Commercialization of Drainage Inspection Services Using Drainage Probe Robot

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Abstract

The Philippines is one of the countries that is most susceptible to natural disaster. Flooding, in specific, has the second highest average annual natural hazard occurrence for 1980 to 2020. Inadequate drainage infrastructure and problems with waste disposal worsened the effects flooding in the Philippines. The government has tried various initiatives including routine desilting, declogging works, dredging, and enhancing culverts. However, the nature of the drainage system in the Philippines makes a comprehensive analysis of its state challenging. Moreover, maintaining drainage systems carelessly could endanger the community and put sanitary employees at risk for diseases.
Therefore, the creation of a drainage probe robot has been made with the intention of replacing human labor with robot technology when examining the drainage system. This feasibility study involves analysis of the marketing, technical, management, legal and taxation, financial, and socio-economic desirability aspect of a drainage inspection service business. The drainage inspection service business will make use of the drainage probe robot in providing services. The study deployed survey questionnaires and interviewed the respondents. The data collected were analyzed using various techniques like qualitative demand analysis. The study also designed and described the service system and information system. The findings show that the business concept alleviates the concern on endangering sanitary workers in doing the manual inspection and the problem on incomprehensible status of the drainage systems using the drainage probe robot in the inspection service.

Keywords
Drainage Inspection, Probe Robot, Drainage Crawler, Drainage Inspection Services

1. Introduction
The Philippines is one of the countries that is most susceptible to natural disaster. Flooding, volcanic eruption, earthquakes, and typhoons have all hit the nation. These catastrophes have claimed tens of thousands of lives and billions of pesos in property damage (World Bank 2005; Philippine Statistics Authority 2020). Flooding, in specific, has the second highest average annual natural hazard occurrence for 1980 to 2020. Storms have been reported 276 times, followed by 136 floods and 71 miscellaneous accidents (World Bank 2022). In the recent Typhoon Rai, 420,000 hectares of land have been lost to storm floods, affecting 925,000 homes and agricultural crops (World Bank 2022). Another flood occurrence in Cebu province displaced over 800 people and affected 400 households (Floodlist in Asia 2020).

Inadequate drainage infrastructure and problems with waste disposal worsened the effects of a typhoon that slammed the Philippines (United Nations 2009). As a response, the local government of Cebu has increased the number of pumping stations and conducted routine desilting, drainage improvement, and declogging works (Letigio 2019; Bongcac 2020). A portion of Cebu City is reportedly undergoing flood control initiatives for 450 million pesos to improve the condition of water bodies. Dredging, enlarging waterways, and enhancing current culverts are among the initiatives (Letigio 2022). However, due to the nature of the drainage system in the Philippines, a comprehensive analysis of its state is challenging. Even the extent of the culvert expansion sparked a dispute between the DPWH and City Engineering of Cebu (Letigio 2020). Moreover, maintaining drainage systems carelessly could endanger the community and put sanitary employees at risk for diseases (Blom 2015).

Therefore, the creation of a drainage probe has been made with the intention of replacing human labor with robot technology when examining the drainage system. A study emphasized the significance of a novel apparatus capable of monitoring and evaluating the interior of the pipe. To traverse and monitor the pipe, the apparatus employs rubber track units. It can travel through vertical, horizontal, and curved pipes while overcoming minor obstacles along the way (Moghaddam et al. 2011). Various improvements and adaptations have been made since then, such as designed for underwater tasks, remote controlled, wireless monitoring, and equipped measuring tools. Furthermore, with the use of CCTV, the drainage probe has proven to be effective in reporting leaks, cracks, fractures, pipe defects, blockages, and holes (Deep Trekker, 2022). However, the current industry standard crawler response to crack detection is based primarily on the observation and annotation of a trained operator to classify the pipe's condition (Khan & Patil 2018). Nonetheless, the crawler camera industry is expected to grow by 10.8 percent by 2026, reaching 275.3 million dollars. Both the government and private companies have made significant investments in the repair and maintenance of their sewage systems and waste management plants (Dublin 2022).

