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Research on Autonomous Navigation and Intelligent Recognition Technology of Ship Hull Cleaning Robots Based on Deep Learning

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Abstract

This paper provides a comprehensive analysis of the profitability outlook and cost projections for a company operating in the intelligent robotics sector, with a specific focus on its flagship product, intelligent warehouse cleaning robots. Utilizing the Tob business model, the company strategically positions itself to deliver high-value services and cultivate enduring client partnerships, thereby ensuring a stable revenue stream. However, the company faces challenges due to initial capital constraints, which hinder timely product development and market competitiveness. Situated in the China (Shanghai) Pilot Free Trade Zone Lingang New Area, the company benefits from favorable policy incentives and a conducive development environment. This examination delves into the favorable factors contributing to profitability, such as innovative technologies and market demand, as well as the unfavorable factors constraining growth, including capital limitations and market saturation. Additionally, a comprehensive cost projection analysis covering various operational facets is presented to provide insights into the company's financial outlook.

Keywords

Intelligent robotics, profitability outlook, cost projections

1. Introduction

This analysis delves into the profitability outlook and cost projections for a company operating within the intelligent robotics sector, with a primary focus on its flagship product, intelligent warehouse cleaning robots. Employing the Tob business model, the company capitalizes on its ability to provide high-value services and cultivate enduring client partnerships, thus fostering a stable revenue stream. However, despite its advantageous position, the company faces challenges stemming from its initial capital constraints, which impede timely product development and market competitiveness. Nevertheless, situated in the China (Shanghai) Pilot Free Trade Zone Lingang New Area, the company benefits from favorable policy incentives and a conducive development environment. This examination provides insights into both the favorable factors contributing to profitability and the unfavorable factors constraining growth, along with a comprehensive cost projection analysis covering various operational facets.

2. Company Development Background

Multi-functional ship cleaning robots are specifically designed robots used for cleaning ship cabins and hulls [1]. They are typically equipped with vacuum cleaners, scrubbers, and other cleaning tools, capable of autonomously moving within the ship's cabin and performing cleaning tasks. These robots enhance cleaning efficiency, reduce labor

costs, alleviate the workload of crew members, and can perform cleaning tasks while the ship is docked or sailing, thereby improving the cleanliness and hygiene conditions of the vessel. With the advancement of technology and progress in artificial intelligence, the application of multi-functional ship-cleaning robots is gradually increasing.

In the past, cleaning the interior of ships usually required a significant amount of manual labor, and due to the confined space and complex environment inside the ship, cleaning tasks were challenging [2]. Therefore, the emergence of multi-functional ship-cleaning robots has brought revolutionary changes to ship cleaning. These robots can autonomously clean the ship's interior, not only improving cleaning efficiency but also reducing labor costs and enhancing work safety. With the development of the shipping industry and the increasing requirements for cleanliness and hygiene on ships, the market demand for multi-functional ship cleaning robots is gradually increasing.

In the future, with continuous technological advancement and the continuous improvement of the functionalities of multi-functional ship cleaning robots, it is expected that the multi-functional ship cleaning robot industry will usher in greater development opportunities and become an integral part of ship cleaning. The industry is moving towards a direction of greater automation, intelligence, environmental friendliness, and multi-functionality. These trends will contribute to improving the efficiency of ship maintenance and cleaning while also meeting the requirements of environmental sustainability. With the continuous advancement of technology, this industry is expected to continue to grow and innovate, becoming an important component of the ship cleaning field.

3. Company Introduction

3.1 Company Name and Overview

The full name of the company is "Shanghai Marketim Information Technology Co., Ltd". Shanghai Marketim Information Technology Co., Ltd. is a technology company focused on services, development, consulting, exchanges, transfer, and promotion of technology; application software development for artificial intelligence; integration of intelligent control systems; integration services for information systems; sales of intelligent unmanned aerial vehicles; computer system services; operational maintenance services for information systems; research and development of intelligent robots; sales of intelligent robots; development of basic software for artificial intelligence; digital technology services; development of animation games; development of software for digital cultural creativity, and other fields.

