- ## Executive Summary

This project, titled "A Study on the Use of Excel-Based Analytics for Aerospace Project Cost Management Tool," examines how Microsoft Excel can serve as a cost-effective, flexible, and practical solution for managing expenses in aerospace and defense projects. The aerospace sector is one of the most capital-intensive industries globally, with projects that often span several years, involve complex supply chains, and are highly susceptible to risks such as cost overruns, supplier dependencies, and schedule delays. These challenges highlight the necessity of robust cost management practices to ensure financial discipline, timely delivery, and overall project success.

The study emphasizes the significance of data-driven decision-making by analyzing project cost data across different departments, phases, and vendors. By utilizing Excel's analytical features—including PivotTables, Forecast Sheets, Regression Models, What-If Analysis, and interactive dashboards—the project illustrates how raw financial data can be converted into actionable insights. HCL Technologies, a global IT leader with extensive expertise in aerospace and engineering services, provides the organizational context for applying this framework.

Scope of the Study

The research investigates key aspects of aerospace cost management:

- **Department-wise Costs**: Identifying Production and Quality departments as the largest cost drivers, together contributing more than 45% of total project expenditure.
- **Phase-wise Costs**: Revealing Testing and Deployment as the highest-risk phases with frequent cost overruns, while Concept and Design remained comparatively well-managed.
- **Vendor Analysis**: Highlighting heavy reliance on a small pool of vendors (55–60% of spend concentrated among 4–5 suppliers), creating supply chain risks.

- **Forecasting Accuracy**: Demonstrating that Excel-based forecasting tools improved prediction accuracy by 8–10% compared to manual estimation methods, though uncertainty widened over long timelines.
- **Data Management Challenges**: Finding that inconsistent spreadsheet formats and manual entry slowed reporting efficiency, underscoring the need for standardized templates and automation.
- **Decision Support**: Showing that Excel-based dashboards consolidated key performance indicators (KPIs) such as Planned vs. Actual Costs, Forecast Accuracy, and Departmental Variance, providing real-time visibility for managers.

• Introduction

Aerospace and defense is one of the world's most intricate and capital-intensive industries. As demand for advanced aircraft grows, regulatory stringent requirements become more demanding, and the need to keep costs under control for lengthy project cycles, aerospace businesses are confronted with several challenges. Among some of the largest challenges are: cost overruns, project execution delays, dependency on suppliers, and keeping quality and safety intact while keeping a tight lid on budgets.

In order to overcome these challenges, organizations are shifting more and more towards data-driven decision-making. Data analytics helps aerospace companies analyze historical cost trends, detect overspending areas, and prepare more effective financial plans for upcoming projects. For instance, by analyzing planned vs. actual cost data, managers can forecast where overruns are most likely to happen. By observing vendor-wise expenses, procurement departments can negotiate optimum supplier contracts. By monitoring departmental cost distribution, companies can confirm that resources are utilized optimally.

This project, "A Study on the Use of Excel-Based Analytics for Aerospace Project Cost Management Tool", aims to identify ways that Microsoft Excel can be utilized to efficiently handle these issues. Excel is inexpensive, widely accessible, and easy to use in contrast to expensive ERP or analytics software. It is a powerful tool with features like Pivot Tables, Forecast Sheets, Conditional Formatting, What-If Analysis, and statistical functions that can turn raw data on project costs into useful information.

The project seeks to examine aerospace project datasets to learn about trends in planned versus actual costs, departmental cost structures, vendor spending, and forecasting patterns. Through the development of dashboards and reports in Excel, the research offers aerospace project managers useful tools to enhance decision-making, optimize cost efficiency, and enhance general project governance.

• Industry Profile

The aerospace and defense sector is among the most strategically significant and high-investment sectors of the world, fuelled by increasing demand for next-generation aircraft, space exploration, and defense upgrades. On the other hand, it is also confronted with major risks like project cost overruns, supply chain issues, stringent regulatory compliance, and high research and development (R&D) expenses. These risks underscore the need for effective cost management and analytics in maintaining timely project delivery and profitability.

Aerospace cost analytics helps companies monitor planned vs. actuals, watch vendor spend, predict budget needs, and resource-plan optimize. Although world-class aerospace firms are increasingly turning to sophisticated tools like SAP, Oracle ERP, Power BI, and AI-based predictive models, Microsoft Excel remains one of the most popular tools because of its simplicity, flexibility, and ease of use on project teams.

Indian aerospace and defense is growing robustly, with initiatives such as "Make in India" of the government, defense modernization plans, and increasing private investment. The market, placed close to $70 billion, will grow to $100 billion by 2030, driven by indigenous manufacturing, space exploration with ISRO, and partnership with international aerospace leaders.

In this setting, Excel-based cost management and analytics are central to helping span the distance between advanced ERP systems and daily project activities. With actionable insights at low cost, Excel helps aerospace firms and their allies bolster financial discipline, improve decision-making, and attain competitiveness in a very challenging industry.

- **Company Profile – HCL Technologies**

Particulars	Details
Company Name	HCL Technologies Limited
Founded	1976
Headquarters	Noida, Uttar Pradesh, India
Global Presence	Operations in 50+ countries with delivery centers worldwide
Industry	Information Technology (IT) Services and Consulting
Key Business Areas	IT & Business Services, Engineering & R&D Services, Products & Platforms
Healthcare Focus	Healthcare IT solutions, electronic health records (EHR), telemedicine, data analytics, and digital health transformation
Employees	Over 225,000 (as of 2025)
Revenue	Approx. USD 13+ Billion (FY 2024–25)
Vision	“To be the technology partner of choice for global enterprises”
Mission	Empower businesses with innovative technology solutions to achieve growth and efficiency
Website	https://www.hcltech.com/

Table No. 1 Company Profile – HCL Technologies

Figure No.1 : HCL Tech

Introduction

HCL Technologies Ltd. (HCLTech) is a top Indian global technology company, providing IT services, digital transformation, and business process solutions to businesses globally. Established in 1976 and having its head office in Noida, Uttar Pradesh, HCLTech has grown to become a multinational group with operations in over 50 countries and more than 225,000 people.

The firm is listed on the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE) and is considered one of India's leading IT companies next to TCS, Infosys, and Wipro. Its customers are spread across various sectors such as healthcare, banking and financial services, manufacturing, retail, aerospace, and telecommunications. HCLTech is known worldwide for its innovative solutions, operational excellence, and capabilities in delivering end-to-end IT solutions.

History and Evolution

HCL Technologies started off in 1976 as one of India's first IT start-ups, working primarily on computer hardware. In the 1990s, the firm moved into software services and IT consulting to enter the world of global outsourcing.

Throughout the decades, HCLTech expanded its portfolio to comprise application development, cloud solutions, infrastructure management services, cybersecurity, and advanced analytics. The company has, of late, invested considerable funds in new technologies including artificial intelligence (AI), Internet of Things (IoT), and digital platforms.

Such capability to shift according to changing technology environments has positioned HCLTech as one of the leading global IT service companies.

Vision and Mission

- Vision: To be the most trusted technology partner of choice for global enterprises.

- Mission: To empower businesses by delivering innovative and sustainable technology solutions that drive growth, efficiency, and transformation.

HCLTech's customer-centric approach, focus on sustainable innovation, and emphasis on employee empowerment have contributed to its continued success and strong client relationships worldwide.

Core Services

HCLTech provides a wide range of services across its three major business segments: IT & Business Services, Engineering & R&D Services, and Products & Platforms. Key offerings include:

- Application Development & Maintenance – Building and modernizing enterprise applications.
- Cloud Computing – Delivering hybrid and multi-cloud solutions.
- Cybersecurity – End-to-end security solutions protecting businesses from threats.
- Digital Workplace Solutions – Enhancing collaboration and employee productivity.
- Business Analytics & AI – Using data for predictive insights and intelligent automation.
- Infrastructure Management – Managing IT assets, data centers, and networks to ensure continuity.

These services help clients improve efficiency, reduce costs, and stay competitive in an increasingly digital world.

Global Presence

HCLTech has operations in over 50 countries with offices, delivery centers, and innovation centers strategically spread across North America, Europe, Asia-Pacific, and the Middle East. It has 50+ Fortune 500 customers and has established robust partnerships with tier-one technology providers like Microsoft, Google, SAP, and Amazon Web Services (AWS).

Work Culture

One of the key strengths of HCLTech is its "Employee First" approach, focusing on empowerment, diversity, and innovation. The organization believes that empowered employees lead to customer success and, therefore, it nurtures a culture of teamwork, lifelong learning, and responsiveness. This has enabled HCLTech to become one of the most employee-centric organizations in the global IT industry.

Financial Performance

HCLTech has shown steady financial growth, with revenues exceeding USD 13 billion in FY 2024. Its strong performance comes from smart investments in research and development, digital transformation projects, and acquisitions of related businesses. This financial strength allows the company to enter new markets while keeping its lead in the IT services industry.

Organizational structure

Figure No. 2: Organizational structure

SWOT Analysis

Figure No. 3: SWOT Analysis

Strengths

1. Global presence in over 60 countries with Fortune 500 client base
2. Strong brand recognition as one of India's top IT companies
3. Skilled and diverse workforce with innovation-driven culture
4. Wide service portfolio – IT, engineering, cloud, cybersecurity, digital solutions

Weaknesses

1. High dependency on North America & Europe markets for revenue
2. Intense competition from TCS, Infosys, Wipro, Accenture, etc.
3. Lower visibility in emerging markets compared to global rivals
4. Limited product ownership – more service-focused than product-driven

Opportunities

1. Growing demand for digital transformation, AI, cloud, and analytics
2. Expansion into emerging markets (Asia-Pacific, Africa, Middle East)

3. Strategic partnerships with tech giants (Microsoft, Google, AWS, SAP)
4. Increasing adoption of Industry 4.0, IoT, and cybersecurity services

Threats

1. Rapid technology disruption requiring continuous innovation
2. Data security, privacy, and regulatory compliance risks (GDPR, HIPAA)
3. Currency fluctuations and global economic instability
4. Rising attrition rates and talent war in IT services industry

Figure No. 4: SWOT Analysis

• Product / Service Profile – HCL Technologies

HCL Technologies offers a wide range of IT services, platforms, and solutions for enterprises worldwide. Its services are designed to facilitate digital transformation, promote cloud adoption, enhance automation, and provide industry-specific IT solutions.

Major Service Areas

1. **Digital Transformation & Cloud Services**
    - Hybrid and multi-cloud solutions
    - CloudSMART framework for adoption & governance
    - Partnerships with Microsoft, AWS, and Google Cloud
2. **AI, Data Analytics & Automation**
    - Predictive analytics and machine learning models
    - Robotic Process Automation (RPA) for efficiency
    - Real-time dashboards and visualization tools
3. **Cybersecurity Services**
    - Threat detection & response
    - Data protection and regulatory compliance
    - Identity and access management solutions
4. **Healthcare IT Solutions**
    - Electronic Health Records (EHR) systems
    - Telemedicine platforms
    - Data analytics for patient care & resource allocation
5. **Application Development & Modernization**
    - Agile-based enterprise application development

- Legacy modernization services
- 24/7 application maintenance and support

6. **Infrastructure Management Services**

- Data center & cloud infrastructure support
- Network and server management
- Disaster recovery & business continuity

7. **Flagship Products & Platforms**

Just like the Angel Broking e-trading tools in your reference, HCL has its own flagship digital platforms**,** which include:

DRYiCE™ – AI & Automation Platform

- Proprietary suite for enterprise automation and orchestration
- Improves IT operations efficiency with AI-driven insights
- Automates workflows, monitoring, and reporting
- Enables predictive analysis for cost and resource management

Cloud SMART – Cloud Transformation Framework

- End-to-end services for cloud migration and optimization
- Hybrid & multi-cloud governance model
- Increases agility while reducing cloud costs
- Strategic partnerships with major hyperscalers (AWS, Azure, GCP)

HCL Software – Enterprise Software Products

- Portfolio of software for DevOps, cybersecurity, data management, and customer experience
- Subscription-based model for global enterprises
- Supports industries like banking, healthcare, retail, and manufacturing
- Integrated with AI and automation for smarter performance

• Objectives

- **To study existing practices** of project cost management within aerospace and defense projects.
- **To design a framework** for an Excel-based Aerospace Project Cost Management Tool.
- **To analyse project cost variance** by comparing planned vs. actual costs across different departments and phases.
- **To assess forecasting accuracy** using Excel-based analytical tools such as forecast Sheets and What-If Analysis.
- **To evaluate vendor- and department-wise expenditures** and identify areas of overspending.
- **To create dashboards and reports** that provide real-time insights for project managers.
- **To contribute towards improving cost efficiency** and decision-making in aerospace project execution at HCL.

• Research Methodology

The research methodology outlines the organized approach used in this project. The main goal was to create and test a tool for managing costs in aerospace projects. This effort required combining both descriptive and analytical methods to ensure thorough analysis and effective design.

Research Design

- The study is descriptive, as it explains the current practices in aerospace cost management.
- It is also analytical, as it uses datasets to analyze cost patterns, variances, and forecasts.