Local governments in the Philippines, however, have yet to adopt this technology, as evidenced by their desilting, declogging procedures, and use of sanitary workers for drainage inspection (Tecson, 2020). The discussion on canal enhancement, culvert expansion, and drainage improvement is appropriate for the drainage crawler's objectives. The main advantage of a drainage probe is the ease of use and accuracy of the data it provides. It will pinpoint the drainage system and pipe issue and offer a comprehensive view for fixing it. The already available commercial drainage probe might also be enhanced via GPS in terms of drainage probe, dimension scanning, picture processing, and fracture identification.

Thus, this study proposes a drainage inspection services company using a drainage probe robot. The service uses a drainage probe robot and a drainage network map to perform a report on the condition and obstacles in the pipe. The robot also offers image processing, fracture detection, and dimension scanning. By assessing the condition of the drainage system before a typhoon and significant rainfall, this service aims to reduce flooding issues. This business will cater specific customer needs and conform to their preferences. The company will be examined in terms of marketing research, technical management, legal and taxation issues, funding and financial considerations, and socioeconomic suitability.

1.1 Objectives

The objective of this study is to create a drainage inspection service where the company utilizes the advancement of technology to provide reports on the health of the drainage systems such as blockages, leaks, obstruction, and analysis. The following questions should be addressed first for the business concept to succeed.

1. What is the design of the business model that demonstrates the following essential elements; customer segment, value proposition, channel, customer relationship, revenue stream, key resources, key activities, key partners, and cost structure?
2. What makes up the company's microenvironment, such as marketing intermediaries, consumers, competitive position, competitors, and the public?
3. What are the qualitative and quantitative market demand analysis, including segmentation, purchasing decision behavior, and purchasing decision process?
4. What marketing methods could assist the company in gaining competitive advantages over other advance technology related business in the market?
5. What are the marketing analytics, findings: customer's preference, the market share estimation and sales projection?

6. What is the concept of the business and its technicalities such as its manpower requirement, quality control, service or product costing, inventory management, service capacity, specific requirements, cycle time of the business operation, and its operation management?
7. What are the legal requirements for DTI, DOLE, BIR, SSS, PhilHealth, PAG-IBIG, public and private insurance firms, and other barangay and city permissions and licenses, as well as the various types and amounts of taxes to be imposed on the business?
8. What are the financial aspects of the business, such as projected income statement, projected balance sheets, projected statement of cash flows, and its financial performance, as well as the financing aspect of the business, such as initial capitalization pre-operating expenses, operating expenses, and its sources of initial capitalization?
9. What are the businesses socioeconomic and desirability impact, as well as its impact assessment and cost-benefit analysis?

2. Literature Review

The problem on flooding persists around the world today even after numerous actions and prevention efforts. In August 2022, the city of Dallas in Texas experienced a high rise of flood water. Climate change has caused dramatic swings in periods of drought and high precipitation, which have contributed to the flood. About 15 million people are reported to be affected by this flooding (Ebrahimji et al. 2022). Another flood occurrence in Indonesia affected approximately 1,715 affected households and 120 hectares of plantation land despite the early warning information of the local government. The flood was triggered by high intensity rainfall (AHA Center 2022). The city of Cebu in the Philippines was also hit by flooding caused by heavy rains. At least 15 barangays experienced knee-deep flooding, destroying 9 homes, and causing minor damage to 41 others (Saranaña 2022). These devastating floods are also blamed on ineffective drainage systems. The Department of Public Works and Highways (DPWH) conducted declogging and cleaning of drainage inlets around various roads in the city of Manila. There are also drainage improvement projects and additional pumping stations in construction to address the issue on flooding (Manila DPWH 2021).

Philippines Drainage and Sewerage System

The Philippines' drainage and sewerage system situation is unclear. Both storm water and septage are collected by the drain. Some areas have underground drainage, whereas others have open concrete ditches. Under sidewalks, drainage systems are covered with concrete slabs. Most drainpipes in Metro Manila were built in the 1960s, with 70% of them being single barrels 24 inches in diameter, whereas the ideal size should be 3 meters by 4 meters. Rehabilitation and reconstruction are planned as a result of this. However, difficulties in land acquisition, tedious coordination with various private and semi-government agencies handling underground utilities, limited area that will be used during project construction, and difficulties due to heavy traffic, among other issues, arise during the rehabilitation processes (JICA, 2015; Taylor, 2019; Bob & Carol, 2014). Furthermore, according to the World Health Organization, less than 10% of the population has access to a piped sewerage system (Magtibay, 2017). On the other hand, the recent completion of La Union's drainage system has proven to be effective in preventing flooding in the city. The project included the construction of a double-barrel 1.5 meters by 1.8 meters Box Culvert 300.50 lane meter, and two rows of 1.5 diameters High-Density Polyethylene (HDPE) Pipe 21.00 lane meter (Austria 2022).

