

March 30th, 2023

Dr. Michael Hegedus

School of Engineering Science

Simon Fraser University

Re: Final project proposal for Healthbot; a mobile robot laundry assistant in a hospital environment.

Dear Dr. Hegedus,

Presented below is the final proposal document for ENSC 405W which has been prepared by Company 04 – MECALAUN. It outlines the scope, risks and benefits, market and competition rationale, company details, project planning, cost estimates, concluding with a summary of the project's potential impact on society.

The purpose of this project is to design and develop a mobile laundry assist robot that automates and streamlines the laundry handling process in a hospital environment. The goal is to enhance efficiency, reduce labor requirements and improve the quality of service to patients.

Hospitals generate significant amounts of laundry daily, including towels, scrubs, gowns, and bed linens. Managing this amount of laundry is time-consuming, labor intensive and poses the risk of cross contamination. Currently, hospital staff must manually transport, sort, wash and prepare laundry which takes time away from more critical tasks such as patient care. Automation of one or more of these tasks can greatly benefit hospitals, employees, and patients.

The benefits of the proposed project will increase the efficiency of the laundry handling process, enhance hospital cleanliness, reduce labor costs, introduce scalability, and improve overall patient satisfaction.

For any questions or concerns, please contact the COO of MECALAUN Steven Borkowski at sborkows@sfu.ca.

Kind regards,

Flynn Dowey

Flynn Dowey

CEO

MECALAUN



Final Proposal

Healthbot

Submitted to Dr. Michael Hegedus

March 30th, 2023

Company Members

Flynn Dowey – CEO

Ngoc Quynh Anh Vo – CFO

Sammy Kaspar – CTO

Steven Borkowski – COO

Bao Nguyen – CMO

Gary Ho – CIO

Abstract

The mobile robot industry has been projected to grow rapidly in the coming years [1]. MECALAUN has set out to address the shortage of healthcare workers in the province of BC's by using robotics for a creative solution. In the development of this solution, Healthbot, MECALAUN has done an analysis of the need for this product, including the benefits it bears for its intended customer and society. The risks of such a solution are also explored. To understand the needs of its customers and the wider community, MECALAUN has conducted extensive market research for Healthbot, and the competition it will face in implementing this product. To ensure that Healthbot is the best possible solution for the healthcare sector, MECALAUN is committed to ongoing innovation and improvement, and will use feedback from its customers to refine and enhance Healthbot.

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1 Introduction

Across the province of BC, the healthcare system is facing a growing nursing and staff shortage, and MECALAUN has set out to apply the field of robotics to address this problem [2]. This proposal presents Healthbot, a laundry transport robot, as a powerful solution to the challenges faced by hospitals in their battle with the staffing crisis. The field of robotics will prove to be especially integral in the laundry workflow, as it will reduce human exposure to dangerous pathogens that are present in used linens [3]. Coming from a wide range of backgrounds and experiences, MECALAUN has committed the research and development necessary to make Healthbot the solution society needs and a competitor in the market.

The scope of the project for this semester is to develop a proof-of-concept for Healthbot, which involves the design, assembly, and testing of a robot capable of transporting linens within a hospital or clinical environment. It will have a storage unit with capacity to store up to 17 pounds of linens. The storage unit will be designed to be sanitary, covered, and secure to prevent pathogens from escaping.

The Healthbot will be equipped with autonomous navigation capabilities, enabling it to move between rooms and hallways safely without colliding with staff, patients, or property. The robot will also be able to navigate precisely around corners or in crowded areas to ensure the safe and efficient delivery of the laundry.

In future versions, the robot will be equipped with a panel to display its status, such as the battery level or the weight of the loads. Additionally, when the battery level reaches a minimum level, the robot will have the ability to return to the charging station by itself.

2 Risks and Benefits

2.1 Benefits

2.1.1 Business

Healthbot can provide many potential benefits to the healthcare system. The first of these is improving the efficiency of hospitals by saving time and reducing the workload of staff. This can lead to better patient care and a better environment. Secondly, Healthbot can reduce hospital staff exposure to bacteria. Hospital laundry is a major source of pathogens and has a risk of spreading diseases ranging from Salmonella to Hepatitis A [4]. By transporting contaminated materials autonomously, Healthbot can increase hospital hygiene overall since they can reduce the risk of cross-contamination and the spread of infections within the hospital. Finally, Healthbot can lead to better patient outcomes and higher levels of satisfaction among staff and patients alike. The success of Healthbot will depend not just on the quality of the product itself, but also on effective marketing and distribution strategies.

