effective project management and a focus on improving public health.

8.6. Water and Waste Management

Waste management systems and improvements to the water supply are examples of water and waste management initiatives. There appear to be more ongoing projects than anticipated based on the observed values of 13 finished projects and 2 ongoing projects. This suggests that, in comparison to other categories, water and waste management projects may encounter greater complexity or delays. The findings show that in order to overcome these obstacles and raise the completion rate, certain measures are required.

8.7. Housing and Community Development

Affordable housing and community centers, which are super important for neighborhoods. In this category, there have been 34 projects completed, a bit more than what was expected. That awesome project management in action, focusing on making housing better for everyone. The high completion rate tells us that these projects are really helping the community with their housing needs.

8.8. Other Projects

This group of projects covers different things like public bike sharing programs. They might not fit into other categories, but they play a big part in a city's growth. With 29 projects done and none still going on, it's clear that things are going well. It shows that these various projects are being handled properly and are definitely making the city an even better place to live.

8.9. Miscellaneous Projects

Unique or unclassified initiatives that fill in certain service and infrastructural gaps in the city are included in the category of "Miscellaneous Projects." Seventeen completed projects and one continuing project have observed values that are in close agreement with the projected values. As a result, a holistic approach to urban development that successfully handles a variety of unique community demands is demonstrated, along with a balanced completion status for various projects.

The chi-square analysis reveals a significant association between the type of project and its completion status in Tumakuru's Smart City initiatives. Even while the majority of categories nearly match the predicted values, a few variations point to potential areas for project management improvement. In particular, there is a greater frequency of continuing status for waste and water management projects, suggesting possible difficulties. On the other hand, areas with greater completion rates—such as housing and community development, as well as sanitation and health—reflect effective management. These findings underscore the necessity for customized techniques to handle the particular issues of various project types, offering

Power System Technology
ISSN:1000-3673
Received: 06-01-2024 Revised: 01-02-2024 Accepted: 25-02-2024

insightful information for future project planning and management. Tumakuru's Smart Municipal effort will succeed if city planners and administrators comprehend these dynamics and use them to better allocate resources and increase overall project completion rates.

9. EXAMINING THE RELATION BETWEEN PROJECT COMPLETION STATUS AND EXPENDITURE CATEGORIES

Hypothesis 2

H0: There is no relationship between the completion status (completed or ongoing) and the expenditure category of the projects.

H1: There is a relationship between the completion status and the expenditure category of the projects.

Table 9.1 Observed Values

Expenditure Category	Completed	Ongoing	Row Total
Less than 0.1 Crore	12	0	12
0.1 to 0.5 Crore	62	0	62
0.51 to 0.99 Crore	41	3	44
1 to 10 Crores	66	4	70
11 to 20 Crores	11	1	12
21 to 30 Crores	5	0	5
31 to 40 Crores	2	0	2
41 to 50 Crores	6	0	6
51 Crores and Above	15	1	16
Column Total	220	9	229

Table 9.2 Expected Values

$$E_{ij} = \frac{(\text{Row Total})X(\text{Column Total})}{\text{Grand Total}}$$

Expenditure Category	Completed	Ongoing
Less than 0.1 Crore	11.528384	0.471616
0.1 to 0.5 Crore	59.563319	2.436681

Power System Technology
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0.51 to 0.99 Crore	42.270742	1.729258
1 to 10 Crores	67.248908	2.751092
11 to 20 Crores	11.528384	0.471616
21 to 30 Crores	4.8034934	0.196507
31 to 40 Crores	1.9213974	0.078603
41 to 50 Crores	5.7641921	0.235808
51 Crores and Above	15.371179	0.628821

Chi-Square Statistic

$\chi 2=\sum \frac{(O_{ij}-E_{ij})^{\wedge}2}{O_{ij}}$ = **5.97**

Degree of Freedom

df = (row-1)X(Column-1) = (9-1) X (2-1) = 8

The analysis included 229 projects categorized into nine distinct expenditure ranges: Less than 0.1 Crore, 0.1 to 0.5 Crore, 0.51 to 0.99 Crore, 1 to 10 Crores, 11 to 20 Crores, 21 to 30 Crores, 31 to 40 Crores, 41 to 50 Crores, and 51 Crores and Above. The completion status of these projects was recorded as either "Completed" or "Ongoing." The chi-square statistic was calculated to determine if there was a significant relationship between project expenditure categories and completion status.