3.2 Company Nature and Organizational Form

Shanghai Marketim Information Technology Co., Ltd. adopts the "ToB" business model. The company provides products, services, or solutions to other enterprises, institutions, or organizations rather than directly to end consumers. This can include providing technology services, development, consulting, exchanges, transfer, and promotion of technology; application software development for artificial intelligence; integration of intelligent control systems; integration services for information systems; sales of intelligent unmanned aerial vehicles; computer system services; operational maintenance services for information systems; research and development of intelligent robots; sales of intelligent robots; development of basic software for artificial intelligence; digital technology services; development of animation games; development of software for digital cultural creativity, etc. The target customers are typically other businesses or institutions rather than individual consumers, ensuring more stable profits. Under this model, the company possesses unique technological advantages and expertise due to the provision of customized services, thereby limiting the entry of competitors and creating higher profit margins for the company.

The "ToB" business model typically requires establishing long-term partnerships with other enterprises to better meet various professional needs and customized services. Such a business model can provide a better customer experience, improve customer satisfaction and loyalty, and further enhance the company's market competitiveness.

3.3 Company Management System

Shanghai Marketim Information Technology Co., Ltd. has five shareholders who jointly participate in the company's decision-making and governance, and provide suggestions and oversight to influence the company's development direction and strategic decisions to ensure its long-term interests. The company adopts the "ToB" business model to better provide customer experience and further enhance its market competitiveness.

4. Product and Technology Analysis

4.1 Product Introduction

We have designed a multifunctional ship cabin cleaning robot that utilizes disruptive cabin cleaning technology combined with advanced six-axis robotic arm systems and autonomous mobile AGV platforms, providing unparalleled flexibility and efficiency [3]. This robot introduces an improved ROS package, Hector-SLAM, and Intel RealSense camera fusion algorithm for simultaneous mapping and localization to ensure higher navigation accuracy during the cleaning process. Additionally, it adopts the costmap navigation avoidance technology of the navigation stack package, enabling the robot to flexibly navigate around obstacles and adapt to various complex environments.

Equipped with a monocular camera and advanced computer vision technology, the robot ensures efficient and precise identification of residues in the ship's cabin, such as dust, debris, grains, and other contaminants [4]. With a fully rotating robotic arm and non-toxic cleaning agents, this robot not only thoroughly cleans every corner of the cabin but also meets food safety standards. Its robust internal structure can carry heavy objects and is equipped with sorting baffles to further enhance cleaning and organizing functions.

Current ship cabin cleaning requires a significant amount of manual labor with high occupational hazards. The design of this cleaning robot aims to significantly improve cleaning efficiency, reduce labor costs, and ensure cabin hygiene and cargo safety [5]. Its intelligent design and high performance make it an ideal choice for ship cabin cleaning.

4.2 Product Design

This product is based on a Mecanum wheel chassis and models a lifting platform, radar, controller, and overall framework [6]. Although pre-modeling consumes a significant amount of time, it ensures the direction of robot development. Based on software modeling, it is gradually built into reality. The design of this product is neat, achieving complete functionality with minimal materials. Additionally, it is aesthetically pleasing and practical, using high-quality steel materials that are durable. The design of the wheels allows for interchangeable structures, enabling the free replacement of wheel size and material based on usage scenarios. The robot arm design has good load-bearing capacity and can be equipped with accessories to achieve diversified functions, such as a simulated recognition camera module that can identify object colors, shapes, sizes, etc., and perform corresponding actions based on the recognized data.

4.3 Core Technology

The laser radar serves as the robot's perception tool for self-positioning, and the fusion algorithm of the Intel RealSense camera enables precise autonomous navigation of the robot [7]. We use the hector-slam package in ROS for simultaneous mapping and localization, integrating the ROS Navigation stack's gmapping package costmap for obstacle avoidance. These algorithms process and filter the laser radar data obtained from the sensor (Lingyun M10P) to extract useful features for positioning and map construction. For map positioning, this module matches the current sensor data of the robot with the established map to estimate the robot's current position. For map construction, the above module processes data obtained from the sensor and integrates it into the existing map to continuously update and improve the map.

Mechanisms for safe motion, obstacle avoidance, integration of multiple sensor data, communication, and remote control, reliability, and safety control, software architecture, modular design, parameter tuning, and adaptive control have been implemented to ensure smooth and efficient operation. Additionally, the use of MoveIt, a series of ROS packages for motion planning, operation control, 3D perception, kinematics, collision detection, etc., further enhances the capabilities and adaptability of the robot.

