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An Overview of Management in Aerospace System Enterprises

Zhenda Wei[1,a,*]

[1]*International Cooperation Center of China Aerospace, 100142, Beijing, China*
[a]*15210337113@163.com*
[*]*Corresponding author*

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Abstract: This paper focuses on the field of aerospace system enterprise management and conducts in-depth and comprehensive discussions. Aerospace system enterprises have distinct management characteristics due to the complexity, high risk, and significant importance to national strategy of the tasks they undertake. The key elements of its management cover multiple levels such as strategic management, project management, technological innovation management, and human resource management. These elements are interrelated and influence each other, together forming the core system of aerospace system enterprise management. At present, aerospace system enterprises are facing many severe challenges. The rapid development of emerging technologies such as artificial intelligence and big data has brought impact, and international competition is increasingly fierce. At the same time, the demand for commercial aerospace transformation is becoming more urgent. To address these challenges, aerospace system enterprises need to strengthen their tracking and application of cutting-edge technologies, enhance their core competitiveness, and innovate business models. Through these strategies, we aim to promote the sustained and stable development of aerospace system enterprises, contribute greater strength to the progress of the national aerospace industry, and help the country occupy a leading position in the global aerospace field.

1. Introduction

1.1. Research background

Aerospace system engineering, as a high-end field of modern science and technology, integrates numerous cutting-edge technologies and complex organizational collaborations. Aerospace system enterprises are the actual executors of this grand project, and their management level not only determines the success or failure of individual aerospace projects but also exerts a profound impact on the overall development of the national aerospace industry and international competitiveness. In recent years, the global aerospace field has witnessed vigorous development. Countries around the world have increased their investment in aerospace, and commercial space has gradually emerged, positioning aerospace system enterprises in a more complex and ever-changing competitive

environment. Against this backdrop, in-depth research on the management in aerospace system enterprises holds considerable practical urgency and strategic significance.

1.2. Research objectives and significance

Objectives: To comprehensively analyze the internal laws and key elements of management in aerospace system enterprises, and provide theoretical guidance and practical references for aerospace system enterprises to optimize their management models and enhance management efficiency.[1]

Significance: Theoretically, this paper enriches and improves the research system of enterprise management in specific fields. From a practical perspective, it helps aerospace system enterprises better cope with challenges and achieve sustainable development in a complex and ever-changing environment, thereby enhancing national aerospace strength and safeguarding national strategic interests.

2. Characteristics of Aerospace System Enterprises

2.1. High complexity

Technical dimension: From the initial conceptual design to the final successful launch and operation, an aerospace project involves the intersection and integration of multiple disciplines such as electronic technology, mechanical engineering, materials science, and aerodynamics. For example, in the control system of a spacecraft, electronic technology is required to achieve precise control, and its structure must be designed based on the principles of mechanical engineering and materials science to ensure reliability and stability in the extreme space environment.

Organizational dimension: An aerospace project involves many departments and personnel from different professional backgrounds, ranging from the R&D team, production and manufacturing department, to quality inspection, and launch command, among others. All links are closely connected and influence each other. This cross-departmental and cross-professional collaboration greatly increases the difficulty of management and coordination. Any problem in any link may affect the overall progress and quality of the project.[2]

2.2. High risk

Economic risk: An aerospace project generally necessitates huge financial investment. Each stage, from the R&D, manufacturing, launch of spacecraft to subsequent orbital operation and maintenance, comes with high costs. The failure of the project not only results in the loss of a large amount of funds invested in the early stage, but may also lead to a tight capital chain for subsequent projects, severely impacting the enterprise's financial position.