Action and Prevention Activities

The local government of the city of Mandaue in the Philippines emphasized the importance of a comprehensive drainage system in permanently addressing flood problems. They proposed that the city's drainage system be completely overhauled because the current system can no longer handle the volume of water during heavy rainfall (Cotejo 2022). Cebu City's local government has also expressed serious interest in resolving the city's flooding issues. Under Executive Order (EO) No. 2 series of 2022, a special task force was formed to specifically address the City's severe flooding problem. The tasks force is composed of different government offices such as Secretary to the Mayor, Office of the City Administrator, City Planning and Development Office (CPDO), Office of the City Engineer, and Department of Public Works and Highways Cebu City District (DPWH), among others (Sabalo 2022). A private firm also proposed a comprehensive study to aid in the resolution of the flooding problem. The study's goal is to find a location for rainwater impoundment facilities and to improve the city's drainage system (Tan 2022). Drainage system inspection is an important step in the improvement of a drainage system. A drain inspection is a system process that evaluates drainage systems to ensure that wastewater flows smoothly from pipelines to sewage systems. The inspection is designed to prevent drainage issues like pipe cracks, corrosion, and major clogging (SafetyCulture 2021).

Pipe Crawler/Drainage Probe

The traditional method of inspecting drainage systems used sanitary workers. It was dangerous, inefficient, and simply did not get the job done. However, as technology advances, previously unknown areas can now be examined. Several studies have been conducted to investigate the idea of using robots to travel inside pipe networks for inspection, cleaning, and repair. Drainage crawlers come in a variety of models and designs, each with its own set of features.
A 2003 study featured a pipe crawler with a novel screw drive concept. The screw drive concept employs three freely spinning wheels attached to a rotor that rotates coaxially with the pipe to provide forward propulsion in the manner of a turning screw. However, the project ran into difficulties while navigating through elbows and vertical sections of a pipe (Martinson et al., 2003). Another study used an inspection robot to traverse inside horizontal and vertical pipes. The robot is made up of two Depth of Field (DOF) cameras for monitoring and an ultrasonic unit for measuring the thickness of the pipe wall. It also has a control and guidance feature that allows an operator to control the robot using a joystick while viewing the camera's video signal on a monitor (Moghaddam & Hadi 2005). A study published in 2016 proposed an in-pipe cylindrical crawler mechanism. Six rubber crawler belts are attached in axial symmetry to a cylindrical frame. The robot is propelled by a single geared motor via a single worm gear. Furthermore, by passively deforming the crawler belt along the pipe shape, the proposed crawler mechanism can propel steps and pass elbows (Nagase & Fukunaga 2016). The camera crawler industry is still evolving at a rapid pace. Size options, GPS monitoring, water resistance, high-resolution camera, camera pan and tilt control, light weight, wireless technology, and software integrations are among the features of commercialized robotic camera crawlers.

Crawler Camera Marketability

Crawler camera systems are used for three main purposes: drain inspection, pipeline inspection, and cavity inspection. A report revealed that pipeline inspection crawler camera had the highest revenue share of 46.4% in 2019. Drain inspection and cavity inspection come in second and third, with 34.1% and less than 20%, respectively. In general, the global crawler camera system market was valued at USD 163.4 million in 2019 and is expected to grow at an 8.3% compound annual growth rate (CAGR) from 2020 to 2027. According to another report, the crawler camera system market was worth USD 170.3 million in 2021 and is expected to reach USD 244.4 million by 2027. With a market share of 32.8%, North America dominated the crawler camera system market. Their government has mandated a prohibition on the use of workers to enter the sewer or pipeline system for surveying and maintenance (Grand View Research, 2020; Dublin, 2022; IMARC Services, 2022). This is consistent with the report, which estimated the market size for crawler camera systems in 2018 at USD 120.2 million (Bhandalkar & Desmukh 2019). The growing demand is attributed to the use of remote-operated inspection systems as a substitute for human entry in some sewers or pipes where space is limited.