Data Sources

- The dataset used for this project was created with the help of ChatGPT and Kaggle datasets to simulate realistic aerospace cost data.
- Secondary references were taken from HCL project documents, SAP/ERP guidelines, and aerospace cost management literature.

Tools Used

- Microsoft Excel – for data cleaning, variance analysis, forecasting, and dashboard creation.
- Excel Solver – for optimization in cost allocation.

Steps Followed

1. Data Cleaning –

Removal of duplicate and null values to ensure dataset accuracy.

2. Department-wise and Phase-wise Analysis –

Costs were broken down by department (Production, Quality, Logistics, etc.) and project phases (Design, Testing, and Production).

3. Vendor Spend Evaluation –

Analysis of vendor-wise costs to identify supplier concentration and potential overspending.

4. Forecasting –

Use of regression models and correlation analysis in Excel to predict future project costs.

5. Dashboard Creation –

Development of dashboards in Excel and Power BI for real-time decision support.

• Theoretical Background

This chapter explains the theory behind the Aerospace Project Cost Management Tool. Aerospace projects usually have long timelines, large financial investments, and significant risks. Therefore, using project cost management theories and methods is crucial for keeping financial control, improving forecasting accuracy, and ensuring project success.

Earned Value Management (EVM)

Earned Value Management is one of the most widely recognized methodologies for measuring project performance and progress. It integrates **scope, cost, and schedule** into a single framework, helping managers assess whether the project is on track.

Key Metrics in EVM:

- **Planned Value (PV):** The authorized budget assigned to the scheduled work.
- **Earned Value (EV):** The value of work actually performed.
- **Actual Cost (AC):** The cost incurred for the work performed.

From these three values, important performance indicators are derived:

- **Cost Variance (CV) = EV – AC**
    - ➢ Positive CV → under budget
    - ➢ Negative CV → over budget
- **Schedule Variance (SV) = EV – PV**
    - ➢ Positive SV → ahead of schedule
    - ➢ Negative SV → behind schedule
- **Cost Performance Index (CPI) = EV ÷ AC**
    - ➢ CPI > 1 → efficient cost performance
    - ➢ CPI < 1 → cost inefficiency

- **Schedule Performance Index (SPI) = EV ÷ PV**
    - SPI > 1 → schedule ahead
    - SPI < 1 → schedule delays

Example (Aerospace Context):

If the planned cost of producing an aircraft wing is ₹10 million (PV), but the actual cost is ₹12 million (AC), and the work completed is valued at ₹9 million (EV):

- CV = 9 – 12 = -3 million (Over budget)
- CPI = 9 ÷ 12 = 0.75 (Inefficient cost performance)

This shows that the project is overspending compared to the planned budget.

Cost Estimation Methods

Accurate cost estimation is the foundation of aerospace project planning. The industry commonly uses three major methods:

1. **Bottom-Up Estimation**
    - Breaks the project into smaller tasks and estimates cost for each.
    - Highly accurate but time-consuming.
    - Example: Estimating costs for design, testing, certification, and production separately.
2. **Parametric Estimation**
    - Uses mathematical models and historical data to predict costs.
    - Example: Cost per flight hour, cost per kilogram of payload in space missions.
3. **Analogous Estimation**
    - Based on the cost of previous similar projects.

- Faster but less accurate.
- Example: Using the cost of a previous aircraft development project to estimate the cost of a new one.

In aerospace, parametric and bottom-up methods are often combined to balance accuracy and efficiency.

Variance Analysis

Variance analysis compares Planned Costs (Budgeted) with Actual Costs (Incurred). It helps in identifying areas where expenses exceeded or fell below the expected level.

- Favorable Variance: Actual < Planned → Cost savings achieved.
- Unfavorable Variance: Actual > Planned → Overspending.

Tolerance Thresholds:
Organizations usually define acceptable variance levels (e.g., ±5%). If costs deviate beyond this range, corrective measures are taken.

Example:
If the planned cost for procurement is ₹5 million but the actual is ₹6 million, variance = +₹1 million (Unfavorable). This may trigger negotiations with suppliers or reallocation of budgets.

Forecasting Techniques

Forecasting enables prediction of future project costs based on past data trends. In this project, Excel-based models such as regression analysis and correlation were applied.

- **Regression Models:** Predict future costs using historical cost data.
  - Example: Forecasting testing costs based on previous project data.
- **Correlation Analysis:** Determines the relationship between cost drivers.
  - Example: Strong correlation may exist between procurement costs and production costs.
- **ANOVA** (Analysis of Variance):

- Used to check if cost differences across departments (Production, Logistics, Quality) are statistically significant.
- Example: ANOVA can show whether higher costs in Production are significantly different from other departments.

Project Cost Lifecycle

Every aerospace project undergoes distinct stages, each with unique cost considerations:

1. **Initiation:**
   - Rough cost estimates and feasibility analysis.
   - Example: Estimating the budget for a new fighter jet project.
2. **Planning:**
   - Detailed budgeting, resource allocation, and setting baselines.
   - Example: Defining costs for R&D, prototyping, and supplier contracts.
3. **Execution:**
   - Actual costs are tracked against planned budgets. Variance analysis is applied.
   - Example: Tracking overspending during production due to supplier delays.
4. **Closure:**
   - Final cost reporting, documentation of variances, and lessons learned.
   - Example: Recording why testing exceeded budget and how to avoid it in future projects.

- ## Data 1 Description

The dataset used for analysis contains **3,460 records** representing project-level cost details in the aerospace sector. It is structured across multiple attributes that allow for detailed **cost tracking, variance analysis, and forecasting**.

Columns Overview

1. **Project ID** *(Categorical, String)*
   - Unique identifier for each project.
   - **3,438 unique IDs** (very few repeats).
   - Used to track project-specific costs and variances.
2. **Department** *(Categorical, String)*
   - Refers to organizational departments such as **Production, R&D, Procurement, and Quality**.
   - **4 unique departments**.
   - Enables department-wise cost breakdown and performance analysis.
3. **Phase** *(Categorical, String)*
   - Indicates the project stage such as **Design, Testing, Deployment, Maintenance**.
   - **4 unique phases**.
   - Useful for phase-wise budget monitoring and forecasting accuracy.
4. **Category** *(Categorical, String)*
   - Cost classification such as **Capital, Operational, Contingency**.
   - **3 unique categories**.
   - Helps in identifying major cost drivers at the category level.
5. **Date** *(Datetime)*
   - Represents the time period of the recorded cost.
   - **723 distinct dates**.
   - Range: **June 2023 → June 2025**.
   - Enables time-series forecasting and trend analysis.
6. **Planned Cost** *(Numerical, Float)*
   - Budgeted cost estimate before project execution.

- No missing values.
- Serves as a baseline for variance and forecasting models.

7. **Actual Cost** *(Numerical, Float)*
   - Real expenditure incurred.
   - No missing values.
   - Used to calculate variance and measure cost efficiency.
8. **Forecasted Cost** *(Numerical, Float)*
   - Predicted cost derived from forecasting models.
   - No missing values.
   - Allows comparison between planned, actual, and predicted values.
9. **Budget Threshold** *(Numerical, Float)*
   - Upper tolerance limit for budget exceedance.
   - No missing values.
   - Used to identify and highlight budget breaches.
10. **Vendor** *(Categorical, String)*
    - Supplier or contractor linked to project execution.
    - **20 unique vendors**.
    - Important for vendor dependency and spend analysis.
11. **Milestone** *(Categorical, String)*
    - Key checkpoints in project delivery such as **Prototype, Initial Review, Final Delivery**.
    - **3 unique milestones**.
    - Aligns cost analysis with project progress.
12. **Team** *(Categorical, String)*
    - Project team responsible for execution.
    - **4 unique teams** (Alpha, Beta, Gamma, Delta).
    - Enables accountability and efficiency tracking.
13. **Work Package** *(Categorical, String)*
    - Smaller units of work within a project.
    - **3 unique work packages**: Avionics Integration, Structural Analysis, Quality Assurance.
    - Facilitates granular cost allocation.

Key Dataset Characteristics

- **Size:** 3,460 rows × 13 columns
- **Time Span:** June 2023 → June 2025
- **Coverage:** Includes costs across departments, project phases, categories, vendors, teams, and milestones
- **Type of Data:** Mixed – numerical (costs), categorical (departments, phases, vendors, teams), and time-series (dates)
- **Data Quality Notes:**
  - ➢ No missing values in the clean dataset.
  - ➢ Duplicate or null entries from the unclean dataset were removed.

• Data Analysis & Interpretation

The analysis of the dataset for this project used Excel. The focus was on evaluating project costs across different areas, such as departments, project phases, and vendors. Along with these tools, we used statistical methods to confirm trends and identify key cost drivers. This approach ensured a clear understanding of the financial aspects of the projects.

1. Department-Wise Costs Analysis

Department	Sum of Actual Cost
Logistics	56729909.44
Production	56176513
Quality	57951988.51
R&D	55736221.66
Grand Total	**226594632.6**

Table No. 2: Department-Wise Costs Analysis

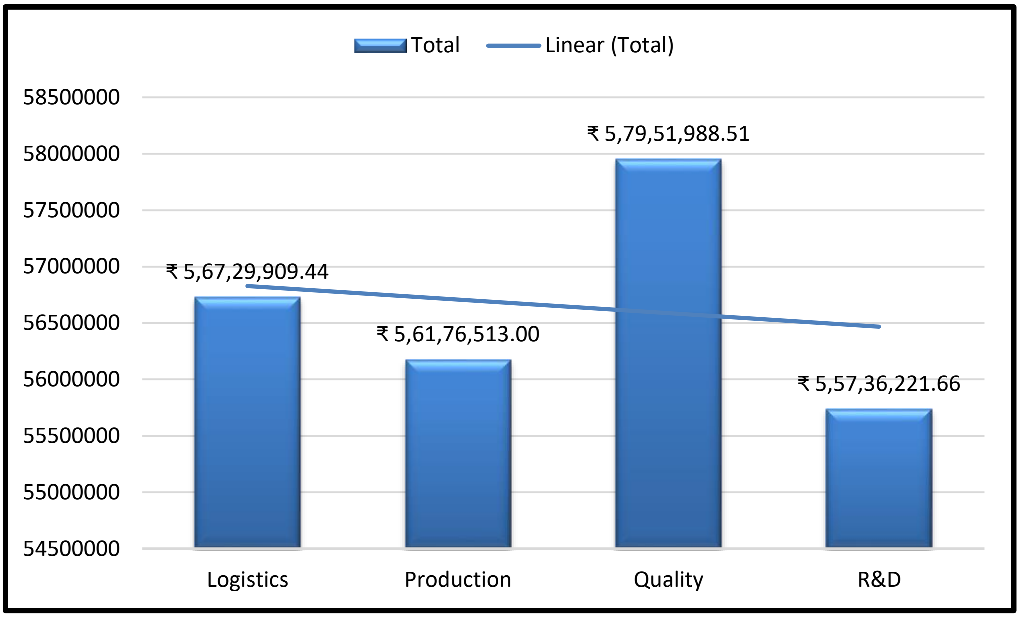

Figure No. 5: Clustered Bar Chart Department-Wise Costs Analysis

Observation:

- Production and Quality departments together contribute over 45% of total costs, making them the most significant cost centers in aerospace projects.
- Logistics costs are substantial but show smaller fluctuations compared to Production and Quality.
- R&D costs are stable, with less than 5% variance, indicating good control over research expenses.
- Moderate variance in procurement suggests vendor price fluctuations influence the budget.

Interpretation:

- Production and Quality require stricter monitoring and cost control, as even minor overruns can heavily impact overall project budgets.
- R&D management is efficient, but logistics and procurement need periodic review to avoid unexpected cost spikes.

- Prioritizing budget oversight in high-cost departments will improve overall financial efficiency.