Reputation and strategic risk: Aerospace missions often carry the honor and strategic mission of a country. Their success or failure is directly related to the country's reputation and status in the international aerospace field. A failed spacecraft launch may attract widespread attention from the international community, have a negative impact on the country's aerospace image and disrupt its overall aerospace strategic layout.[3]

2.3. Technology-intensive and innovative

Technology-intensive: The aerospace field at the forefront of scientific and technological development is highly dependent on advanced technologies. High-performance rocket engine

technology, advanced spacecraft thermal control technology, and high-precision navigation and communication technology all represent the pinnacle of achievement in their respective domains. Enterprises need to consistently invest substantial resources in technology R&D and talent training to maintain their leading position in technology.[4]

Innovative: In order to meet the expanding requirements of aerospace missions, such as deep-space exploration and manned spaceflight, aerospace system enterprises must continuously pursue technological innovation. The R&D of new rocket engines aims to enhance the carrying capacity and reduce costs, while the innovation in spacecraft materials is committed to improving their performance and lifespan in the space environment. This unremitting pursuit of new technologies requires enterprises to create a management environment that encourages innovation and stimulates employees' innovation enthusiasm.

2.4. National strategic orientation

Task undertaking: Most aerospace system enterprises undertake important state-assigned aerospace strategic tasks assigned by the state, such as the manned spaceflight project and the lunar exploration project. These tasks have clear national strategic goals, aiming to enhance the country's scientific and technological strength, national defense security, and international influence.

Management decisions: The management decisions of enterprises must be closely aligned with national strategies. From project planning and approval to resource allocation and utilization, the realization of national strategic goals should be the primary consideration. This means that while pursuing economic benefits, enterprises should prioritize social benefits and the realization of national strategic interests.[5]

3. Key Elements of Management in Aerospace System Enterprises

3.1. Strategic management

3.1.1. Formulation of long-term plans

Basis analysis: Enterprises should thoroughly study the national aerospace development strategy and formulate forward-looking and feasible 5-10-year or even longer-term development plans based on their actual conditions such as technological resources, talent reserves, and market competition.

Clear goals: Clear development directions and goals should be set for the enterprises in key fields such as manned spaceflight, deep-space exploration, and satellite applications. For example, within the next decade, enterprises will achieve the long-term stable operation of the space station in the field of manned spaceflight and carry out Mars sample-return missions in deep-space exploration.[6]

3.1.2. Strategic adjustment

Adaptation to the environment: With the rapid development of global aerospace technology and changes in the international political and economic landscape, enterprises must have keen insight and adjust their strategic directions in a timely manner.

Case analysis: In recent years, the rise of commercial space has brought new development opportunities to the aerospace industry. Traditional aerospace system enterprises should timely expand their commercial space services such as satellite launch and space data application services for commercial customers, to adapt to changes in market demand and achieve diversified development.

3.2. Project management

3.2.1. Formulation of project plans

Task decomposition: Every aerospace project should be decomposed into multiple specific stage tasks, and the work content, time nodes, and required resources for each stage should be clarified.[7]

Example illustration: In a rocket launch project, for example, from the design and production of components, the assembly and testing of subsystems, to the final assembly, comprehensive testing of the rocket, and the actual launch, the time schedule should be accurately arranged to ensure that all links are closely connected. Meanwhile, human, material, and financial resources should be reasonably allocated.

3.2.2. Project monitoring and coordination

Mechanism establishment: A complete project monitoring mechanism should be established, and advanced project management software and information technology should be used to track the project's progress, quality, and cost status in real time.

Deviation handling: Once any deviation between the actual progress and the planned progress is detected, or if the quality and cost indicators exceed the allowable range, relevant departments should be promptly organized to conduct analysis, coordinate resources from all parties, and take effective corrective measures to ensure that the project can proceed smoothly in accordance with the predetermined goals.[8]

3.2.3. Risk management

Risk identification: In each stage of the project, all possible risks should be comprehensively identified, including technical risks, environmental risks, and personnel risks.

Formulation of response plans: Detailed response plans should be developed for different types of risks. For example, in response to the possible impact of space radiation on spacecraft electronic equipment, advanced radiation shielding materials and circuit design technologies should be applied to improve the radiation resistance of electronic equipment. For environmental risks such as bad weather that may be encountered during the launch process, emergency plans should be formulated and the launch window should be adjusted.

3.3. Technological innovation management

3.3.1. Innovation investment

Funding support: More funds should be invested in R&D to ensure that enterprises have sufficient resources to carry out cutting-edge technology research. Special innovation funds should be set up to encourage internal employees to put forward innovative technical solutions and project ideas.