Overall, the comprehensive design and integration of various technologies make this ship cabin cleaning robot highly efficient, safe, and adaptable to various operating environments and tasks.

5. Market Analysis

Tank cleaning operations in bulk carriers are fraught with risks, primarily due to the complex and hazardous working environment [8]. The main risks include lifting injuries, falls from heights, being struck by objects, and machinery injuries.

Lifting injuries, such as bucket touching or misoperation, are common and severe. Factors contributing to these accidents include improper positioning of personnel, operational errors, and inadequate safety measures. Falls from heights occur during boarding and disembarking or while working near the hatch, often due to positioning errors or equipment malfunction.

Being struck by objects, including falling goods or tools, poses significant risks. Operational errors, inadequate safety protocols, and complacency contribute to these accidents. Machinery injuries, though less frequent, are still a concern. These injuries result from operational errors, mechanical failures, or inadequate safety equipment.

To mitigate these risks, technological advancements like unmanned tank-cleaning robots are being developed. These robots utilize intelligent arm mechanisms to perform cleaning tasks efficiently and safely. Additionally, universities and companies are patenting innovative solutions, such as integrated grain bulk carrier tank cleaning robots, to address the challenges in this sector.

Despite these advancements, challenges remain, especially in ensuring the safety of workers and optimizing cleaning processes in bulk carrier holds. Therefore, continued research and innovation are essential to further improve safety and efficiency in tank cleaning operations.

6. Profitability Analysis

The Tob business model presents several advantageous elements [9]. Firstly, it facilitates the provision of high-value services, such as specialized technical support and tailored solutions, enabling the company to command higher service fees and licensing charges, thereby augmenting profitability. Additionally, Tob models often cultivate enduring partnerships with clients, fostering a steady stream of revenue through personalized and customized support services. Moreover, by offering bespoke services, companies in Tob models establish a technological monopoly, limiting competitors' entry and creating ample room for profit margins. Furthermore, Tob models predominantly cater to institutional clients within stable industries, ensuring consistent market demand unaffected by individual consumer purchasing power, thus stabilizing profitability.

Furthermore, the company's diverse business scope, with a primary focus on intelligent products, contributes positively to its profitability outlook. With operations spanning multiple domains, including R&D and sales of intelligent robots, integration of smart control systems, and AI-based software development, the company enjoys varied avenues for profit generation. In particular, given the burgeoning demand and technological advancements in AI and robotics, the company's flagship product, intelligent warehouse cleaning robots, holds promising market potential within the logistics and storage sectors.

Lastly, the geographical advantage of being situated in China (Shanghai) Pilot Free Trade Zone Lingang New Area offers favorable policy benefits and a conducive development environment, bolstering the company's prospects.

Despite these favorable aspects, the company faces challenges stemming from its initial registered capital of 1 million RMB, signifying a relatively low initial investment. This limitation manifests in several ways: prolonged product development cycles due to insufficient funding, hampering technological innovation, and the timely introduction of new products to market. Moreover, constrained market competitiveness arises from inadequate investment in marketing and channel development, limiting market penetration and sales revenue. Additionally, slow expansion progress poses a threat, with insufficient funds impeding the attraction of top talent and exacerbating operational risks during market expansion, thus hindering profitability.

Cost projections encompass various facets of the company's operations. R&D and production costs for intelligent warehouse cleaning robots involve raw material procurement, hardware design, and manufacturing, with complexities dictating expenses. Human resource costs, integral to the technology and service industry, encompass salaries, training, and social insurance contributions. Operational maintenance costs include equipment upkeep, software optimization, and customer service, with ongoing expenditure contingent on post-launch operational demands. Marketing and promotion costs encompass advertising, promotional activities, and market strategy execution, while administrative management costs cover organizational support expenses, reflecting the company's scale and structure.

7. Company Strategic Planning

In navigating the nascent marine cleaning robot market, Marco Team Information Technology Co., Ltd. remains committed to a strategic approach centered on market orientation, technological innovation, and ethical conduct [10]. With a steadfast focus on bolstering technical expertise and refining management systems, we strive to attain a

competitive edge through cost leadership and differentiation. Our overarching goal is to deliver superior marine cleaning robots while solidifying our position as a premier domestic and global player in the industry.

