Research on Cost Management of Civil Aviation Product R&D Projects

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Abstract. Project cost management, as an integral component of project management, serves as a guarantee for the successful implementation of projects. However, for research-oriented institutions with relatively lagging management capabilities, enhancing the level of cost management in their product development projects becomes even more imperative. This paper combines theoretical research with case implementation to analyze how a research-oriented institution within a specific system optimizes cost management strategies and selects cost management methods during the implementation of aerospace new product development projects. It further conducts a simulation study using the cost management strategies and methods proposed in this paper, based on a completed project cost management case. The results show that there are various cost estimation methods, cost budgeting methods, and cost control methods available for different projects and business scenarios. It is essential for research-oriented institutions to choose cost management methods that are suitable for their specific projects based on their actual circumstances. This helps improve the overall level and efficiency of project cost management, while also enhancing the value of the projects. Research institutes must further optimize their cost management system and establish modern and standardized cost management processes.

Keywords: Aviation new product projects, project cost management, cost control, civil aircraft projects

1 Introduction

The field of aviation science and technology has experienced rapid development, and the aviation industry has gradually become a strategic industry and a significant symbol of a country's rise. It is also considered a crucial factor in competing on the global stage and participating in international competition [1]. In particular, in the management of aviation product research and development projects, the majority of aviation technology enterprises in China still rely on the product project management model inherited from the Soviet Union in the last century. This outdated model no longer meets the requirements of modern aviation product research and development management and needs to be adjusted promptly. Due to the prevalent mindset of "emphasis on technology, neglect of management" in most aviation technology enterprises, Chinese aviation

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products often lack emphasis on the economic and resource-saving aspects of research and development [2].

In the field of research and development project cost management, scholars have conducted extensive research [3]. Lucas et al. initiated their study from the perspective of cost management and established a Hamilton equation for dynamic cost management of research and development projects under conditions of project completion time certainty and uncertainty [4]. Through their research, they discovered that the optimal project cost expenditure varies in quantity under different conditions. Among subsequent scholars, Grossman et al. further expanded upon Lucas's research by improving the Hamilton equation, incorporating modifications, and considering the impact of technological changes on optimal cost expenditure, leading to new research findings [5]. Dutta et al. analyzed the entire cost management process of research and development projects and studied cost management issues that arise from the interplay of various project activities [6].

However, there is still relatively little research on cost management in research and development projects. Existing research has mostly focused on the design and application of cost management methods, while research on the overall framework of cost management in research and development projects and the design of cost management systems needs to be strengthened [7].

This study focuses on A's civil aviation aircraft new product development project, guided by project management theory. Its aim is to explore how to establish a scientifically effective cost management system in aviation new product development projects and provide some reference for cost management in such projects. By using a specific aviation new product development project of A Company as a case study, scientific project cost management theories and methods are employed to implement a cost management plan. A comparison is made between the implementation effects of the plan and the actual cost management results of the project to determine the feasibility of the cost management approach and methods used in this study.

2 The R&D Project of Civil Aircraft Aviation New Products

This article takes A Company's new product development project, specifically the C-band multi-mode transmission module II, as a pilot study. Cost management for this R&D project is conducted according to a new cost management approach. The characteristics and processes of cost management in this type of development project are similar to those of aviation new product development projects undertaken by A Company, with the only difference being a slightly lower level of confidentiality involved. The operational methods and management content of cost management are similar in both cases.

The C-band multi-mode transmission module II is a microwave transmitter equipment and one of the microwave product development projects of a subsidiary company under A. The main function of this product is to achieve the signal transmission process for communication signals in aviation equipment. It also requires high anti-interference

capability, reliability, and other technical conditions. According to user requirements, this product can be customized to meet individual needs. Currently, this product is relatively new in the product lineup of A's subsidiary company. The development of this product project is very similar to the development of A's aviation new products, characterized by a small scale and high requirements for product quality and technical reliability. It closely aligns with the subject of this article's research and possesses strong representativeness, making it suitable for case analysis.

Due to the short duration of the project and its non-priority status within the organization, a special application has been made to pilot project management for this particular project, with a focus on innovative application of cost management. Consequently, an independent pilot team has been established for this project. All management methods operate in accordance with the redesigned cost management approach mentioned in the previous section. An independent virtual project account has been set up to facilitate tracking and querying of financial data. The following analysis will apply the standard cost management process and the guiding principles of cost management to the C-band multi-mode transmission module II project in the aviation industry.

The resource plan refers to the list of tangible and intangible resources required and used based on the project WBS (Work Breakdown Structure), including human resources, equipment hardware, work software, raw materials, and workplace work content. In this project, the specific resource plan required is shown in Table 1.

Table 1. Resource planning table.