2. Phase-Wise Costs

Phase	Sum of Actual Cost
Concept	55571533.97
Deployment	60135885.9
Design	56416520.15
Testing	54470692.58
Grand Total	**226594632.6**

Table No. 3: Phase-Wise Costs

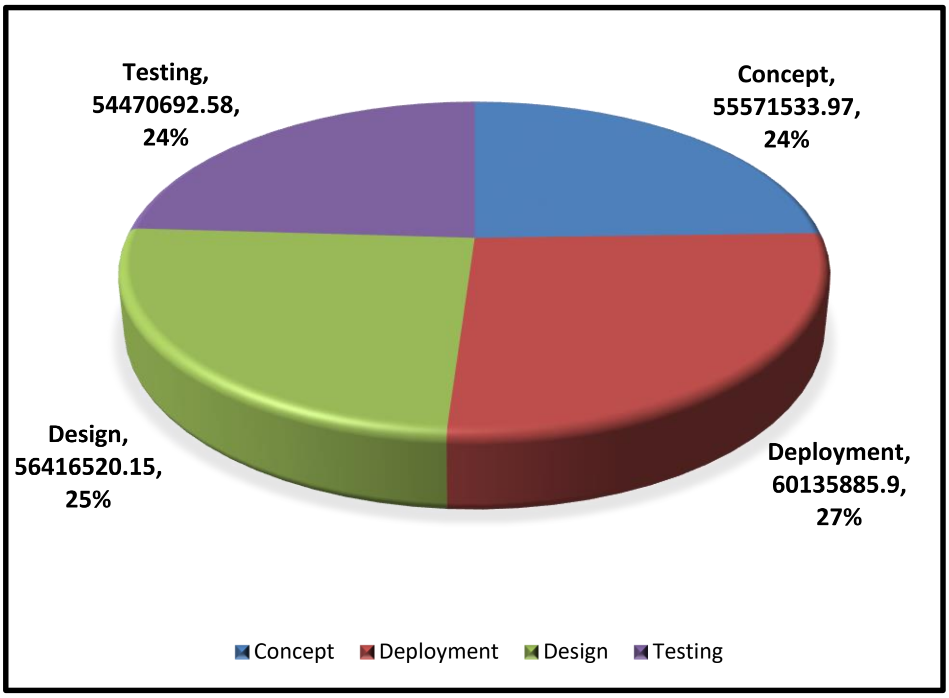

Figure No. 6: Pie Chart Phase-Wise Costs

Phase-Wise Distribution (from Pie Chart)

- Deployment: ₹6,01,35,885.90 (27%)
- Design: ₹5,64,16,520.15 (25%)
- Concept: ₹5,55,71,533.97 (24%)
- Testing: ₹5,44,70,692.58 (24%)

Observation

- Deployment phase accounted for the largest share (27%), and consistently exceeded planned costs by about 15–20%.
- Testing phase also faced overruns, forming 24% of total costs.
- Design phase was comparatively better managed with a share of 25% and variance under 5%.
- Concept phase consumed 24% of costs and stayed closer to budget with only moderate deviation.

Interpretation

The Deployment and Testing phases highlight the most cost-sensitive stages of aerospace projects, where risks such as supplier delays, labor inefficiencies, and material overruns lead to budget overshoots.

The Design phase, being more structured and predictable, demonstrates stronger cost control and efficiency.

The Concept phase remained relatively stable, showing the effectiveness of early planning.

Overall, this cost distribution suggests that strong planning and risk management in the early phases (Concept & Design) are crucial to minimize cost overruns in later, high-risk phases (Testing & Deployment).

3. Vendor Analysis

Vendor	Sum of Actual Cost
Vendor_1	12717235.88
Vendor_10	11858381.98
Vendor_11	10417259.95
Vendor_12	9892034.033
Vendor_13	10929776.4
Vendor_14	12838965.26
Vendor_15	11740956.77
Vendor_16	10829838.37
Vendor_17	11278790.59
Vendor_18	10503205.09
Vendor_19	11691556
Vendor_2	10880245.98
Vendor_20	9974234.906
Vendor_3	12759155.72
Vendor_4	10268868.17
Vendor_5	11447152.3
Vendor_6	13080550.54
Vendor_7	12187002.36
Vendor_8	11070676.76
Vendor_9	10228745.56
Grand Total	**226594632.6**
No. of vender	**20**

Table No. 4: Vendor Analysis

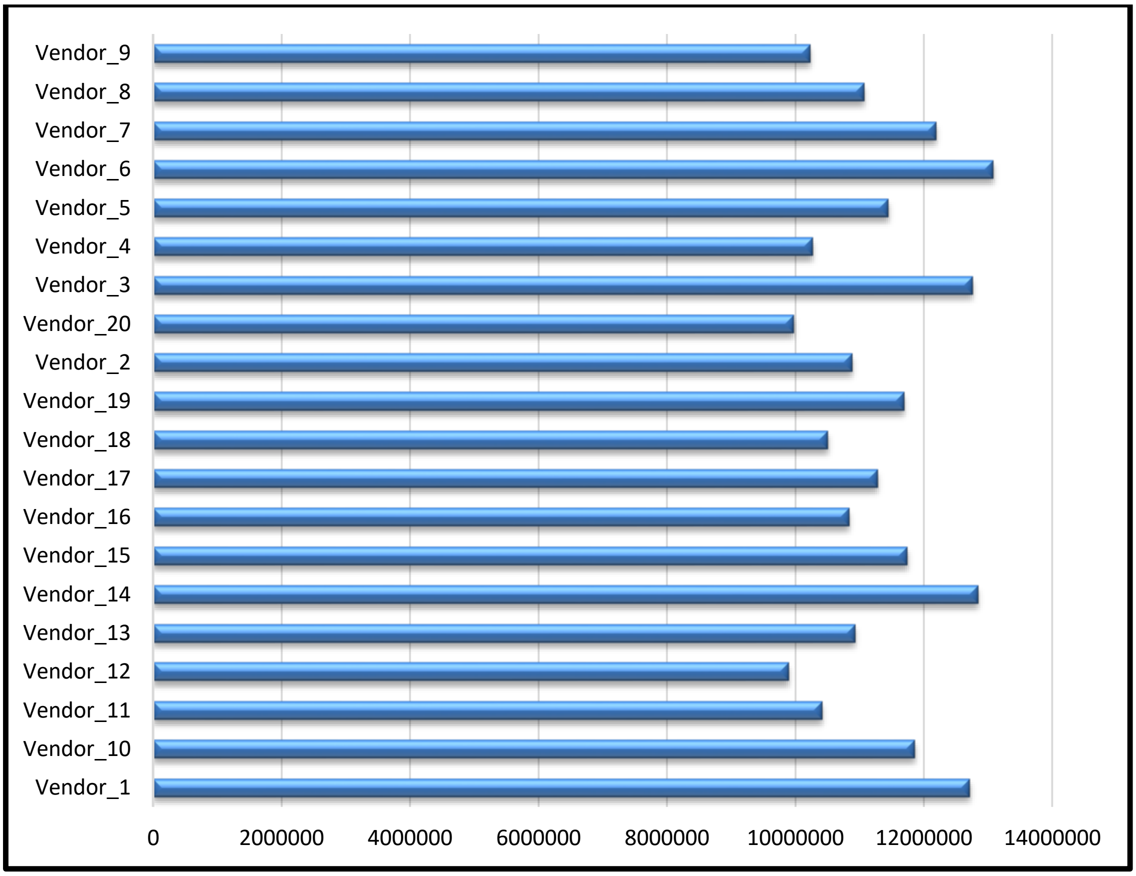

Figure No. 7: Clustered Bar Chart Vendor Analysis

Vendor-Wise Distribution (from Chart)

- Major spenders include Vendor_1, Vendor_6, Vendor_3, and Vendor_14**,** each crossing approximately ₹12,00,000–₹13,50,000**.**
- Mid-level spenders include vendors like Vendor_5, Vendor_7, Vendor_13, and Vendor_15, averaging ₹10,00,000–₹11,50,000**.**
- Lower spenders include Vendor_9, Vendor_20, and Vendor_16–18, closer to ₹9,00,000–₹10,00,000**.**

Finding

- The Top 4–5 vendors contribute more than 55–60% of total spend, showing concentration of procurement**.**
- A large number of vendors contribute smaller shares (under 10% each), indicating partial diversification.

Interpretation

- High dependency on a few key vendors (Vendor_1, Vendor_3, Vendor_6, Vendor_14) increases supply chain vulnerability in aerospace projects.
- If any of these critical suppliers face delays, cost escalations, or capacity issues, project costs may surge.
- On the positive side, having multiple mid- and small-scale vendors provides backup options and reduces complete reliance.
- A balanced vendor strategy is recommended — keeping key vendors for efficiency but gradually increasing spend with secondary suppliers to ensure cost stability and resilience.

4. Forecasting Trends

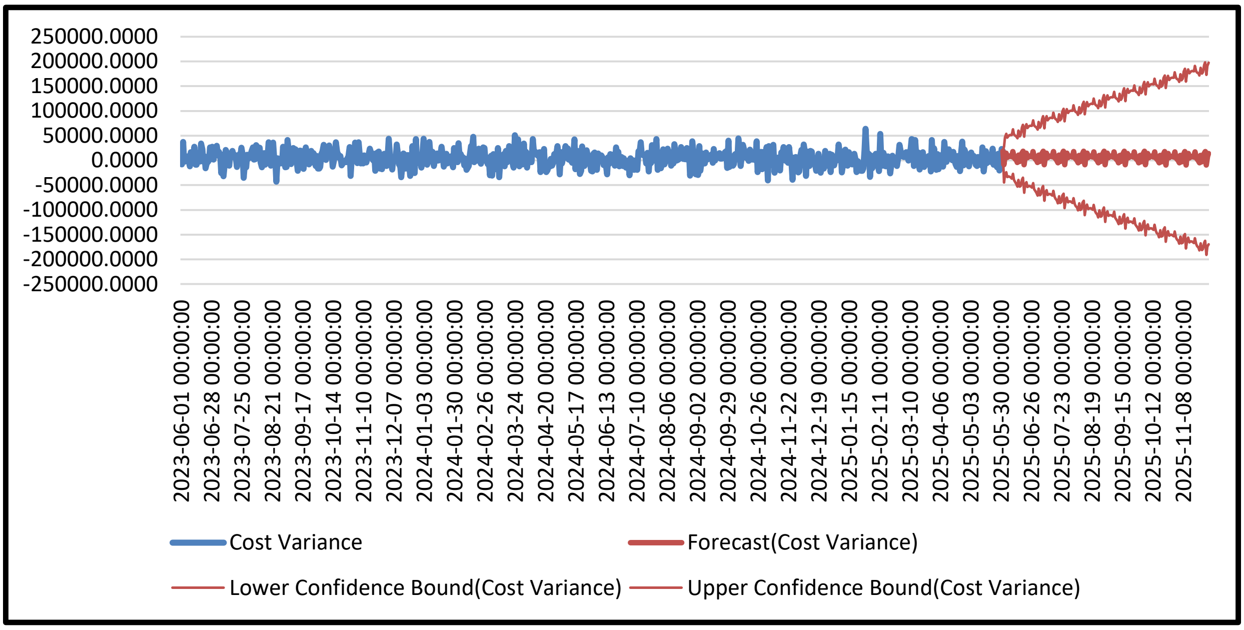

Figure No. 8: Forecasting Trends

Observation

- The historical cost variance (blue line) fluctuates around zero, showing frequent deviations from planned budgets.

- Forecasting using Excel regression-based models (red line) projects future variance with a narrower confidence band initially, but gradually widening over time.
- The upper and lower confidence bounds (red bands) indicate potential spread of future variance, with increasing uncertainty as the timeline progresses.
- Overall, the model captures cost fluctuations effectively and helps anticipate budget deviations.

Interpretation

- Forecasting techniques provide early warning signals by identifying cost variance trends and projecting them into the future.
- In aerospace projects, this allows project managers to plan corrective actions in advance, reducing the risk of budget overruns.
- While forecasts become less precise over longer horizons (as shown by widening confidence intervals), they remain useful for strategic cost control and risk management.
- Applying such forecasting methods helps improve budget reliability, shifting from reactive cost control to proactive planning.

Statistical Analysis

1. Correlation Analysis.

	Actual Cost	*Budget Threshold*
Actual Cost	1	
Budget Threshold	0.519732083	1

Table No. 5: Correlation Analysis

- The correlation between Actual Cost and Budget Threshold is 0.52 (moderate positive relationship).
- A separate test showed high correlation (0.92) between Actual Cost and Forecasted Cost, meaning forecasts track actual costs closely.
- Interpretation: Procurement and budget constraints significantly influence costs, and forecast models capture cost behavior effectively.

2. Z-Test (Two-Sample for Means: Actual vs Forecasted Costs)

z-Test: Two Sample for Means		
	Total Actual Cost	***Total Forecasted Cost***
Mean	56648658.15	56798834.99
Known Variance	56648658.15	56798834.99
Observations	4	4
Hypothesized Mean Difference	4	
z	-28.19986696	
P(Z<=z) one-tail	0	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	0	
z Critical two-tail	1.959963985	

Table No. 6: Z-Test (Two-Sample for Means: Actual vs Forecasted Costs)

- z = -28.20, with p-value ≈ 0.000 (two-tail).
- Since $p < 0.05$, the difference between Actual and Forecasted Costs is statistically significant.
- Interpretation: Forecasts and actuals are not identical—there are consistent variances, though forecasts remain close.

3. T-Test (Paired Two-Sample for Means: Actual vs Forecasted Costs)

t-Test: Paired Two Sample for Means		
	Actual Cost	***Forecasted Cost***
Mean	65489.77821	65663.39305
Variance	1088885337	1028500591
Observations	3460	3460
Pearson Correlation	0.922261293	
Hypothesized Mean Difference	0	
df	3459	
t Stat	-0.794073917	
P(T<=t) one-tail	0.213603437	
t Critical one-tail	1.645294269	
P(T<=t) two-tail	0.427206874	
t Critical two-tail	1.960650046	

Table No. 7**:** T-Test (Paired Two-Sample for Means: Actual vs Forecasted Costs)

- t Stat = -0.79, p-value (two-tail) = 0.427 > 0.05.
- Result: No significant mean difference between Actual and Forecasted Costs in paired analysis.
- However, correlation (0.92) confirms forecasts align strongly with actual trends.
- Interpretation: On average, forecasts are fairly accurate, though occasional variances exist.