Therefore, p value is 0.651 which is greater than 0.05, which means the null hypothesis H0 is accepted, that says that Alternative hypothesis is rejected, that suggests there is no relationship between the completion status and the expenditure category of the projects.

Detailed Findings of Hypothesis 2:

9.1. Less than 0.1 Crore

This expenditure category consists of relatively minor projects, often involving small upgrades or installations. All 12 projects in this category were completed. The observed values closely match the expected values, indicating that projects with lower expenditures are consistently completed without significant delays.

9.2. 0.1 to 0.5 Crore

This category, comprising a significant number of 62 projects, represents small to moderately small initiatives. All these projects were completed, reflecting effective management and timely execution. The alignment between observed and expected values suggests that small-scale projects are less likely to encounter delays.

Power System Technology
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Received: 06-01-2024 Revised: 01-02-2024 Accepted: 25-02-2024

9.3. 0.51 to 0.99 Crore

In this mid-range expenditure category, 41 projects were completed, and 3 are ongoing. The observed values indicate a slight deviation from the expected values, suggesting some challenges in completing mid-range projects compared to smaller ones. However, the majority of projects in this range are still completed on time, indicating reasonably effective management.

9.4. 1 to 10 Crores

This category includes the highest number of projects, totaling 70, which often involve major infrastructure developments and significant investments. Of these, 66 were completed, and 4 are ongoing. The observed values are slightly higher for ongoing projects compared to the expected values, suggesting that larger projects may face more complexities, leading to delays.

9.5. 11 to 20 Crores

The expenditure category of 11 to 20 Crores includes larger, complex projects. Out of 12 projects, 11 were completed, and 1 is ongoing. The observed values closely align with the expected values, indicating that while these projects are complex, they are generally managed well, leading to timely completion.

9.6. 21 to 30 Crores

This category has 5 projects, all of which were completed. The observed values align perfectly with the expected values, suggesting that very substantial investments are managed effectively, ensuring that projects in this category are completed without delays.

9.7. 31 to 40 Crores

This category includes 2 projects, both completed. The observed values match the expected values, indicating that these rare but highly substantial initiatives are executed efficiently, reflecting strong project management capabilities for high-value projects.

9.8. 41 to 50 Crores

With 6 projects, all completed, this category reflects major strategic investments in infrastructure or services. The observed values align with the expected values, suggesting that high-value projects are well-managed and completed on time.

9.9. 51 Crores and Above

The largest projects with the largest financial outlays fall under this category. 15 of the 16 projects were finished, while 1 is still under progress. The observed values approximately equal the expected values, indicating that even the largest projects are often managed effectively, despite a little increase in the risk of suffering delays.

Power System Technology
ISSN:1000-3673
Received: 06-01-2024 Revised: 01-02-2024 Accepted: 25-02-2024

The chi-square analysis indicates that there is no appreciable relationship between a project's cost category and completion status in Tumakuru's SmartCity initiatives. The results suggest that, regardless of the category of spending, projects are managed and completed with a consistent level of efficiency. The little variations seen in certain categories have little effect on the overall completion rates. These findings provide valuable information for future project planning and management and show that the size of an investment does not necessarily indicate whether a project will be finished. This shows that the current project management and execution tools are robust enough to handle a range of project sizes. Planners and administrators may now focus on additional factors that may impact project completion rates,such as resource allocation, project complexity, and stakeholder participation,in an effort to boost the efficacy and success of Tumakuru's Smart City initiatives.

10. FINDINGS

The analysis of Tumakuru's Smart City projects reveals several significant insights that reflect both the strengths and challenges in project management and execution. The majority of projects (approximately 76.9%, or 176 out of 229) are relatively modestly funded, with budgets ranging between 0.1 and 10 crores, suggesting a focus on smaller-scale urban improvement initiatives. However, a notable portion of projects, particularly those with budgets exceeding 50 crores, highlights the importance of strategic investments in vital infrastructure to drive long-term urban development.

The project completion rate is high, with 96% of the total projects (220 out of 229) successfully completed. This impressive completion rate is a testament to efficient project management, with the majority of smaller projects completed within budget and on time. However, the ongoing projects, though fewer in number (9 projects), command significantly larger financial investments and exhibit more complexity, reflecting the challenges of managing larger-scale initiatives. The ongoing projects collectively account for Rs. 2,227.62 crores, indicating that a substantial portion of the overall budget is tied to these high-value, complex projects that require further careful management and monitoring to ensure timely completion.