2.1.2 Society

In addition to having an impact in hospitals and nursing homes, Healthbot can have a positive effect on society as well. An unfortunate reality is that hospitals are a major source of cross infections, such that a hospital visit can result in serious complications for both staff and patients [5]. By eliminating one potential source of infection in hospitals, Healthbot can improve the health of the communities where it is implemented. Furthermore, the use of such technology can create a sense of comfort and reassurance for the patients, and this would help to elevate their perception of the hospital's services as well as enhance their satisfaction rates.

2.2 Risks

2.2.1 Business

The development and deployment of a complex robot like Healthbot can be expensive, and there may be additional costs associated with training staff to use the robot effectively. Therefore, without proper financial planning, the use of the Healthbot may result in higher expenditure, making it economically unfeasible. Moreover, the robot may require regular maintenance and updates to ensure it continues to function correctly. Furthermore, in the event of a malfunction or accident involving the robot, the company may be held legally liable for any damages or injuries [6]. This could result in significant financial and reputational damage. Another risk that must be considered is that hospitals and clinical facilities may be hesitant to adopt new technology like Healthbot if they felt it would disrupt their existing flow or require significant investment in training and infrastructure or have existing systems in place. This could limit the potential market for the robot and challenge the company to generate revenue and achieve widespread adoption.

2.2.2 Society

Despite the many benefits Healthbot can yield for society, several risks present themselves as well. The first of these is the risk of malfunction or breakdown. A failure of the critical systems of Healthbot would cause serious delays in the hospital workflow and create additional work for the staff. This in turn could impact patient care and outcomes, and negatively affect the reputation of the technology and the company. Additionally, care must be taken to clean and maintain the robot with relevant regulatory standards and guidelines for infection control and prevention such that it does not spread pathogens itself and cause infection in the community.

3 Market and Competition

3.1 Available Market

There are many industries where Healthbot could make an impact on the workflow. First and foremost, Healthbot has been designed for use in BC hospitals and nursing homes. According to Vancouver Coastal Health's financial statements for the year of 2022, \$72,738 was spent on purchasing equipment and \$1,832,121 in employee salaries [7]. Healthbot could save BC Hospitals time and money by reducing the staff required on-site. Secondly, hotels could also make use of a laundry transport robot such as Healthbot, as they also produce many soiled linens [8]. Finally, although the primary focus of Healthbot is transporting laundry, such a device could also transport waste in office buildings and schools, for example. A report which gathered hospital labor expenses in the housekeeping sector from 2017 to 2021 showed that the expenses steadily increased over the five-year period. In 2017 the average cost was \$2 million, while the cost in 2021 was \$2.29 million [9]. Healthbot has been designed to be as affordable as possible and to be a useful solution for as wide a number of facilities as possible. As will be seen later, the budget for the proof-of-concept design is approximately \$600.

3.2 Market Size

Many different sectors present the need for the secure transport of laundry that Healthbot can provide. Thus, Healthbot can tap into many existing markets. The first of these is the global service robotics market, which is currently valued at \$19.52B USD and is projected to be worth \$57.35B USD by 2029. This growth is driven by the improvement of technology such as artificial intelligence, as well as the fact that robots have become more and more affordable over time [10]. MECALAUN is also homing in on the mobile robot market, which is worth \$3.90B USD, and projected to grow to \$10.52B USD [11].