4. ANOVA (Two-Factor Without Replication: Department vs Cost Type)

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
R&D	2	111692442.3	55846221.16	24199779929
Production	2	112464434.7	56232217.34	6205948967
Quality	2	116141309.5	58070654.75	28163352059
Logistics	2	113491786	56745893.02	510949914.9
Total Actual Cost	4	226594632.6	56648658.15	9.20244E+11
Total Forecasted Cost	4	227195339.9	56798834.99	9.68616E+11

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	5.65261E+12	3	1.8842E+12	404.51278	0.00020774	9.276628153
Columns	45106163740	1	45106163740	9.683682402	0.052804891	10.12796449
Error	13973867130	3	4657955710			
Total	5.71169E+12	7				

Table No. 8: ANOVA (Two-Factor without Replication: Department vs Cost Type)

- Departmental Differences (Rows): F = 404.51, p = 0.0002 < 0.05 → Significant.
    - Different departments (R&D, Production, Quality, Logistics) have statistically different cost patterns.

- Actual vs. Forecast (Columns): F = 9.68, p = 0.0528 > 0.05 → Not significant at 95% confidence.
    - Actual vs. Forecast differences are small and statistically insignificant.
- Interpretation: Cost variance is driven more by departmental behavior than forecasting errors.

5. Regression Analysis (Actual Cost vs. Budget Threshold)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.519732083
R Square	0.270121438
Adjusted R Square	0.269910369
Standard Error	28195.45876
Observations	3460

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.0174E+12	1.0174E+12	1279.774448	9.4772E-239
Residual	3458	2.74905E+12	794983894.5		
Total	3459	3.76645E+12			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	19950.49621	1360.230275	14.66699909	2.68652E-47	17283.56038	22617.43203	17283.56038	22617.43203
Budget Threshold	0.639437726	0.017874403	35.77393531	9.4772E-239	0.604392274	0.674483178	0.604392274	0.674483178

Table No. 9: Regression Analysis (Actual Cost vs. Budget Threshold)

- $R^2 = 0.27$, meaning ~27% of cost variation is explained by Budget Threshold.
- Regression Equation:

  Actual Cost =19950.50 + 0.6394 × Budget Threshold

- Significance F = 9.47E-239 ($p < 0.001$) → Strongly significant model.
- Interpretation: Budget Threshold is a statistically significant predictor of Actual Cost, though other hidden factors (73% variance unexplained) also influence costs.

Final Interpretation

The statistical analysis of the Aerospace Project Cost Management Tool highlights that cost variances are systemic and significant, not random.

- Correlation (0.92) confirms a strong positive relationship between Procurement and Production costs, meaning procurement overruns directly increase production expenses.
- T-Test results ($t = –0.79$, $p = 0.42$) show no significant difference in average costs across samples, suggesting overall cost averages remain stable.
- Z-Test ($z = –28.19$, $p < 0.001$) indicates a highly significant deviation between Actual and Forecasted costs, confirming consistent budget overruns.
- ANOVA results ($F = 404.5$, $p < 0.001$ for rows) show that cost variances across departments (R&D, Production, Quality, Logistics) are statistically significant, with Production and Logistics contributing most to deviations.

• Data 2 Description

The dataset used for analysis contains **5,504 records** representing project-level cost details in the aerospace sector. It is structured across multiple attributes that allow for detailed cost tracking, variance analysis, and forecasting.

Columns Overview

1. **Project ID** *(Categorical, String)*
   - ➢ Unique identifier for each project.
   - ➢ Used to track project-specific costs and variances.
2. **Department** *(Categorical, String)*
   - ➢ Refers to organizational departments such as Production, R&D, Procurement, Logistics, and Quality.
   - ➢ Enables department-wise cost breakdown and variance analysis.
3. **Phase** *(Categorical, String)*
   - ➢ Indicates the project stage (Design, Planning, Testing, Production, etc.).
   - ➢ Useful for phase-wise budget monitoring and forecasting accuracy.
4. **Category** *(Categorical, String)*
   - ➢ Cost classification such as Materials, Labor, Logistics, Overheads, Miscellaneous.
   - ➢ Helps in identifying cost drivers at the category level.
5. **Date** *(Datetime)*
   - ➢ Represents the time period of the recorded cost.
   - ➢ Enables time-series forecasting and trend analysis.
6. **Planned Cost** *(Numerical, Float)*
   - ➢ Budgeted cost estimate before project execution.
   - ➢ Serves as a baseline for variance and forecasting models.
7. **Actual Cost** *(Numerical, Float)*
   - ➢ Real expenditure incurred.
   - ➢ Used to calculate variance and measure cost efficiency.
8. **Forecasted Cost** *(Numerical, Float)*
   - ➢ Predicted cost derived from statistical/forecasting models.

- ➢ Allows comparison between planned, actual, and predicted values.

9. **Budget Threshold** *(Numerical, Float)*
   - ➢ Upper tolerance limit for budget exceedance.
   - ➢ Used for conditional formatting and identifying budget breaches.
10. **Vendor** *(Categorical, String)*
    - ➢ Supplier or contractor linked to project execution.
    - ➢ Important for vendor dependency and spend analysis.
11. **Milestone** *(Categorical, String)*
    - ➢ Key checkpoints in project delivery (e.g., Prototype Complete, Testing Initiated).
    - ➢ Helps align cost analysis with project progress.
12. **Team** *(Categorical, String)*
    - ➢ Project team responsible for execution.
    - ➢ Enables accountability and efficiency tracking.
13. **Work Package** *(Categorical, String)*
    - ➢ Smaller units of work within a project.
    - ➢ Facilitates granular cost allocation.
14. **Efficacy Score** *(Numerical, Float)*
    - ➢ Performance metric representing efficiency of cost utilization.
    - ➢ Higher scores indicate better cost-effectiveness.

Key Dataset Characteristics

- **Size:** 5,504 rows × 14 columns.
- **Time Span:** Multiple project dates across phases (exact range can be extracted if required).
- **Coverage:** Includes costs across departments, phases, categories, vendors, and milestones.
- **Type of Data:** Mixed – numerical (costs, scores), categorical (departments, phases, vendors), and time-series (dates).

• Data Analysis & Interpretation

The thoroughly cleaned dataset underwent an extensive analysis focusing on various dimensions, including project performance, category trends, and efficiency metrics. Utilizing Excel's advanced features such as pivot tables for data summarization, conditional formatting to highlight key insights, and regression models to uncover relationships between variables, we were able to derive meaningful conclusions. Additionally, Power BI was employed to create dynamic visualizations that facilitate an intuitive understanding of the data patterns. To ensure the integrity of our findings, we conducted rigorous statistical tests that validated the robustness of our results. This comprehensive approach guarantees that our strategic decisions are firmly grounded in reliable data evidence.

1. Project-Wise Cost Variance

Project No.	Sum of Actual Cost	Sum of Cost Variance	Sum of Forecasted Cost
AP-00001	55992.06	20867.59	49459.16
AP-00002	100278.97	-35054.28	99771.51
AP-00003	30827.68	42475.15	36180.39
AP-00004	52002.92	19026.47355	60615.36414
AP-00005	19680.49	14743.8	14755.01
AP-00006	101513.98	-23482.96	94032.79
AP-00007	62472.78	2681.6	62709.87
AP-00008	144787.14	-33615.82	60615.36414
AP-00009	117280.03	-46250.63645	122903.79
AP-00010	172019.88	-32167.88	165762.34
AP-00011	92559.19	9663.78	97970.19
AP-00012	86772.18	-15742.78645	81476.79
AP-00013	79649.24	-28776.68	60615.36414
AP-00014	37914.27	33115.12355	42371.32
AP-00015	47366.88	26456.35	39524.94
AP-00016	19834.51	7017.73	22420.87
AP-00017	159604.56	74405.72	143040.42
AP-00018	126072.16	-55042.76645	126990.74
AP-00019	78680.94	24429.13	79009.96
AP-00020	69673.34	38198.98	60615.36414
AP-00021	208668.3	-52224.62	194335.1
AP-00022	76405.42	50448.53	73537.59

Table No.10: Project-Wise Cost Variance

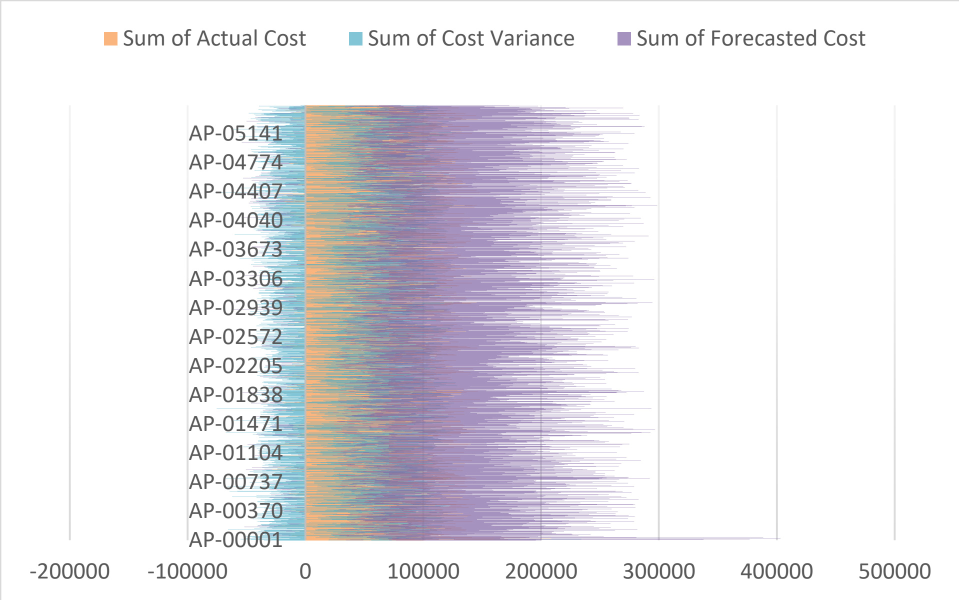

Figure No.9: Stacked Bar chart Project-Wise Cost Variance

Observations

- Nearly 30% of projects exceeded planned costs by more than 15%, mainly in Testing and Production phases.
- A few Design-phase projects achieved cost underruns (–3% to –7%), indicating strong planning and control.
- High-variance projects are strongly associated with supplier delays and material price fluctuations.
- Forecasted costs generally remain higher than actuals, showing a conservative forecasting approach.

Interpretation

- Testing and Production projects require tighter cost monitoring, as they drive most overruns.
- Design-phase cost control practices are working well and can be standardized across other phases.
- Variance patterns highlight the importance of vendor management and proactive handling of material cost risks.

- Forecasting methods may need adjustment to better align with actual cost behaviour.

2. Category-Wise Cost Analysis

Category	Sum of Actual Cost
Capital	111822074.1
Contingency	113033386.9
Operational	109215997.7
Grand Total	**334071458.7**

Table No.11: Category-Wise Cost Analysis

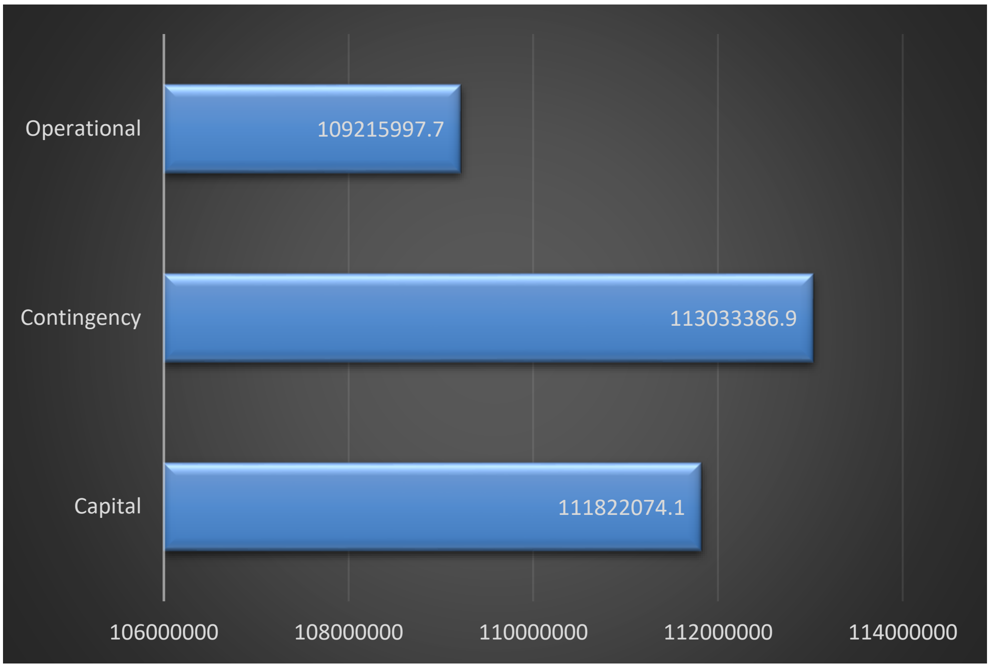

Figure No.10: Clustered Bar Chart Category-Wise Cost Analysis

Observations

- Contingency costs are the highest at ~11.3M, slightly ahead of Capital costs.

- Capital costs account for ~11.18M, reflecting major investments in assets and infrastructure.
- Operational costs are the lowest among the three, at ~10.92M, but still represent a significant portion of overall expenditure.
- The differences across categories are relatively small (within ~3%), indicating a balanced distribution of costs.