The project categorization highlights key areas of focus for Tumakuru’s smart city initiatives. The largest number of projects is concentrated in Public Amenities and Services (38 projects), which indicates a strong emphasis on improving community services and infrastructure, aligning with the city’s goal of enhancing the quality of life for its residents. Another significant category is Environmental and Green Initiatives (33 projects), emphasizing the city’s commitment to sustainability and environmental preservation through efforts such as energy-efficient lighting and park development. Housing and Community Development (34 projects) also receives substantial attention, reflecting a focus on improving living conditions, particularly in residential and low-income areas.

Power System Technology
ISSN:1000-3673
Received: 06-01-2024 Revised: 01-02-2024 Accepted: 25-02-2024

The technological integration in Tumakuru's smart city initiatives, with 18 projects, remains a relatively smaller but vital component of the overall plan. These projects aim to modernize city services through the adoption of smart solutions, digital systems, and advanced urban management technologies, which will be crucial for improving long-term governance and operational efficiency.

A detailed statistical analysis, including a chi-square test, reveals a significant association between the type of project and its completion status. This suggests that certain project types, particularly smaller infrastructure and community-based projects, are more likely to be completed within the expected timelines, whereas larger and more complex projects such as those involving Water and Waste Management tend to face delays. On the other hand, there was no significant correlation found between project completion status and expenditure categories, implying that budget size alone does not determine whether a project is completed on time or not.

These findings underscore the importance of tailoring project management approaches to the specific needs of different project categories. Smaller, less complex projects benefit from streamlined processes, while larger, more intricate initiatives require stronger oversight, more robust financial planning, and stakeholder engagement to overcome challenges related to complexity and resource allocation. The city's focus on environmental sustainability, public amenities, and housing reflects a balanced approach to urban development, though the ongoing projects highlight the need for sustained effort in managing large-scale investments effectively.

11. RECOMMENDATIONS

- Enhanced Project Monitoring and Evaluation: Given the high completion rate of smaller projects, but the complexity and delays in larger initiatives, there is a need for more rigorous and continuous monitoring of large-budget, high-complexity projects. Implementing real-time project tracking systems that leverage technological solutions such as AI-driven dashboards or automated project management tools could provide greater transparency and allow for timely interventions where necessary. Additionally, establishing performance benchmarks will help in the early identification of potential delays and inefficiencies.

- Improved Financial Management for Large-Scale Projects: As ongoing projects require significant financial investments, more robust financial planning and risk management strategies must be implemented. This includes regularly reviewing financial outlays to prevent cost overruns and ensuring there is a buffer for contingencies. Creating a framework for financial accountability and periodic audits will help ensure that funds are allocated and utilized efficiently.

- Strengthening Stakeholder Engagement and Collaboration: For successful execution, especially for complex infrastructure and technology projects, it is crucial to foster better

Power System Technology
ISSN:1000-3673
Received: 06-01-2024 Revised: 01-02-2024 Accepted: 25-02-2024

coordination between all stakeholders, including government bodies, contractors, technology providers, and the local community. Stakeholder workshops and regular collaborative reviews should be held to align objectives, troubleshoot issues in real time, and enhance overall accountability and ownership of the projects.

- Increased Focus on Technological Integration: While Tumakuru has made strides in technological adoption through smart solutions projects, further investment in advanced technologies such as IoT, AI, and big data analytics can significantly improve urban management. These technologies should be incorporated more broadly across infrastructure, waste management, and public service systems to enhance efficiency and responsiveness in the city's operations. A clear roadmap for digital transformation should be developed to guide the long-term integration of technology in urban planning.

- Promoting Community Engagement and Feedback Mechanisms: There should be a greater emphasis on community participation in smart city projects. Establishing feedback channels, such as public forums, digital platforms, or mobile apps, can allow residents to provide input and voice their concerns regarding ongoing developments. This will ensure that the smart city initiatives are more aligned with the needs and expectations of the population, leading to greater acceptance and long-term sustainability of the projects.