Item	Number	Description
Designer	10	4 people are responsible for hardware development, 4 people are responsible for software development, and 2 people are dedicated to material procurement, financial data communication, and after-sales service tracking.
Place	5	3 independent R&D rooms and 2 equipment debugging rooms
Original material	-	Procurement according to project requirements
Funds	500,000 yuan	Cost estimation

This plan was reviewed in detail by experts, and specific indicators were discussed in detail. After thorough discussions by the project technical leader, designer, and project supervisor, some indicators unrelated to the project were removed, and the research and development scope of the project was determined without increasing costs.

3 Cost Estimation for Aviation New Product Development Projects

In this project, the project staff have gained a preliminary understanding of the basic functions of the new product and established a work breakdown structure for the R&D

project, thus gaining a certain understanding of the potential scale involved in the project. At the new product development project scale evaluation meeting organized by the R&D department, the scope of the project was estimated from the perspective of the functional module composition of the product and the stage composition of the project. The basic content of the project scale estimation is shown in Table 2.

The project uses different measurement units for scale estimation, such as document pages for estimating the scale of documents, design codes for estimating the scale of functional module design, and debugging iterations for estimating the scale of debugging tasks. The main reason for using different units is that it is difficult to quantify the scale of the product development project using a single unit of measurement. The product development and design involve multiple units of measurement, making it challenging to choose a single unit of work to equate the scale of the project. The purpose of using different scale measurement units is to provide references to project managers when estimating specific task workloads and cost expenses. By employing various scale measurement units, it helps project managers gain a macro-level understanding of the scope and magnitude of the C-band multi-mode transmission module II development project.

Table 2. Estimation of R&D project scale.

Stage	Mission	Scale
requirement analysis	Feasibility analysis	30 pages
	requirement analysis	80 pages
High voltage power supply	High frequency switching power supply	4k design code
High voltage power supply	High voltage power supply	4k design code
Gate modulator	Drive and protection of modulators	3k design code
	Positive bias power supply	4k design code
	Negative bias power supply	4k design code
Charging circuit	Charging circuit	4k design code
Cooling system	Cooling system	3k design code
Control and protection circuits	Monitoring extension	3k design code
	Detection machine	3k design code
Product debugging	Functional module debugging	100 times
	Overall debugging	200 times

After completing the scale estimation of the project, the next step is to perform a detailed workload estimation for each work task or work package. Only by understanding the workload of each cost estimation unit and the resources required for the workload, can we further estimate the detailed cost of the entire project. Based on the cost estimation method determined in the project cost management optimization plan, this case will adopt a bottom-up approach for cost estimation. This means breaking down the entire project into the smallest units of work packages that can be directly estimated, and estimating the workload and specific costs based on these work packages.

Therefore, this project sets the minimum unit for workload estimation as work packages, with the work package decomposition based on the project's WBS. Guided by the project's WBS, this paper decomposes the entire project into work packages, resulting in 18 work packages suitable for workload and cost estimation. After the work package decomposition is completed, it is necessary to conduct detailed estimates of the workload for each work package. Detailed workload estimation involves estimating the time required for each work package from start to finish using certain methods. According to the cost estimation methods mentioned in the design of the cost management optimization plan, this project will adopt historical project analogy analysis and expert judgment methods for estimating the workload of bottom-level work packages. The unit of workload measurement is person/month, indicating how many people are needed to complete the work package in one month or how many months one person needs to complete it from start to finish.

The development of C-band multi-channel modulation transmission component II also requires the composition of specific hardware equipment, which are products purchased by the project team from specific manufacturers. Therefore, when estimating the cost of the entire product project, it is necessary to consider the proportion of such equipment occupied. Based on the functional modules of the final product and the project team's understanding of product development, a list of R&D hardware equipment and costs that need to be purchased can be obtained as shown in Table 3.

Table 3. List of equipment and expenses for project product research and development.

Names of device	Price (1000yuan)
High voltage power supply related equipment	2
Hardware equipment related to modems	2
Cooling system related equipment	3
Various hardware equipment related to circuits	4

4 R&D Project Cost Budget

Cost budgeting is conducted after the completion of the three major tasks: work breakdown structure, cost estimation, and work schedule planning. The work breakdown structure and cost estimation tasks have been completed earlier in the document. Based on the modular complexity of the aviation new product, C-band multi-channel modulation transmission component II development project, as well as the skill level of the project personnel, this paper plans the project schedule for the development of the product. Simultaneously, considering the client's requirements, which typically demand earlier progress due to their specificity, a schedule is designed for the development project of the C-band multi-channel modulation transmission component II. This schedule is formulated by integrating the client's specific schedule requirements with the available personnel and various resources.

Based on the integration of project materials including the project work breakdown structure, project cost estimation, and project schedule, the cost budgeting adopted in the case study investigated in this paper involves disaggregating the overall project cost

to specific work tasks at certain reporting points in time, and establishing time reporting points to accumulate planned budget costs within these intervals. This ultimately leads to the formulation of a budgeted cost plan for each time reporting point, also known as the cost baseline plan. In accordance with the characteristics of this project, standard time reporting points are implemented on a monthly basis, where the cost budget for each monthly work task is calculated, resulting in the final monthly planned cost.