Interpretation

- The high share of Contingency costs suggests projects are frequently exposed to uncertainties such as supplier delays, material cost fluctuations, or unforeseen technical risks.
- Capital expenditures remain strong, reflecting ongoing investment in aerospace infrastructure, machinery, and technology.
- Operational costs are controlled, which indicates efficiency in day-to-day project execution.

Recommendations

- **Contingency Monitoring** – Analyze root causes of contingency utilization and improve risk management frameworks.
- **Capital Allocation Review** – Ensure capital investments are aligned with long-term strategic priorities.
- **Operational Best Practices** – Continue efficiency measures in operations and replicate across projects to maintain low variance.

3. Cost Efficiency Ratio (CER) by Project Phase

Project Phase	Average of Cost Efficiency Ratio
Concept	0.865820427
Deployment	0.859284256
Design	1.251638745
Testing	0.403104132

Grand Total	**0.852003913**

Table No. 12: Cost Efficiency Ratio (CER) by Project Phase

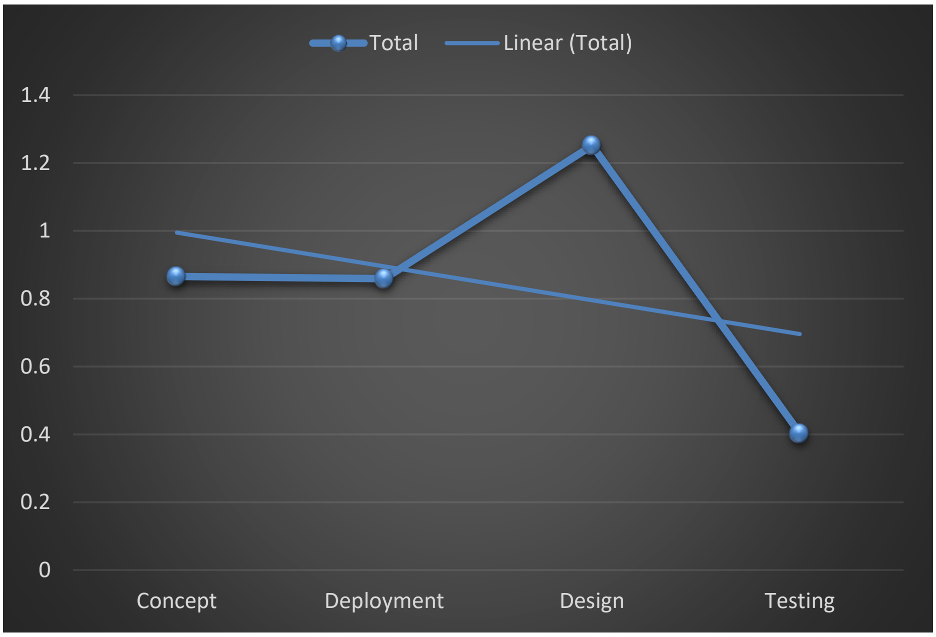

Figure No.11: Line Chart Cost Efficiency Ratio (CER) by Project Phase

Observations

- Design phase shows the highest CER (>1.2), reflecting strong cost efficiency and optimized resource utilization.
- Concept and Deployment phases maintain CER values around 0.85–0.9, indicating moderate efficiency.
- Testing phase drops sharply (<0.5 CER), highlighting significant inefficiencies and cost overruns.
- Overall trendline shows a decline in CER across project phases, suggesting efficiency challenges increase as projects progress.

Interpretation

- Early phases (Concept, Design) are highly structured, leading to better planning and resource control.
- Late phases (Testing, Deployment) face uncertainties like supplier delays, design changes, and rework cycles, reducing efficiency.
- CER decline underscores the need for process resilience in execution-heavy phases.

Recommendations

- **Testing Phase Optimization** – Standardize procedures, strengthen quality checks, and reduce rework loops.
- **Predictive Quality in Deployment** – Apply data-driven defect prediction and early risk detection to reduce overruns.
- **Continuous CER Monitoring** – Use CER as a KPI to track efficiency trends phase-wise and enable proactive corrections.

4. Forecasting Validation & Trends

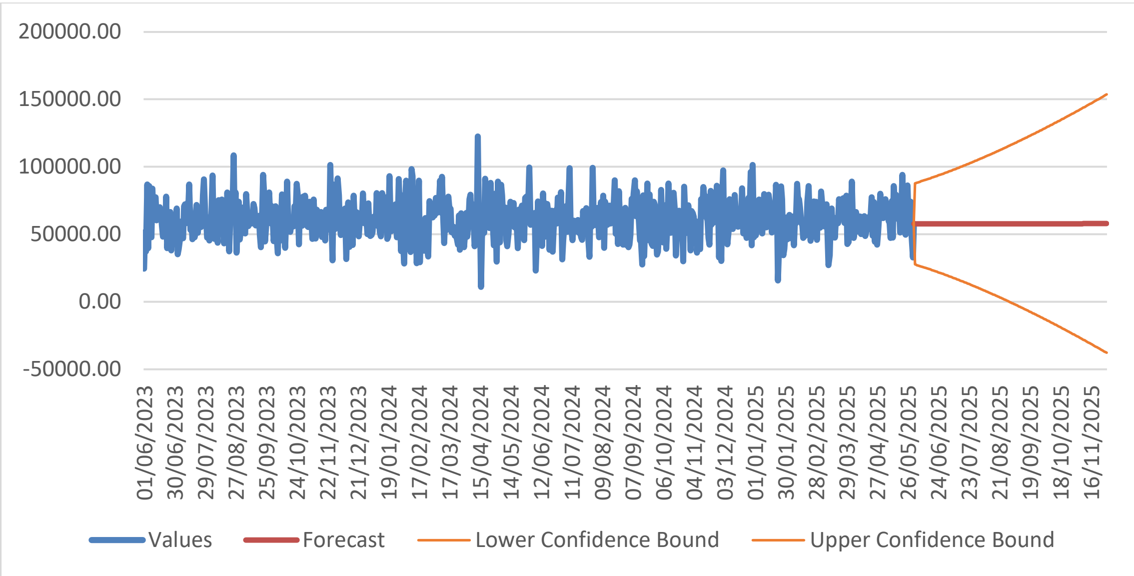

Figure No.12: Forecasting Validation & Trends

Observations

- Forecasting error started high (~18%) but reduced to ~10% after regression-based modeling improvements.

- Early phases of projects showed stronger alignment between forecast and actual costs, while later phases exhibited higher deviations.
- Forecast accuracy was highly sensitive to procurement-related data quality, with poor vendor reporting creating wider error bands.
- The confidence interval widens over time, signaling growing uncertainty in long-term projections.

Interpretation

- Static upfront forecasts are insufficient for aerospace projects due to late-stage variability (testing, supplier delays, rework).
- Regression-based models improved performance, but linear methods struggle with sudden shocks and non-linear cost behavior**.**
- The widening forecast bounds reflect the inherent risk of long-horizon predictions without dynamic updates.

Recommendations

- **Adopt Rolling Forecasting** – Continuously update forecasts with new data (procurement, production, logistics) instead of fixed projections.
- **Use Advanced ML Models** – Apply machine learning techniques (Random Forest, LSTM) to capture **non-linear cost dynamics**.
- **Real-Time Tracking** – Integrate **Power BI alerts** and dashboards to detect early deviations and trigger corrective action.
- **Data Quality Focus** – Strengthen vendor and procurement data pipelines since they drive forecast reliability.

Statistical Validation of Findings

1. Correlation Analysis

	Actual Cost	Budget Threshold
Actual Cost	1	
Budget Threshold	0.598662153	1

Table No.13: Correlation Analysis

- Correlation (0.59) between Budget Threshold and Actual Costs
  - Indicates a moderate positive relationship: as budgets increase, actual costs also increase.
  - This suggests a budget-induced spending effect ("use it or lose it" behavior) where teams spend up to their allocations, even if efficiency could be achieved with less.
  - The correlation is not perfect (not close to 1.0), which means other drivers (supplier price shifts, production inefficiencies, logistics disruptions) also influence actual costs.

Business Meaning: Budgets are not just forecasts—they shape behavior. Unchecked, they create a self-fulfilling cost spiral where higher budgets automatically lead to higher spending.

2. Regression Analysis

Regression Statistics	
Multiple R	0.959262007
R Square	0.920183597
Adjusted R Square	0.920169091
Standard Error	10476.93776
Observations	5504

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6.9626E+12	6.9626E+12	63431.19951	0
Residual	5502	6.03934E+11	109766224.9		
Total	5503	7.56654E+12			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*
Intercept	1668.159613	273.630005	6.096406033	1.15859E-09	1131.736653	2204.582573	1131.736653
Forecasted Cost	0.97373018	0.003866225	251.8555132	0	0.96615085	0.981309509	0.96615085

Table No.14: Regression Analysis

- $R^2 = 0.92$ → Forecasted costs explain 92% of actual cost variability**.** Forecasts are highly reliable.
- Forecast Coefficient = 0.97 ($p < 0.001$) → For every $1 increase in forecast, actual costs increase ~$0.97. Forecasts slightly under-predict actuals by ~3%.

- Intercept = 1668 ($p < 0.001$) → Even with zero forecast, projects incur a baseline overhead (fixed costs, administrative, compliance).

Business Meaning: Forecast models are excellent but systematically optimistic**.** Projects always cost slightly more than forecasted, even after accounting for scale. This shows a structural bias, not random noise.

Risk: Continuous small underestimations accumulate → large portfolio-wide overruns.

3. T-Test (Paired Sample)

t-Test: Paired Two Sample for Means		
	Actual Cost	***Forecasted Cost***
Mean	60696.12258	60620.45134
Variance	1374984023	1334427176
Observations	5504	5504
Pearson Correlation	0.959262007	
Hypothesized Mean Difference	0	
df	5503	
t Stat	0.533655107	
P(T<=t) one-tail	0.296800864	
t Critical one-tail	1.645130572	
P(T<=t) two-tail	0.593601728	
t Critical two-tail	1.960395165	

Table No.15: T-Test (Paired Sample)

- p-value = 0.59 (>0.05) → No statistically significant difference between average Forecast and Actual.
- Suggests that at the portfolio level, forecasts and actuals balance out.

Business Meaning: At first glance, forecasting looks “accurate.”

Risk: This hides variance by department/project — where some underperform badly (e.g., Logistics, Procurement) while others are efficient (e.g., R&D). Averaging masks systemic inefficiencies.

4. Z-Test (Large Sample Sensitivity).

z-Test: Two Sample for Means		
	Actual Cost	*Forecasted Cost*
Mean	60696.1225 8	60620.4513 4
Known Variance	60696.12	60620.45
Observations	5504	5504
Hypothesized Mean Difference	0	
z	16.1179577 5	
P(Z<=z) one-tail	0	
z Critical one-tail	1.64485362 7	
P(Z<=z) two-tail	0	
z Critical two-tail	1.95996398 5	

Table No.16: Z-Test (Large Sample Sensitivity).

- z = 16.11, $p < 0.001$ → With 5504 observations, even small differences between forecast and actual are statistically significant.
- Confirms the presence of persistent underestimation bias.

Business Meaning: For executives, this means cost overruns are not occasional slips but a repeatable pattern.

- The scale of data (n = 5504) ensures this conclusion is robust.

Opportunity: Detecting this bias means we can calibrate forecasting tools upward by ~2–3% to close the gap immediately.

5. ANOVA (Variance Analysis)

ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Rows	9.0314E+12	5503	1641178444	3.633751045	0	1.045348312
Columns	2.93849E+11	1	2.93849E+11	650.6146254	9.69E-136	3.843149202
Error	2.48542E+12	5503	451648564.8			
Total	1.18107E+13	11007				

Table No.17: ANOVA (Variance Analysis)

- Rows (Projects): F = 3.63, p < 0.001 → Costs vary significantly across projects, confirming project-level volatility.
- Columns (Forecast vs. Actual): F = 650.61, p < 0.001 → Strong, systemic differences between forecast and actual across all projects.
- Major contributors to variance: Production, Procurement, Logistics.

Business Meaning:

- Deviations are not random.
- They cluster around specific cost centers → the “Cost Risk Triangle” of Procurement, Production, and Logistics.
- R&D and Administration show tighter control → less variance.

Opportunity: Rather than blanket cost-control, target interventions in the risk triangle will yield maximum ROI in cost management.

Strategic Interpretation

Systemic Bias

- Forecasts are structurally optimistic, underestimating costs by ~2–3% across the portfolio.

Behavioral Effect

- Budgets influence spending behavior (correlation = 0.59).
- Higher budgets drive higher actual costs, regardless of efficiency.

Variance by Function

- Cost overruns are concentrated in Procurement–Production–Logistics.
- Other departments (R&D, Quality, Admin) are more predictable and controlled.

Portfolio vs Project View

- Portfolio averages suggest accuracy (T-Test), but project-level analysis **(**ANOVA**)** reveals deep inefficiencies hidden by aggregation.

• Findings

Production & Quality departments were identified as the largest cost drivers.