Global Service Robotics Market Share, By Application, By Industrial/Commercial 2021

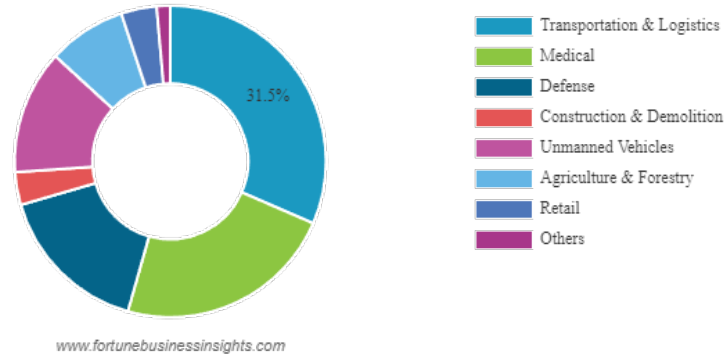


Figure 1. Industrial/Commercial Segment to Showcase Majority Share during Forecast Period [10]

According to the above pie chart, Healthbot has a great opportunity to grow in the future as it can be used in both the transportation & logistics and medical industries, which represent the largest portion of the global service robotics market share in 2021. By providing efficient and secure transportation of soiled linens and freeing up healthcare staff to focus on other tasks, Healthbot has the potential to significantly improve the workflow and efficiency of hospitals and clinical environments.

In addition, the hospitality industry is a growing market for the use of robots like Healthbot. Major global hotel chains such as Marriott and Hilton are the pioneers in switching to robots instead of human staff to perform tasks such as housekeeping, cleaning, luggage, and food delivery for guests. The demand for implementing robots in the hospitality industry is rising due to the extraordinary versatility that robots can bring, especially during the pandemic. During the pandemic in 2020, the online segment for robot market was evaluated at \$169.4 million and is forecast to reach approximately \$1.6 billion in 2030 [12].

Lastly, it is worth noting that robots are being increasingly used in healthcare to assist nurses and other healthcare professionals in their tasks. As technology continues to improve, the use of robotics in healthcare is expected to continue to grow as healthcare facilities seek ways to improve efficiency, reduce costs, and improve patient outcomes. Along with this, the market size for nursing robots is expected to grow from US\$482.939 million in 2019 to US\$2,232.717 million by 2026 [13].

Given the rapidly expanding market size of delivery robots, it is becoming an appealing industry for startups to enter and scale up their businesses. The projected market size for delivery robots is set to reach billions of dollars in the near future, providing an opportunity for startup companies to capitalize on the increasing demand from various sectors by developing innovative and efficient delivery robot solutions. This presents an opportunity for startups to establish themselves as major players in the industry and gain a competitive edge in the delivery robot market.

3.3 Competition

Implementing service robots in the healthcare field is an area of active research. Thus, Healthbot will be facing competition in the market.

The first such competition is Aethon's TUG, a mobile robot used for delivery in hospitals. This robot is also provided with biometric security and unique pin codes. TUG only allowed authorized medical personnel to have access to the secured cabinet. This robot can be used for the transport of

pharmaceuticals, food, waste, or clean linens. Like Healthbot, it has been developed with reliability and safety in mind and seeks to improve patient satisfaction [14].



Figure 2. Aethon's TUG3XL [14]

Another competitor currently on the market is Techmetc's Tech-i, an autonomous mobile robot that functions in a range of different industries, ranging from healthcare to hospitality. It has been developed to function in any setting with as little supervision as possible [15]. Below is a diagram of Tech-i and its main features.

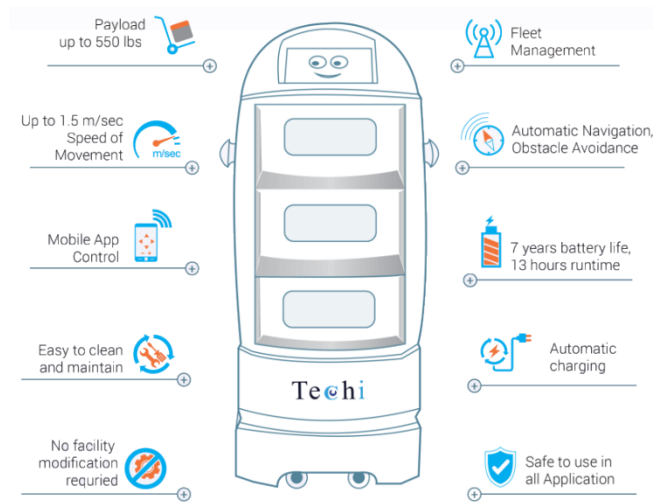


Figure 3. Techmetc's Tech-i [15]

Tiago base is a mobile robot platform developed by PAL Robotics for research and development in robotics. It is equipped with various sensors that provide 360-degree perception and localization capabilities, including cameras, LIDAR, and ultrasound sensors. The platform has a modular design that allows for customization and integration of additional hardware and software components, making it suitable for a wide range of applications such as delivery, inspection, and monitoring tasks. It has been successfully used in two hospitals in Barcelona to handle delivery jobs [16]. However, the cost of these

robots is between a couple thousand to tens of thousands of dollars. This is why Healthbot can still be in the market with through competitive pricing.