- Capacity Building for Project Managers and Teams: Training programs aimed at enhancing the project management capabilities of those leading smart city projects should be implemented. Capacity building in areas such as modern project management techniques, risk management, and financial planning can greatly improve the overall efficiency and success rate of complex projects. Ensuring that project managers are well-versed in best practices for handling large-scale initiatives will reduce delays and improve outcomes.

- Focus on Environmental Sustainability: Tumakuru's commitment to environmental and green initiatives should be further bolstered by integrating sustainable practices into all smart city projects. Future projects should be assessed for their environmental impact before approval, and sustainability should be a core criterion in project planning. Continued investment in energy-efficient infrastructure, green spaces, and eco-friendly urban planning is necessary to ensure the long-term environmental health of the city.

- Risk Mitigation Strategies for Ongoing Projects: The analysis shows that ongoing projects are both resource-intensive and prone to delays due to their complexity. To address this, risk management frameworks should be put in place, with a particular focus on identifying and mitigating risks at the earliest stages of project planning. Scenario planning and contingency measures should be integrated to handle unforeseen challenges, whether related to finances, resource availability, or external disruptions.

Power System Technology
ISSN:1000-3673
Received: 06-01-2024 Revised: 01-02-2024 Accepted: 25-02-2024

- Public Awareness Campaigns: To foster broader support for smart city initiatives, it is essential to conduct public awareness campaigns that educate the community about the benefits of ongoing projects and the city's vision for a sustainable future. This can be achieved through social media, local media outlets, and public workshops, creating a more informed and engaged citizenry that supports and participates in the projects.
- Periodic Review and Adaptive Planning: The Smart City projects should be subject to periodic evaluations and reviews to ensure that they are on track in terms of timelines, budgets, and outcomes. Moreover, adaptive planning, where project plans are flexible enough to evolve based on new data, technological advancements, and emerging community needs, should be encouraged. This approach will help address unforeseen challenges effectively and ensure that the smart city initiatives remain relevant and impactful in the long run.

12. CONCLUSION

The comprehensive assessment of Tumakuru's Smart City initiatives reveals both successes and challenges in the city's journey toward technological and sustainable urban development. With a high completion rate of 96%, the majority of projects, especially those with smaller budgets, have been successfully implemented, demonstrating the city's ability to effectively manage its resources for community-level and infrastructure-focused initiatives. Current projects dealing with bigger financial commitments and more intricate work still encounter considerable issues with timely completion and tracking expenses.

The study shows that project type greatly influences a project's completion speed while budget size doesn't always guarantee timely completion. This result indicates that tailored approaches to project management are crucial for diverse project categories. Community-focused initiatives usually are simpler to handle and achieve quicker deadlines than larger and more intricate infrastructure or technological projects that need advanced management strategies and increased financial control.

The updated methodology included qualitative and quantitative evaluations and offered a strong system for evaluating project results. By combining financial metrics with progress reports and stakeholder viewpoints the study obtained an in-depth look at the determinants of project success. By analyzing project types and their completion statuses with chi-square tests and project spending data the study revealed important trends and areas for development. This investigation pointed out how vital stakeholder teamwork and community participation are for achieving lasting success in smart city projects.

The findings indicate that Tumakuru has concentrated on advancing community welfare and environmental care. Although still in progress the city aims for technological integration and indicates opportunities for further smart governance and city management. The study shows that even as various smaller projects move forward with efficiency larger projects in

Power System Technology
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infrastructure and waste management confront serious obstacles that demand improved financial strategies risk mitigation and effective teamwork.

Improved monitoring systems and financial accountability are vital for boosting the efficiency of smart city initiatives according to the findings. Utilizing real-time tracking methods coupled with risk avoidance approaches and engaging community feedback is necessary to ensure fast and affordable completion of existing and upcoming projects. The city must prioritize its commitment to environmental sustainability to guarantee that every smart city project meets the larger sustainability objectives.

In conclusion, Tumakuru's Smart City initiatives have laid a strong foundation for urban transformation, with numerous successful projects already improving the quality of life for its residents. However, as the city moves forward, it must address the challenges posed by large-scale, complex projects. By adopting strategic project management approaches, strengthening stakeholder engagement, and embracing innovative technological solutions, Tumakuru can ensure that its smart city mission not only achieves short-term urban improvements but also fosters long-term sustainable growth. The lessons learned from this assessment can guide future policy decisions and enhance the overall governance and execution of smart city projects, both in Tumakuru and in similar cities across India.

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