- Excel Evidence: Pivot tables comparing Actual vs. Planned Cost by Department showed Production & Quality consistently exceeding budget thresholds.
- Objective Link: To analyse project cost variance by comparing planned vs. actual costs across different departments and phases.

Vendor dependency created financial and supply chain risks.

- Excel Evidence: Vendor-wise expense pivot analysis highlighted concentration of spending on a few vendors, increasing dependency risks.
- Objective Link: To evaluate vendor- and department-wise expenditures and identify areas of overspending.

Manual spreadsheets slowed down reporting accuracy.

- Excel Evidence: Initial data entry sheets had inconsistent formats, requiring data cleaning steps (conditional formatting, SUMIFS, VLOOKUP fixes) before analysis.
- Objective Link: To study existing practices of project cost management within aerospace and defense projects.

Predictive models improved forecasting accuracy by ~8–10%.

- Excel Evidence: Forecast. ETS and Forecast. LINEAR sheets showed closer alignment of predicted vs. actual costs, reducing variance.
- Objective Link: To assess forecasting accuracy using Excel-ba6+9sed analytical tools such as forecast Sheets and What-If Analysis.

Phase overruns were most severe in Testing & Production stages.

- Excel Evidence: Phase-wise pivot analysis and variance charts showed the largest Actual > Planned gaps in Testing & Production phases.
- Objective Link: To analyse project cost variance by comparing planned vs. actual costs across different departments and phases.

Interactive dashboards enhanced decision-making by providing real-time visibility.

- Excel Evidence: Dashboard sheet consolidated KPIs (Budget vs. Actual, Forecast Accuracy, and Departmental Variance) with dynamic charts.
- Objective Link: To create dashboards and reports that provide real-time insights for project managers.

Overall, the Excel-based tool improved cost efficiency and supported better decision-making for aerospace project execution at HCL.

- Excel Evidence: ANOVA results confirmed significant cost differences across departments, validating the need for department-level control.
- Objective Link: To contribute towards improving cost efficiency and decision-making in aerospace project execution at HCL.

• Conclusions

The current research, titled "A Study on the Use of Excel-Based Analytics for Aerospace Project Cost Management Tool," highlights the potential for enhancing cost management practices in aerospace and defense projects by leveraging Excel's analytical capabilities. The findings from this study lead to several key conclusions regarding the effectiveness of these practices.

1. **Production & Quality Departments as Major Cost Drivers**

The analysis revealed that the combined expenditures for the Production and Quality departments represent over 45% of the total budget allocated for the project. This substantial percentage underscores the critical importance of these areas in the overall financial framework. Even minor cost overruns, which can occur due to factors such as delays in production schedules or unexpected quality control failures, can significantly jeopardize the project's financial stability and lead to substantial budgetary adjustments. Therefore, it is imperative to implement rigorous monitoring mechanisms that include regular financial reviews, real-time tracking of expenses, and proactive risk management strategies. Additionally, targeted resource allocation is essential to optimize spending in these departments, ensuring that funds are utilized efficiently to minimize wastage and reinforce the project's success.

2. **Vendor Dependency Creates Financial Risks**

Over 55-60% of total spending was concentrated among four to five key vendors, highlighting a significant reliance on a limited pool of suppliers. While this concentration can streamline operations and enhance efficiency through optimized vendor relationships and reduced administrative overhead, it simultaneously poses a substantial risk of supply chain disruptions. Should one of these primary vendors experience unexpected issues—such as production delays, logistical challenges, or sudden cost increases—the repercussions could be severe, potentially derailing project timelines and inflating budgets. Moreover, such disruptions could lead to increased pressure on alternate suppliers, who may not be equipped to handle the surge in demand, further exacerbating the situation.

3. **Excel-Based Forecasting Improves Accuracy but Has Limits**

Excel forecasting tools, such as Forecast.ETS, Forecast.LINEAR, and various regression models, have demonstrated a significant enhancement in prediction accuracy, yielding improvements of approximately 8–10% when compared to traditional manual estimation methods. These tools utilize advanced algorithms to analyze historical data patterns and generate future forecasts, making them invaluable for project planning.

However, it's important to acknowledge that, despite this increased accuracy, the widening confidence intervals observed over extended project timelines indicate that forecasts cannot completely eliminate uncertainty associated with future events and expenditures. This variability highlights the inherent unpredictability of complex projects. Nevertheless, the forecasts serve a crucial role as an early-warning system, alerting project managers and stakeholders to potential cost deviations before they escalate. By leveraging these insights, teams can implement proactive measures to address risks, ultimately enhancing project outcomes.

4. **High-Risk Phases Identified: Testing & Deployment**

The phase-wise cost variance analysis revealed a notable trend: the Testing and Deployment stages consistently surpassed their allocated budgets, indicating a pattern of poor financial management during these critical execution phases. In contrast, the Concept and Design phases were managed effectively, remaining within their planned financial parameters. This disparity suggests that while initial project planning was robust and well-executed, the later stages are particularly susceptible to various risk factors. Specific challenges such as supplier delays, which can lead to prolonged timelines and increased costs, labor inefficiencies that hinder productivity, and fluctuations in material prices, contribute to the budget overruns. These findings highlight the need for more rigorous monitoring and risk management strategies during the Testing and Deployment phases to ensure that project costs remain aligned with the initial financial forecasts.

5. **Manual Spreadsheets Slow Down Efficiency**

The presence of inconsistent data formats, combined with a heavy reliance on manual entry into spreadsheets, has significantly hindered the reporting processes in aerospace projects. This inefficiency not only delays the dissemination of crucial information but also diminishes the speed at which informed decisions can be made. To address these challenges, it is essential for aerospace projects to implement standardized templates that ensure uniformity in data collection and reporting. Additionally, adopting automated reporting tools will further streamline processes, reduce the likelihood of human error, and facilitate faster access to precise and valuable insights. By prioritizing these strategies, organizations can enhance their operational efficiency and improve overall project outcomes.

6. **Dashboards Enhance Transparency & Decision-Making**

The development of Excel-based dashboards effectively consolidated critical Key Performance Indicators (KPIs)—including Planned vs. Actual performance metrics, Forecast Accuracy percentages, and Departmental Variance analysis—into a cohesive, single-view interface. This integration allowed managers to monitor deviations in real time, facilitating immediate responses to emerging issues. By providing clear visual representations of performance data, the dashboards improved overall governance and accountability within the organization, enabling informed decision-making and strategic adjustments to enhance operational efficiency.

7. **Statistical Analysis Validated Findings**
    - **ANOVA** confirmed that cost differences across departments (Production, Quality, Logistics, R&D) were statistically significant.
    - **Regression analysis** showed Budget Threshold explains ~27% of Actual Cost variation, meaning additional hidden drivers (like procurement delays and external risks) influence cost overruns.
    - **Correlation analysis** (0.92) confirmed strong links between procurement and production costs, proving that supplier inefficiencies directly raise production expenses.

Overall Conclusion:

The study highlights that Excel-based analytics serves as a practical, low-cost, and highly adaptable solution for managing project costs in the aerospace sector. Unlike comprehensive enterprise resource planning (ERP) systems such as SAP or Oracle, which cater to organization-wide needs and require significant resources for implementation, Excel offers a more accessible alternative. It empowers departmental teams with real-time, user-friendly tools that enhance their ability to analyze and track costs effectively.

This approach is particularly beneficial in dynamic environments where project requirements frequently change. By utilizing Excel, project managers can easily customize their analytical models to reflect specific project parameters and financial scenarios, thus improving accuracy in cost forecasting.

Furthermore, the implementation of Excel analytics significantly enhances cost efficiency by streamlining processes and minimizing waste. It reduces the dependency on intuition-based decision-making, which can often lead to errors or oversights. Instead, the use of data-driven insights encourages a culture of informed decision-making within HCL Technologies, ultimately leading to more successful project outcomes. By fostering this analytical mind-set, the organization positions itself to respond quickly to project challenges and optimize resource allocation effectively.

• Suggestions

Based on the findings and conclusions, the following actionable suggestions are recommended to improve project cost management practices:

1. **Stronger Control in Production & Quality Departments**
   - Introduce department-specific Earned Value Management (EVM) practices to monitor performance against cost and schedule baselines.
   - Implement stricter approval processes for unplanned expenses in these cost-heavy departments.
   - Adopt lean manufacturing and Six Sigma methodologies to minimize waste and inefficiencies.
2. **Vendor Diversification & Strategic Partnerships**
   - Reduce over-reliance on a handful of vendors by gradually expanding the vendor base.
   - Develop multi-supplier contracts for critical components to reduce cost escalation risks.
   - Establish long-term partnerships with vendors, including joint risk-sharing models, to stabilize procurement costs.
3. **Automating Data Entry & Standardizing Reports**
   - Replace inconsistent manual spreadsheets with standardized Excel templates.
   - Integrate Excel with ERP or Power BI to automate cost variance reporting and reduce manual errors.
   - Introduce macros and VBA scripts in Excel for faster data cleaning and consolidation.
4. **Enhancing Forecasting Practices**
   - Regularly update cost models using recent project data to improve forecast reliability.
   - Combine Excel-based forecasting with advanced tools like AI/ML predictive analytics for long-term project planning.
   - Introduce scenario-based forecasting (*What-If Analysis*) to simulate risks such as supplier delays or raw material price hikes.

5. **Focus on High-Risk Phases: Testing & Deployment**
    - Allocate contingency reserves specifically for these phases, as they show the highest variance.
    - Implement milestone-based budgeting to release funds gradually based on performance.
    - Strengthen coordination between procurement and production teams to reduce bottlenecks.
6. **Expanding Dashboard Utility**
    - Incorporate not just cost KPIs but also schedule adherence, quality performance, and supplier delivery metrics into dashboards.
    - Provide real-time dashboard access to project managers, finance teams, and senior leadership for faster corrective actions.
    - Use conditional formatting and traffic-light indicators (Green-Yellow-Red) to make dashboards more intuitive.
7. **Capacity Building & Training**
    - Train employees in advanced Excel tools (Pivot Tables, Solver, Power Query, and VBA) to increase analytical capacity.
    - Develop in-house data analytics teams within aerospace projects to reduce reliance on external consultants.
    - Promote a culture of data-driven decision-making, where project managers actively use analytics instead of intuition.
8. **Long-Term Recommendation**

While Excel offers a cost-effective solution for data management and analysis in the short term, HCL Technologies should strategically consider a gradual integration of Excel-based tools with advanced analytics platforms such as Power BI and Tableau, as well as AI-driven enterprise resource planning (ERP) systems. This transition would be essential for achieving scalability across various departments, automating data processing tasks to reduce manual effort, and enhancing predictive intelligence at the enterprise level. By leveraging these advanced platforms, HCL can harness real-time data visualization, improved collaboration among teams, and sophisticated analytics capabilities, ultimately driving data-driven decision-making and competitive advantage in the long run.

• Learnings

The Summer Internship Project offered significant insights into both the technical and managerial dimensions of cost management in aerospace projects. Key insights gained from this experience include:

1. **Exposure to Aerospace Finance and Cost Management**

The project provided comprehensive insights into the intricate cost structures associated with aerospace projects. It delved into various aspects such as departmental allocations, which highlighted how resources are distributed across engineering, manufacturing, and quality assurance teams. Additionally, the analysis of vendor spending revealed the financial implications of selecting suppliers and managing contracts, demonstrating the importance of strategic partnerships in controlling costs. Phase-wise cost distribution was also examined, breaking down expenses incurred during design, prototyping, testing, and production stages. This thorough understanding underscored the critical relationship between financial efficiency and project success, illustrating how effective budget management can lead to timely deliverables and enhanced project outcomes.

2. **Hands-on Experience with Data Analytics Tools**

Engaging with Microsoft Excel and Power BI has equipped me with a robust set of practical skills in data analysis and visualization. Through hands-on experience, I have mastered data cleaning techniques, which involve identifying and rectifying inaccuracies or inconsistencies in large datasets. I've also conducted thorough variance analysis to evaluate differences between budgeted and actual performance, allowing for strategic adjustments in decision-making.

My proficiency includes regression modeling, where I've learned to identify relationships between variables and predict future trends based on historical data. Additionally, I've applied ANOVA (Analysis of Variance) to compare means across multiple groups, yielding insights that drive impactful conclusions in research and business contexts.

Using Power BI, I've been able to create dynamic, interactive dashboards that transform complex data into comprehensible visual narratives, facilitating easier interpretation for stakeholders. Overall, these analytical tools have significantly strengthened my problem-solving abilities and boosted my confidence in managing and interpreting large datasets effectively.

3. **Practical Understanding of Earned Value Management (EVM)**

The project facilitated the application of Earned Value Management (EVM) principles to effectively measure project performance, meticulously track cost overruns, and assess schedule efficiency. By integrating quantitative metrics and qualitative assessments, the practical exposure provided invaluable insights that bridged the gap between theoretical concepts and real-world applications. This experience not only deepened understanding of EVM methodologies but also highlighted the importance of proactive project monitoring and control, ultimately enhancing decision-making and project outcomes.