Figure 4. PAL Robotics’s TIAGo Delivery [16]

4 Company Details

MECALAUN is made up of six students from a range of experience and backgrounds, all with a shared vision of using robotics to find a creative solution to the nursing shortage in BC. The following is an overview of the team members and their roles, as well as their skills.



Flynn Dowey – Chief Executive Officer

Flynn is a 4th year Systems engineering student with experience in robotics, machine/deep learning, and algorithms. Last year he completed an 8-month internship at the Robotics Algorithms and Motion Planning Laboratory (RAMP) where he held a NSERC award. His research focused on object detection and segmentation using a seven degree of freedom robot. He also has proficient knowledge of using Robotic Operating System (ROS).



Ngoc Quynh Anh Vo – Chief Financial Officer

Anh is a 4th year Systems Engineering student with experience in product synthesis, financial management and strategy development.



Sammy Kaspar – Chief Technology Officer

Sammy is a 4th year Computer Engineering student with experience in embedded systems, software development, testing automation, data modeling, and database systems.



Steven Borkowski – Chief Operating Officer

Steven is a 4th year Systems Engineering student with experience in automation, testing and compliance, and project management.



Bao Nguyen – Chief Marketing Officer

Bao is a 4th-year Electronics Engineering student, possesses experience in designing and analyzing electronic circuits as well as knowledge of semiconductor devices, including diodes, transistors, and integrated circuits.



Gary Ho – Chief Information Officer

Gary is a 4th-year Systems Engineering student with experience in 3D modeling, product verification, and programming.

Each member is committed to building a quality product that will have a positive impact on the healthcare system.

5 Project Planning

Below is a schedule MECALAUN has followed in the design and development of Healthbot.