Since the cost estimation has already provided the salaries for different work content for each month, by converting the salaries and considering the number of project participants, the planned labor cost budget for each work task per month can be obtained. Further, by aggregating the costs of each task, the monthly project labor cost expenditure can be determined. Additionally, regarding the cost budget plan for hardware equipment development, the allocation is directly based on the project implementation process. Specifically, the $110,000 equipment procurement cost is allocated across the cost expenditure from the first month to the fourth month. The rationale for this allocation is that hardware equipment procurement typically occurs in the early stages of project development, and the research and development process can only proceed smoothly after the arrival of the equipment.

5 Cost Control Plan for Research and Development Projects

According to the principles of Earned Value Analysis (EVA), when conducting cost control analysis using EVA, the first requirement is to provide three key pieces of data: the Budgeted Cost of Work Scheduled (BCWS), the Actual Cost of Work Performed (ACWP), and the Budgeted Cost of Work Performed (BCWP), which are associated with the planned work volume for the entire project. The ACWP is determined by measuring the actual expenditures over specific time intervals, requiring no complex calculations but merely the compilation of actual cost expenditures over standard time periods, in this project analyzed on a monthly basis. The budgeted quota for planned work volume is the product of the planned work volume and the budgeted quota. In this project, the unit of planned work volume is "month," hence the monthly budget value represents the quota for completing the work volume for that month. The budgeted cost of work performed reflects the difference between the completed work volume and the planned work volume.

In this case study, monthly intervals are used as inspection units for checking cost and schedule variances. Through data organization, the BCWS, ACWP, and BCWP values are ultimately obtained for each inspection point throughout the entire project process.

Using the formulas CV=BCWP-ACWP, SV=BCWP-BCWS, calculate the cost deviation and schedule deviation, and create a relationship diagram for three types of costs (Figure 1). It can be observed that, on the one hand, the product development project has incurred some cost overruns during the execution process, with minimal differences in the curves, indicating that the situation of cost overrun is not severe but still warrants the attention of project managers. On the other hand, from the Schedule Variance (SV)

and the relationship diagram, it is evident that there has been a slight delay in project execution, characterized by short-term extensions, which also demands sufficient attention from managers. Typically, the occurrence of these situations indicates inefficiencies in the overall project, affecting the progress of the entire work and presenting issues of premature expenditure of project funds. In response to these issues, project managers need to examine the project's operational status at each standard time node and formulate cost control measures based on the actual circumstances.

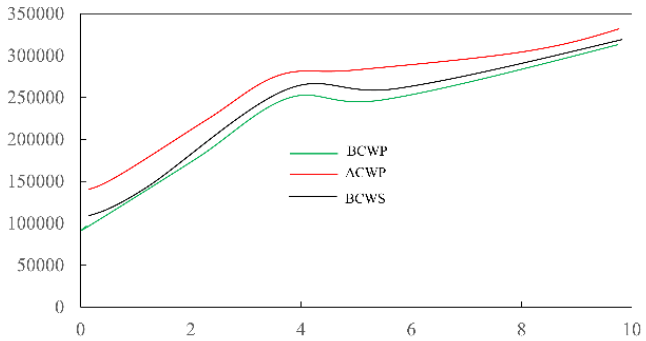

Fig. 1. C-band Multiplex Modulation Transmission Module II Project Three Category Cost Relationship Diagram.

6 Conclusion

In the realm of cost management, there exist various methods for cost estimation, budgeting, and control tailored to different projects and business scenarios. It is imperative for research-oriented institutions to select cost management methods that are suitable for their specific project circumstances. By doing so, the overall level and efficiency of cost management within the project can be enhanced, consequently adding value to the project.

References

1. A. B .ASSESSMENT MECHANISM OF THE STRATEGIC EFFICIENCY OF PROJECTS ON THE CREATION OF HIGHTECH PRODUCTS IN THE AVIATION INDUSTRY.Vestnik Universiteta,2019,0(6),51-56..
2. Jaifer R ,Beauregard Y ,Bhuiyan N .New Framework For Effort And Time Drivers In Aerospace Product Development Projects.Engineering Management Journal,2020,33(2),1-20.
3. Francois J T .Air Products invests in Chinese syngas project[J].CHEMICAL ENGINEERING NEWS,2017,95(37),12-12.
4. C.Lucas. Intergrated Costand Sehedule Control in Project Management. Joumalof Project Management, 2002, 24(3),56-72.
5. Grossman, Shapiro.A Study on Project Cost Control with the Method of Hamilton Equation. Project Management Journal, 1998, 5(3),25-36.

6. S Dutta.Developing a Risk Management Matrix for Effective Project Planning-an Empirical Study. Project Management Journal, 2001, 18(3),48-69.
7. Müller K A ,Wald A,Görner A.Comparing project management practices in new product development: a study in the automotive, aerospace and rail transport industry.Int. J. of Project Organisation and Management,2012,4(3),203-217.