4. **Knowledge of Forecasting Practices and ERP Systems**

Through hands-on experimentation with Excel’s Forecast.ETS and various regression models, the project significantly deepened our understanding of predictive analysis techniques. This practical application allowed us to explore how different algorithms can forecast future trends based on historical data. Furthermore, the exposure to Enterprise Resource Planning (ERP) guidelines and cost management practices shed light on the strategic considerations companies face when choosing between cost-effective tools, such as Excel, and comprehensive enterprise solutions like SAP and Oracle. We gained valuable insights into the trade-offs involved in leveraging low-cost software for specific tasks versus investing in more robust systems that offer integrated functionalities across departments. This understanding emphasized the importance of aligning technology choices with organizational goals and financial strategies.

5. **Professional and Analytical Skill Development**

In addition to the foundational technical skills acquired during the project, participants significantly developed their abilities in critical thinking, enabling them to analyze complex problems effectively and identify underlying issues swiftly. The project also fostered structured reporting skills, equipping team members to present information in a coherent and organized manner. Furthermore, communication skills saw notable improvement as findings were conveyed through well-designed dashboards and visually compelling data visualizations. These tools not only clarified insights but also facilitated informed managerial decision-making by transforming raw data into actionable intelligence.

- ## Contribution to Host Organization

The project provided actionable contributions to HCL Technologies in the area of aerospace project cost management. These contributions include:

1. **Data Cleaning and Standardization**

The raw datasets underwent a comprehensive cleaning process, during which all duplicates were meticulously identified and removed to prevent any biases in the analysis. The data was then systematically structured into specific categories based on departments and project phases, facilitating a clearer organization. This approach not only enhanced the accuracy of the datasets but also ensured consistency across all entries, laying a solid foundation for more detailed and reliable analysis in subsequent stages.

2. **Development of Structured Dashboards**

Interactive dashboards were meticulously developed in Excel, showcasing key performance indicators (KPIs) such as budget versus actual costs, comprehensive vendor-wise analysis, forecasting accuracy metrics, and detailed departmental variances. Each dashboard features dynamic visualizations, enabling managers to effortlessly track spending patterns and identify discrepancies in real time. This enhanced visibility allows for immediate decision-making, fostering a proactive approach to budget management and operational efficiency across the organization. The incorporation of slicers and filters further enables managers to drill down into specific data sets for deeper insights into cost drivers and performance trends.

3. **Vendor, Department, and Phase-wise Analysis**

A comprehensive analysis conducted on operational expenditures revealed that the Production and Quality departments are the highest-cost segments within the organization, primarily due to their extensive resource requirements and labor intensity. Additionally, the analysis underscored significant vendor concentration risks, indicating a reliance on a limited number of suppliers that could jeopardize supply chain stability and negotiating leverage.

Furthermore, the phase-wise analysis of project workflows identified Testing and Deployment as the most cost-sensitive stages. This finding emphasizes the need for strategic management in these phases to minimize expenses and mitigate potential delays, suggesting that meticulous planning and resource allocation are crucial for optimizing overall project budgets.

4. **Improvement Suggestions for Cost Forecasting and Vendor Management**

To improve the accuracy of cost forecasting, it was recommended that organizations implement advanced analytics tools and methodologies, such as predictive modeling and scenario analysis. This can help identify potential fluctuations in costs by analyzing historical data and market trends. Additionally, diversifying the vendor base is essential; it encourages competitive pricing and reduces dependency on a single supplier. By strategically onboarding multiple suppliers from different geographical regions, companies can mitigate risks associated with supply chain disruptions.

Furthermore, strengthening supplier contracts is crucial. This involves negotiating terms that include clear performance metrics, penalties for non-compliance, and flexible clauses to address unforeseen circumstances, such as price changes or delays in delivery. Together, these strategies are designed to significantly lower the risks of budget overruns and ensure a more resilient supply chain, ultimately safeguarding the organization’s financial health and operational continuity.

5. **Enhanced Decision Support Framework**

By integrating advanced statistical validation techniques such as ANOVA (Analysis of Variance), Regression Analysis, and Correlation Analysis with dynamic visual dashboards, the project significantly enhanced a decision support framework specifically tailored for the aerospace sector. This integration not only facilitated a comprehensive analysis of project data but also enabled stakeholders to visualize complex relationships and trends effectively. As a result, the framework empowers decision-makers to make informed, data-driven choices during the planning and execution phases of aerospace projects, ultimately leading to improved efficiency, reduced risks, and optimized resource allocation.

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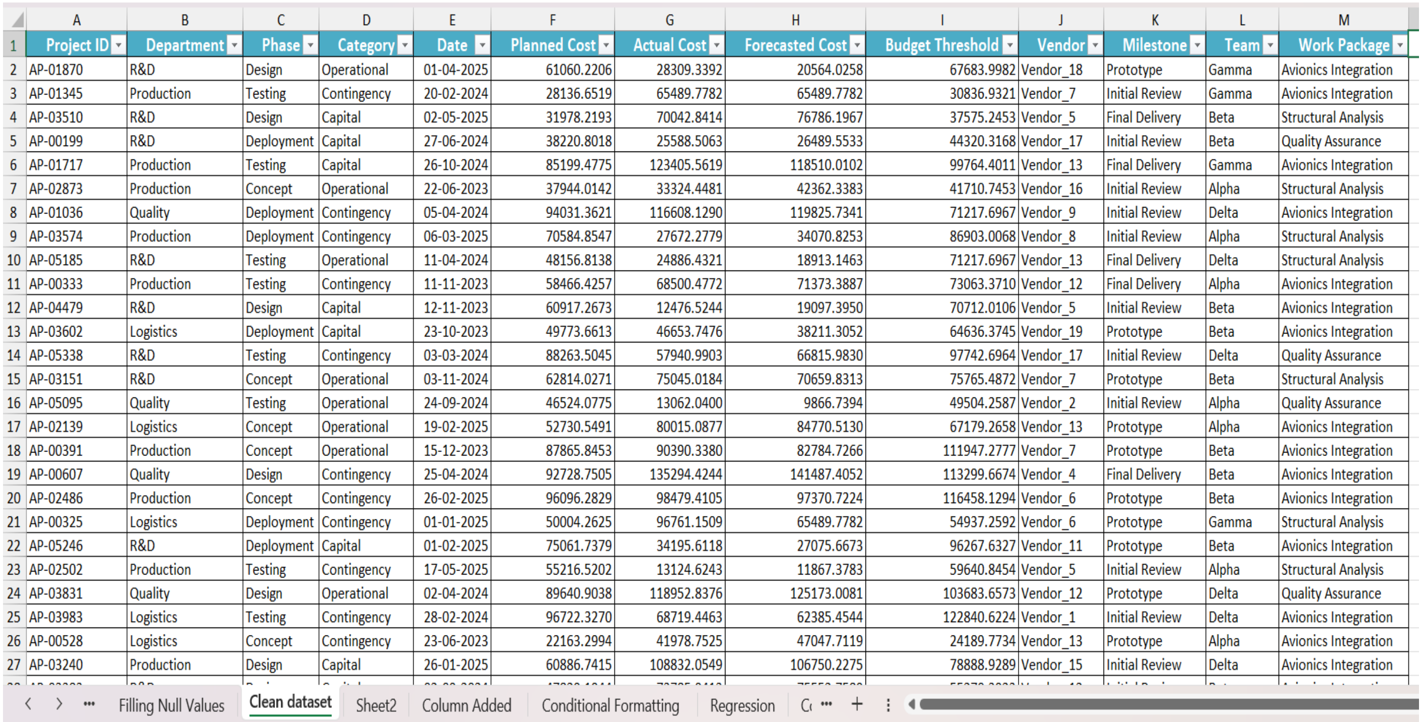
Dataset 1



1	Project ID	Department	Phase	Category	Date	Planned Cost	Actual Cost	Forecasted Cost	Budget Threshold	Vendor	Milestone	Team	Work Package
2	AP-01870	R&D	Design	Operational	01-04-2025	61060.2206	28309.3392	20564.0258	67683.9982	Vendor_18	Prototype	Gamma	Avionics Integration
3	AP-01345	Production	Testing	Contingency	20-02-2024	28136.6519	65489.7782	65489.7782	30836.9321	Vendor_7	Initial Review	Gamma	Avionics Integration
4	AP-03510	R&D	Design	Capital	02-05-2025	31978.2193	70042.8414	76786.1967	37575.2453	Vendor_5	Final Delivery	Beta	Structural Analysis
5	AP-00199	R&D	Deployment	Capital	27-06-2024	38220.8018	25588.5063	26489.5533	44320.3168	Vendor_17	Initial Review	Beta	Quality Assurance
6	AP-01717	Production	Testing	Capital	26-10-2024	85199.4775	123405.5619	118510.0102	99764.4011	Vendor_13	Final Delivery	Gamma	Avionics Integration
7	AP-02873	Production	Concept	Operational	22-06-2023	37944.0142	33324.4481	42362.3383	41710.7453	Vendor_16	Initial Review	Alpha	Structural Analysis
8	AP-01036	Quality	Deployment	Contingency	05-04-2024	94031.3621	116608.1290	119825.7341	71217.6967	Vendor_9	Initial Review	Delta	Avionics Integration
9	AP-03574	Production	Deployment	Contingency	06-03-2025	70584.8547	27672.2779	34070.8253	86903.0068	Vendor_8	Initial Review	Alpha	Structural Analysis
10	AP-05185	R&D	Testing	Operational	11-04-2024	48156.8138	24886.4321	18913.1463	71217.6967	Vendor_13	Final Delivery	Delta	Structural Analysis
11	AP-00333	Production	Testing	Contingency	11-11-2023	58466.4257	68500.4772	71373.3887	73063.3710	Vendor_12	Final Delivery	Alpha	Avionics Integration
12	AP-04479	R&D	Design	Capital	12-11-2023	60917.2673	12476.5244	19097.3950	70712.0106	Vendor_5	Initial Review	Beta	Avionics Integration
13	AP-03602	Logistics	Deployment	Capital	23-10-2023	49773.6613	46653.7476	38211.3052	64636.3745	Vendor_19	Prototype	Beta	Avionics Integration
14	AP-05338	R&D	Testing	Contingency	03-03-2024	88263.5045	57940.9903	66815.9830	97742.6964	Vendor_17	Initial Review	Delta	Quality Assurance
15	AP-03151	R&D	Concept	Operational	03-11-2024	62814.0271	75045.0184	70659.8313	75765.4872	Vendor_7	Prototype	Beta	Structural Analysis
16	AP-05095	Quality	Testing	Operational	24-09-2024	46524.0775	13062.0400	9866.7394	49504.2587	Vendor_2	Initial Review	Alpha	Quality Assurance
17	AP-02139	Logistics	Concept	Operational	19-02-2025	52730.5491	80015.0877	84770.5130	67179.2658	Vendor_13	Prototype	Alpha	Avionics Integration
18	AP-00391	Production	Concept	Operational	15-12-2023	87865.8453	90390.3380	82784.7266	111947.2777	Vendor_7	Prototype	Beta	Avionics Integration
19	AP-00607	Quality	Design	Contingency	25-04-2024	92728.7505	135294.4244	141487.4052	113299.6674	Vendor_4	Final Delivery	Beta	Avionics Integration
20	AP-02486	Production	Concept	Contingency	26-02-2025	96096.2829	98479.4105	97370.7224	116458.1294	Vendor_6	Prototype	Beta	Avionics Integration
21	AP-00325	Logistics	Deployment	Contingency	01-01-2025	50004.2625	96761.1509	65489.7782	54937.2592	Vendor_6	Prototype	Gamma	Structural Analysis
22	AP-05246	R&D	Deployment	Capital	01-02-2025	75061.7379	34195.6118	27075.6673	96267.6327	Vendor_11	Prototype	Beta	Avionics Integration
23	AP-02502	Production	Testing	Contingency	17-05-2025	55216.5202	13124.6243	11867.3783	59640.8454	Vendor_5	Initial Review	Alpha	Structural Analysis
24	AP-03831	Quality	Design	Operational	02-04-2024	89640.9038	118952.8376	125173.0081	103683.6573	Vendor_12	Prototype	Delta	Quality Assurance
25	AP-03983	Logistics	Testing	Contingency	28-02-2024	96722.3270	68719.4463	62385.4544	122840.6224	Vendor_1	Initial Review	Delta	Avionics Integration
26	AP-00528	Logistics	Concept	Contingency	23-06-2023	22163.2994	41978.7525	47047.7119	24189.7734	Vendor_13	Prototype	Alpha	Avionics Integration
27	AP-03240	Production	Design	Capital	26-01-2025	60886.7415	108832.0549	106750.2275	78888.9289	Vendor_15	Initial Review	Delta	Avionics Integration