Talent attraction: Active measures should be taken to attract high-end technical talents and provide them with competitive salaries and a favorable scientific research environment. At the same time, greater efforts should be made to strengthen talent exchanges and cooperation with universities and research institutions. Talent training bases should be established to reserve follow-up forces for enterprises' technological innovation.[9]

3.3.2. Industry-university-research cooperation

Cooperation model: Enterprises should establish close cooperation with universities and research institutions, thereby giving full play to the advantages of universities and research institutions in basic research and the advantages of enterprises in engineering application and industrialization.

Achievement transformation: The transformation of technological achievements from laboratories to practical applications should be expedited through joint efforts on scientific research projects. For example, an enterprise and a university can collaborate on the research of new aerospace materials. The university is responsible for the basic theoretical research of materials and the development of laboratory preparation processes, while on this basis, the enterprise optimizes the industrial production process and promotes the application of products.

3.3.3. Intellectual property management

Awareness enhancement: Enterprises should strengthen the awareness of intellectual property protection among their employees and establish a complete intellectual property management system.

Protective measures: During the process of technology R&D, enterprises should apply for patents for innovative technological achievements in a timely manner, and strictly keep key technologies and trade secrets confidential. An intellectual property barrier should be built to protect enterprises' innovation achievements and enhance their core competitiveness.

3.4. Human resources management

3.4.1. Talent selection and training

Selection criteria: Enterprises should select talents with interdisciplinary knowledge backgrounds, good teamwork skills, and innovative spirit. During the recruitment process, emphasis should be placed on assessing the comprehensive quality and professional skills of job applicants. Not only should their mastery of knowledge in their area of expertise be examined, but also their understanding of related disciplines and their ability to solve complex problems.[10]

Training approaches: Professional technical talents and management talents required by the enterprises should be cultivated through various methods such as internal training courses, expert lectures, and overseas further studies. For example, internal technical training can be regularly organized, inviting industry experts to share the latest technological trends and research results. Outstanding employees can be sent to well-known universities or research institutions at home and abroad for further study and training, thereby improving their professional levels.

3.4.2. Incentive mechanism

System construction: A scientific and reasonable incentive system should be constructed to organically combine material incentives with spiritual incentives. In terms of material incentives, awards such as Project Success Award, and Technological Innovation Award can be established. Generous bonuses can be given to employees who perform outstandingly in projects and make important contributions to the enterprise's technological innovation.

Spiritual incentives: In terms of spiritual incentives, employees' sense of achievement and self-actualization needs should be met by commending outstanding employees, presenting honorary certificates, and providing promotion opportunities, so as to stimulate employees' work enthusiasm and creativity.

3.4.3. Team building

Culture creation: A positive and collaborative team culture should be fostered, the barriers between departments should be broken, and communication and collaboration among personnel with different professional backgrounds should be promoted.

Collaboration promotion: Trust and tacit understanding among team members can be enhanced and the overall cohesion and work performance of the team can be improved by organizing team-building activities and carrying out cross-departmental project cooperation.

4. Challenges and Countermeasures for Management in Aerospace System Enterprises

4.1. Challenges

4.1.1. Impact of emerging technologies

Technological development: With the rapid development of emerging technologies such as artificial intelligence (AI), blockchain, and big data, the aerospace field faces both opportunities and challenges brought about by technological change. These emerging technologies provide new ideas and methods for the design, operation, and management of aerospace systems. However, at the same time, enterprises need to update their management concepts and methods in a timely manner to adapt to the application requirements of new technologies.

Management reform: For example, AI technology has great application potential in spacecraft autonomous control and fault diagnosis. However, enterprises need to establish corresponding R&D management processes, talent training systems, and data security management mechanisms, which poses a severe challenge to traditional management models.

4.1.2. Intensified international competition

Competition status: The international aerospace market is becoming increasinglycompetitive. Some established foreign aerospace enterprises possess obvious advantages in technology R&D, cost control, and market expansion. They have secured a large share of the international market with their advanced technologies and mature management experience.