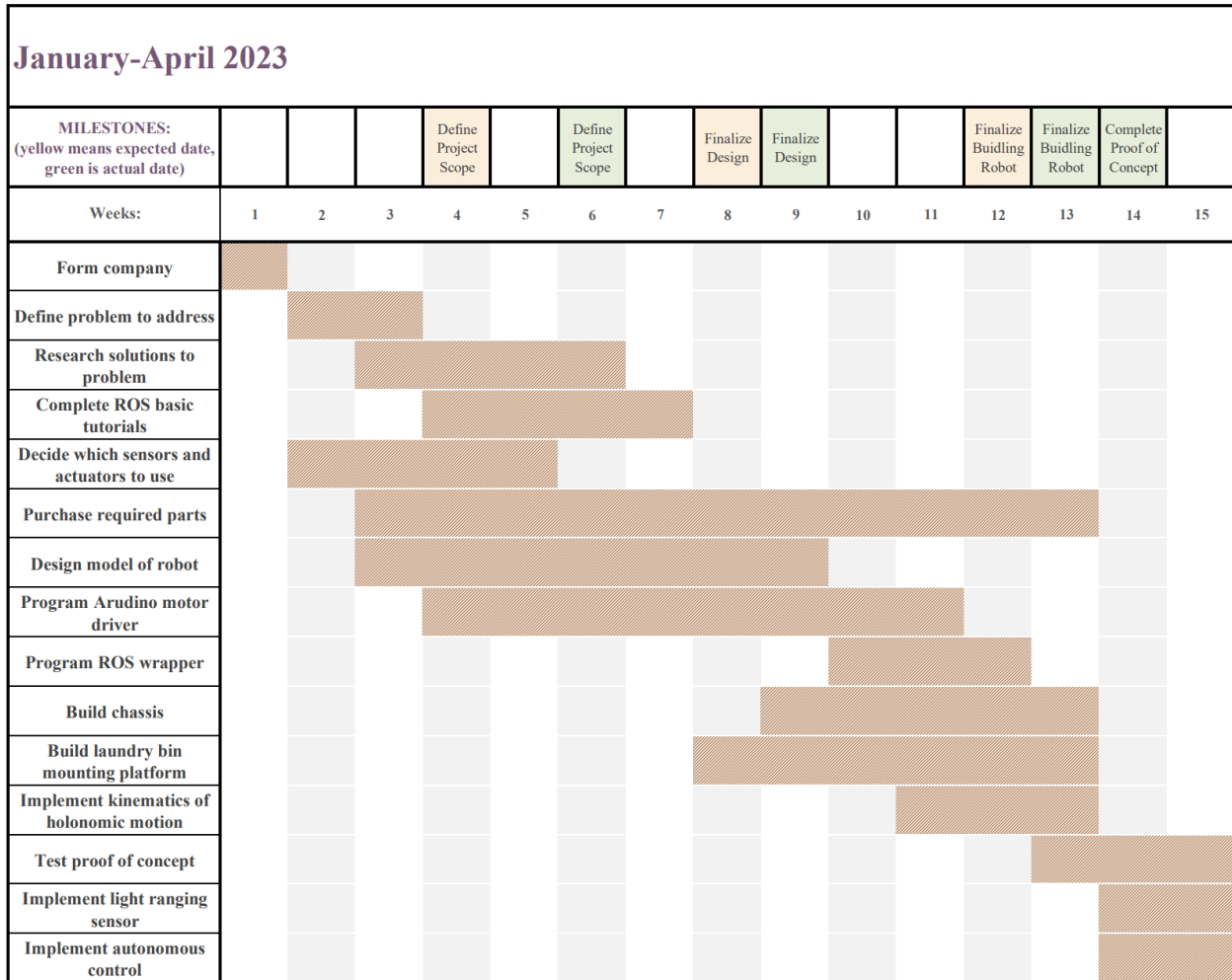


Table 1. Gantt chart for the development of Healthbot

6 Cost Considerations

As Healthbot is developed, there are several cost considerations that must be taken into account. These include material and labor costs, maintenance and repair costs, and training costs. By including contingencies, MECALAUN can better understand the financial implications of building Healthbot to mitigate any potential risks or challenges. The below table lists items that have been purchased in the building of Healthbot’s proof-of-concept version (a ‘-’ in the price column indicates the part was borrowed):

Component of Device	Parts	Price (\$)
Chassis	DC Geared Motor (x4)	197.86
	Arduino Mega	-
	RPLidar A1	-
	DC Motor Controllers	65.94
	37mm DC motor mounts	18.96

Chassis	Mecanum wheels kit (x4)	129.50
	Fasteners	15.87
	Lead acid battery	-
	MDF boards	-
	U-channel aluminum beam	37.16
	Jumper wires	17.91
	Barrel jack adaptors	12.30
	On/off switches	13.19
	10ft USB cable	10.99
Laundry bin platform	Slotted aluminum extrusion	51.00
	Laundry bin	33.59
	4 ft wooden rail	-
Contingency	Mecanum wheels (x4)	48.63
	Motor Driver Controller L298N	20.15
	Arduino Leonardo (x2)	98.44
	Total:	771.48

Table 2. Budget of Healthbot's proof-of-concept version

Current sources of funding include the Wighton Fund, MDDC Awards for Biomedical Engineering, and personal funds of individual members. Regarding the MDDC Award, MECALAUN will be applying under the category of increasing the efficiency of healthcare workers to save time and money [17].

7 Conclusion

In this proposal, MECALAUN has set out to present the research and steps necessary to design a response to the nursing shortage that is not only an effective solution but also a competitor in the market. First, the benefits that Healthbot can yield were enumerated, regarding not only hospitals but also to society. Conversely, the risks involved were described. Secondly, research into the market MECALAUN finds itself in was discussed, as well as the competition it will face. Finally, the proposal also highlights the experience of individual members of the MECALAUN team and their commitment to delivering a high-quality product. The schedule and budget of the project were also listed to demonstrate the company's careful planning and dedication to the project. Hospitals, their staff, and their patients can rest assured that the development of Healthbot has been methodical, and that meeting their needs is the highest priority of MECALAUN.

8 References

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