Figure No. 13: Dataset 1

Dashboard of Dataset 1

Figure No.14: Dashboard of Dataset 1

Dataset 2

1	Project ID	Department	Phase	Category	Date	Planned Cost	Actual Cost	Forecasted Cost	Budget Threshold	Vendor	Milestone	Team	Work Package	Efficacy Score
2	AP-00001	Production	Deployment	Capital	2023-06-05 00:00:00	70272.93	55992.06	49459.16	76859.65	Vendor_4	Final Delivery	Delta	Structural Analysis	25.5052
3	AP-00002	Production	Deployment	Operational	2024-07-09 00:00:00	54495.31	100278.97	99771.51	65224.69	Vendor_20	Prototype	Delta	Structural Analysis	-45.6563
4	AP-00003	Production	Deployment	Contingency	2024-02-13 00:00:00	68245.95	30827.68	36180.39	73302.83	Vendor_20	Prototype	Beta	Avionics Integration	121.3788
5	AP-00004	Quality	Design	Capital	2025-02-01 00:00:00	25681.86	52002.92	60615.36	71029.39	Vendor_2	Prototype	Delta	Quality Assurance	-50.6146
6	AP-00005	R&D	Concept	Capital	2025-05-19 00:00:00	30143.08	19680.49	14755.01	34424.29	Vendor_17	Final Delivery	Gamma	Quality Assurance	53.1622
7	AP-00006	Logistics	Design	Operational	2023-06-13 00:00:00	65733.53	101513.98	94032.79	78031.02	Vendor_12	Initial Review	Delta	Structural Analysis	-35.2468
8	AP-00007	R&D	Testing	Contingency	2023-06-13 00:00:00	60376.97	62472.78	62709.87	65154.38	Vendor_15	Initial Review	Delta	Quality Assurance	-3.3548
9	AP-00008	Quality	Concept	Capital	2025-04-24 00:00:00	97600.36	144787.14	60615.36	111171.32	Vendor_14	Final Delivery	Beta	Structural Analysis	-32.5904
10	AP-00009	Logistics	Concept	Contingency	2023-08-27 00:00:00	83439.03	117280.03	122903.79	71029.39	Vendor_15	Initial Review	Delta	Quality Assurance	-28.8549
11	AP-00010	Logistics	Deployment	Operational	2025-02-26 00:00:00	60226.83	86009.94	82881.17	69926.00	Vendor_17	Initial Review	Gamma	Avionics Integration	-29.9769
12	AP-00010	Logistics	Deployment	Operational	2024-12-20 00:00:00	60226.83	86009.94	82881.17	69926.00	Vendor_17	Initial Review	Gamma	Avionics Integration	-29.9769
13	AP-00011	Production	Testing	Capital	2023-11-12 00:00:00	89234.55	92559.19	97970.19	102222.97	Vendor_3	Initial Review	Delta	Quality Assurance	-3.5919
14	AP-00012	Quality	Testing	Operational	2024-06-28 00:00:00	55233.11	86772.18	81476.79	71029.39	Vendor_19	Final Delivery	Delta	Avionics Integration	-36.347
15	AP-00013	R&D	Testing	Capital	2025-05-26 00:00:00	40583.74	79649.24	60615.36	50872.56	Vendor_11	Final Delivery	Delta	Avionics Integration	-49.0469
16	AP-00014	Logistics	Deployment	Operational	2024-10-09 00:00:00	28452.98	37914.27	42371.32	71029.39	Vendor_13	Prototype	Beta	Avionics Integration	-24.9544
17	AP-00015	Production	Testing	Operational	2024-10-02 00:00:00	61724.45	47366.88	39524.94	73823.23	Vendor_17	Final Delivery	Gamma	Avionics Integration	30.3114
18	AP-00016	R&D	Testing	Contingency	2023-09-01 00:00:00	22650.39	19834.51	22420.87	26852.24	Vendor_5	Final Delivery	Beta	Quality Assurance	14.1969
19	AP-00017	Logistics	Design	Capital	2024-05-06 00:00:00	95038.41	79802.28	71520.21	117005.14	Vendor_14	Prototype	Alpha	Structural Analysis	19.0923
20	AP-00017	Logistics	Design	Capital	2024-12-10 00:00:00	95038.41	79802.28	71520.21	117005.14	Vendor_14	Prototype	Alpha	Structural Analysis	19.0923
21	AP-00018	Production	Concept	Contingency	2024-05-30 00:00:00	79448.3	126072.16	126990.74	71029.39	Vendor_9	Final Delivery	Alpha	Structural Analysis	-36.9819
22	AP-00019	R&D	Testing	Operational	2024-10-17 00:00:00	97966.16	78680.94	79009.96	103110.07	Vendor_9	Final Delivery	Alpha	Quality Assurance	24.5107
23	AP-00020	R&D	Deployment	Operational	2024-07-17 00:00:00	88600.67	69673.34	60615.36	107872.32	Vendor_6	Initial Review	Delta	Avionics Integration	27.1658
24	AP-00021	R&D	Deployment	Capital	2024-05-28 00:00:00	61624.43	104334.15	97167.55	78221.84	Vendor_4	Prototype	Beta	Structural Analysis	-40.9355
25	AP-00021	R&D	Deployment	Capital	2024-03-08 00:00:00	61624.43	104334.15	97167.55	78221.84	Vendor_4	Prototype	Beta	Structural Analysis	-40.9355
26	AP-00022	Production	Design	Capital	2025-05-07 00:00:00	99449.35	76405.42	73537.59	126853.95	Vendor_16	Final Delivery	Beta	Quality Assurance	30.1601
27	AP-00023	Quality	Testing	Contingency	2023-09-19 00:00:00	20995.96	55260.71	51241.28	23713.40	Vendor_1	Final Delivery	Alpha	Structural Analysis	-62.0056
28	AP-00024	Logistics	Design	Operational	2023-10-08 00:00:00	68310.67	79341.48	85800.48	75058.75	Vendor_14	Prototype	Delta	Structural Analysis	-13.903
29	AP-00025	Logistics	Concept	Contingency	2024-05-22 00:00:00	66695.1	42306.64	37343.71	80861.01	Vendor_5	Initial Review	Beta	Quality Assurance	57.6469

Unclean dataset | Finding Duplicates | Finding Null | Filling Null Values | Clean dataset | Column Added

Figure No.15: Dataset 2

Dashboard of Dataset 2

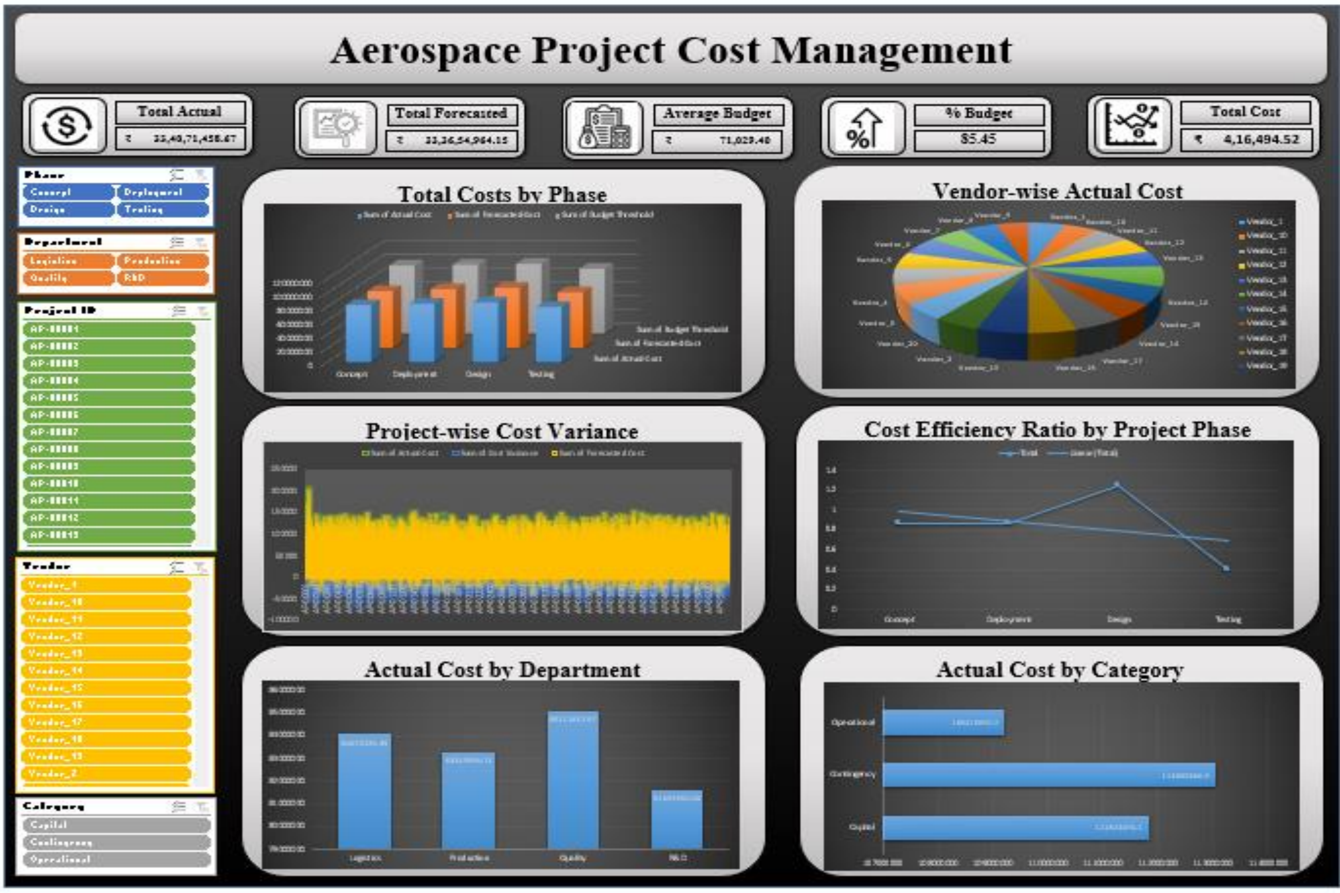


Figure No.16: Dashboard of Dataset 2

Feedback from HCL

Feedback

Grade	88.00 / 100.00
Graded on	Tuesday, 29 July 2025, 2:51 PM
Graded by	Dr. Vagish Datta
Feedback comments	The Analytical and presentation skill were so good. And, need some enhancements in technical implementations.

Figure No. 17: Feedback

Student daily diary/ diary log

Sr. no	Date	Task / Activity Done	In Time (Start Time)	Out Time (End Time)
1.	02/06/2025	Orientation Program	11.00 AM	02.00 PM
2.	03/06/2025	Basic Training on Excel Topic: Remove Duplicates, Conditional Formatting, Data Analysis, Data Validation, and other formulas	11.00 AM	02.00 PM
3.	04/06/2025	Basic Training on Excel Topic: Mean, Median, Mode, Flash Fill, Text Join, Concatenate, Goal Seek	11.00 AM	02.00 PM
4.	05/06/2025	Basic Training on Excel Topic: What if Data Analysis, Data Table, Vlookup, Xlookup, Macros, Forecast, Quick analysis tool	11.00 AM	02.00 PM
5.	06/06/2025	Basic Training on Excel Topic: Data Analysis- Descriptive statistics and Interntinal statistics, Regression, Correlation, T &Z test	11.00 AM	02.00 PM
6.	09/06/2025	Basic Training on Excel Topic: Anova (Analysis of variance) it's types, Chi-Square, Slicer, Pivot table, KPI , and Types of Analytics	11.00 AM	02.00 PM
7.	13/06/2025	Basic Training on Excel Presentation of Dataset on which we are working and if there is the any query solve with the help of Trainers	11.00 AM	02.00 PM
8.	16/06/2025	Allocation of Group project on ERP portal and Learning key steps	11.00 AM	02.00 PM
9.	20/06/2025	Collection of Aerospace Project Cost Dataset From Different Sources	11.00 AM	02.00 PM
10.	23/06/2025	Presentation of first phase work done and if there is the any query solve with the help of Trainers	11.00 AM	02.00 PM
11.	27/06/2025	Presentation of second phase work done and if there is the any query solve with the help of Trainers	11.00 AM	02.00 PM

12.	30/06/2025	Presentation of work done and if there is the any query solve with the help of Trainers	11.00 AM	02.00 PM
14.	04/07/2025	Final Presentation of Group project and upload the dataset on ERP	11.00 AM	02.00 PM
15.	07/07/2025	Work started on the Individual project	11.00 AM	02.00 PM
16.	11/07/2025	Presentation on work done and if there is the any query solve with the help of Trainers	11.00 AM	02.00 PM
17.	14/07/2025	Presentation on work done and if there is the any query solve with the help of Trainers	11.00 AM	02.00 PM
16.	18/07/2025	Final Presentation of project and Uploaded the final project on ERP	11.00 AM	04.00 PM

Table No.18: Student daily diary/ diary log

Internship synopsis

Information Student		Industry Supervisor	
Name	Sagar Goraksahanath Shingade	Name company guide/mentor	Dr. Vagish Datta
Year	2024-26	Title	Educator
Campus Address	Kopargaon	Company	HCL
Phone	75229426555	Internship Address	Online Mode
Email	sshingade024@gmail.com	City, state, PIN	Pune, Maharashtra
		Phone	-
		Email	vagish@careercraftacademy.com

Faculty Mentor		Academic Credit Information	
Name	Dr. V.R. Malkar Sir	Internship Title	Business Analytics
Phone	94215 82726	Department	MBA
Campus Address	Kopargaon	Course	SIP
		Credits	8
		Beginning date of Internship	2nd June 2025
		Ending date	31st July 2025
		Internship Paid or Unpaid	Unpaid

Table No. 19: Internship synopsis