To achieve this vision, our strategic planning unfolds in stages. Initially, we prioritize robust R&D efforts, recognizing that a strong foundation is pivotal for sustainable growth. By channeling resources into meticulous product development and talent acquisition, we aim to lay the groundwork for future success. Simultaneously, our market research endeavors and strategic partnerships seek to fortify our market positioning and secure essential funding for initial operations.

Moving into the mid-term phase, our focus shifts toward operational integration and brand building. We envision a seamless convergence of R&D and operations, underpinned by a culture of user-centricity and continuous improvement. Through targeted investments in product optimization and brand equity, we aspire to enhance our market presence and profitability. Concurrently, we seek to expand our network of partnerships and customers, fostering mutual growth and innovation.

Looking ahead to the long term, our strategic trajectory encompasses sustained innovation, operational excellence, and global expansion. We are committed to staying abreast of industry trends, learning from industry leaders, and adapting our products to meet diverse market demands. Moreover, our commitment to corporate social responsibility underscores our dedication to sustainable development and environmental stewardship.

In summary, Marco Team Information Technology Co., Ltd. is poised to navigate the complexities of the marine cleaning robot market through strategic foresight, technological prowess, and unwavering integrity. By aligning our actions with our vision, we are confident in our ability to achieve sustainable growth and make a meaningful impact in the industry.

8. Legal Protection

In the realm of legal safeguarding, our company acknowledges various risks, particularly those pertaining to robot technology and intelligent systems regulations. Given the international scope of our product deployment, adherence to diverse national and regional legal requirements is paramount. To mitigate legal disputes, we engage professional legal teams for regular reviews of robot sales, service agreements, and supply chain contracts, ensuring compliance and legality.

Should legal disputes arise, we swiftly initiate internal investigations and seek assistance from legal counsel. Our objective is to resolve disputes through negotiation and mediation, thereby avoiding the costs and time consumption associated with litigation.

Throughout transaction processes, we emphasize the importance of clear and comprehensive contract terms to delineate rights and obligations. Rigorous transaction review processes, including customer background checks and payment condition confirmations, are implemented to ensure adherence to company policies and legal regulations. In addressing transaction disputes, mediation and negotiation take precedence. If necessary, we prepare thorough transaction records and evidence to support our position and seek legal resolution.

In terms of infringement and protection, regular intellectual property reviews and monitoring are conducted to safeguard against violations. Proactive applications for patents, trademarks, and copyrights protect our technological innovations and designs. In cases of infringement, we prioritize amicable resolution through communication. Persistent or severe infringements prompt legal action to uphold our lawful rights.

Regarding intellectual property protection, priority is given to registering trademarks and patent applications related to "IntelliSweep." This includes unique designs, software algorithms, and operating systems of our robots. Collaboration with intellectual property lawyers ensures compliance with legal requirements and expedites approval processes.

Active participation in intellectual property registration and involvement in objection or dispute procedures during trademark and patent examinations safeguard our interests. Implementation of comprehensive brand strategies through robust marketing and public relations activities enhances the market recognition and brand influence of "IntelliSweep," emphasizing technological innovation and product superiority.

Furthermore, we plan to enhance corporate patent and trademark management systems to ensure effective management and utilization of intellectual property. Establishing effective talent incentive mechanisms encourages employee participation in innovation and intellectual property creation, thereby promoting enterprise development.

9. Conclusion

In conclusion, the analysis underscores the multifaceted dynamics shaping the profitability and cost structure of the company operating in the intelligent robotics domain. Leveraging the Tob business model, the company stands to benefit from its capacity to deliver high-value services, foster enduring client relationships, and maintain a competitive edge in the market. However, the challenges posed by initial capital constraints necessitate strategic resource allocation to mitigate impediments to product development and market expansion. Despite these challenges, the company's strategic location within the China (Shanghai) Pilot Free Trade Zone Lingang New Area offers a strategic advantage, providing access to favorable policy incentives and an enabling environment for growth. By addressing the identified challenges while capitalizing on its strengths, the company can position itself for sustained profitability and growth in the evolving intelligent robotics landscape.

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