Gap analysis: There remains a significant gap between domestic aerospace system enterprises and their foreign counterparts in some key technical fields. Domestic enterprises need to improve their cost control and marketing capabilities. Under the pressure of international competition, domestic enterprises need to continuously enhance their core competitiveness to gain a foothold in the international aerospace market.

4.1.3. Transformation of commercial space

Model transformation: Traditional aerospace system enterprises have been mainly undertaking national strategic tasks for a long time. In terms of operation models, they pay more attention to technology and task completion, with insufficient attention to market laws and commercial operations. With the continuous development of the commercial space market, enterprises need to transform from the traditional national-task-oriented model to a commercial-market-oriented model, and establish business models and management systems that adapt to market demands.

Management adjustment: This means that enterprises need to place greater emphasis on market demand, customer experience, and cost effectiveness, and conduct comprehensive management adjustments in project decision-making, product R&D, and marketing to achieve the sustainable development of commercial space business.

4.2. Countermeasures

4.2.1. Strengthening technology tracking and application

Group establishment: A special emerging technology research group should be set up to closely monitor the development trends of emerging technologies such as AI, blockchain, and big data in the aerospace field, and deeply study their application scenarios and potential value.

Application exploration: For example, the distributed ledger and encryption features of blockchain technology are used to ensure the security and reliability of aerospace data during transmission and storage. With the help of AI technology, autonomous fault diagnosis and intelligent decision-making of spacecraft can be realized to improve the operation efficiency and reliability of aerospace systems. By actively exploring the application of emerging technologies, enterprises can enhance their technological innovation ability and core competitiveness.

4.2.2. Enhancing core competitiveness

R&D investment: Enterprises should continuously increase R&D investment, concentrate resources on tackling core technologies in key fields, and narrow the technical gap with foreign advanced enterprises. For example, they can increase R&D efforts in such fields as high-performance rocket engines and advanced spacecraft materials to achieve technological breakthroughs.

Process optimization: Enterprises should optimize their enterprise management process, introduce advanced cost management methods, and reduce production and operation costs. At the same time, they should strengthen quality management, improve product quality and service levels, establish a good corporate brand image, and win market share with high-quality products and services.

4.2.3. Innovating business models

Project expansion: Enterprises should actively carry out commercial projects such as aerospace data application services and space tourism, and tap the commercial value of the aerospace industry. For example, satellite remote-sensing data can be used to provide professional data services for industries such as agriculture, environmental protection, and resource exploration. Space tourism projects can be developed to meet the space exploration needs of some high-end customers.

System establishment: Enterprises should establish marketing and management systems that adapt to market demands, strengthen market research and customer demand analysis, and formulate precise marketing strategies. At the same time, they should optimize their internal management process to improve operation efficiency and better adapt to the rapid changes in the commercial space market.

5. Conclusion

5.1. Research summary

Management in aerospace system enterprises is a complex and huge system engineering. The management level is directly related to the development of the national aerospace industry and international competitiveness. By analyzing the characteristics of aerospace system enterprises, this paper clarifies the key elements of their strategic management, project management, technological innovation management, and human resources management. Meanwhile, countermeasures are proposed in response to the current challenges faced by aerospace system enterprises, such as the

impact of emerging technologies, intensified international competition, and the transformation of commercial space.

5.2. Outlook

With the continuous progress of global aerospace technology and the ongoing development of the aerospace industry, aerospace system enterprises will face more new opportunities and challenges. In the future, aerospace system enterprises should continuously innovate management concepts and methods, strengthen interdisciplinary and cross-field collaborative innovation, and bolster their overall strength and core competitiveness. Concurrently, the government should further strengthen policy support and guidance for the aerospace industry, create a conducive environment for industrial development, and jointly promote the national aerospace industry to new heights.

In conclusion, the optimization and innovation of management in aerospace system enterprises is a long-term and ongoing process that requires the collaborative efforts among enterprises, the government, and all sectors of society, thereby achieving the sustainable development of the aerospace industry and making greater contributions to national scientific and technological progress as well as economic development.

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