Drainage Inspection Service

The massive market for crawler cameras prompted inspection services companies to expand as well. Companies use various robots and provide various service offerings. Ground Penetrating Radar Systems (GPRS), LLC takes pride in using cutting-edge HD cameras and a sewer inspection system to inspect the interior of buried drain and sewer lines. Their CCTV system provides maximum visibility and adaptability, which is required for accurate pipeline inspection. They can assess pipe grade and depth, sewer and pipe integrity, and sewer or pipeline obstructions. They can also measure and monitor pipe temperature and pressure (Ground Penetrating Radar Systems 2022). Another company, Lanes for Drains, offers accurate diagnosis of any potential problems via their drain inspection services. Their CCTV drain survey service enables them to provide the most efficient and cost-effective method of inspecting drains and sewers. They provide a detailed report based on the results of their drainage testing and inspection, which includes the current condition of the pipes as well as the necessary maintenance work. They also use sonde and trace techniques to locate blockages and collapses in non-metallic sewers, drains, and pipes, which involve the use of a small sonde sensor. They also provide solutions for their report and repair structural defects (Lanes for Drains 2022). Another well-known drainage inspection service provider is The Drain Man. The company was founded in Melbourne and has been serving Sydney suburbs since 2017. They collect accurate and high-quality data, verify the pipeline's condition, and confirm the location of any defects using cutting-edge system CCTV robotic cameras mounted on mobile pipeline inspection vehicles. Blockage inspection, junction location, drainage mapping, pre- and post-remediation surveys, culvert inspection, sink hole investigation, and maintenance structure inspection and reporting are all part of their inspection service (The Drain Man 2022).

3. Methods

Scope and Limitations of the Study

The scope of the study aims to propose robot technology that is used for drainage inspection services. This study focuses on the Local Government Unit (LGU) who seeks to help the human labor to replace a robot technology to help them reach those small drainage in that area. Wherein we only use the robot for inspecting services such as dimension scanning, picture processing, and fracture identification.

The research was conducted in LGU offices in Cebu. The researchers were conducting phone interviews with the heads or representatives of engineering offices in Cebu. There have already been studies on the subject, but the focus of this study is on the proposal of a drainage inspection service that uses advanced technology to identify drainage issues that cause flooding. This study is conducted in June 2022 and is expected to be finished in May 2023, Academic Year 2022-2023. A market study was targeted on the whole province of Cebu. The target market is composed of the44 municipalities, 2 highly urbanized cities, 1 chartered city, and the 6 component cities, a total of 53 local government units. The local government unit of each of these places is mainly responsible for monitoring and maintaining the welfare of their place, including efforts pertaining to flooding concerns.

4. Data Collection

The researchers utilized convenience sampling and reached out to all the target markets identified. A total of 7 responses were gathered. Four were interviewed online, one was interviewed face-to-face, and one answered a survey questionnaire form. Online interviews, face-to-face interviews, and survey questionnaires were utilized to gather information. The interview used a guide questionnaire which contains questions about the profile of the local government unit, estimates on their budget on their current drainage inspection activities, and their willingness and preferences to avail the company's services.

5. Results and Discussion

This section will go into detail on the results and discussions for each aspect, the marketing aspect, technical aspect, management aspect, legal and taxation aspect, financial aspect, and socioeconomic desirability aspect, providing a comprehensive analysis of the feasibility study findings.

A. Marketing Aspect

The business offers a drainage inspection service using a drainage probe robot that can quickly inspect the drainage systems and detect any cracks or blockages. This drainage probe robot provides a much more convenient and efficient drainage maintenance solution. Table 1 summarizes the list of services offered by the business.

Table 1. List of Services

Type of Service	Ocular Inspection + Report on Blockages	Crack Detection + Dimension Scanning + Report on Pipe Condition	Analysis on Report	Inclusion	Additional
Inspection 1 Package (I1P)	x			500 meters	Additional 1000 pesos per 100 meters
Inspection 2 Package (I2P)	x	x		500 meters	Additional 2000 pesos per 100 meters
Inspection 3 Package (I3P)	x	x	x	500 meters	Additional 3500 pesos per 100 meters

The target market for of the business is segmented into three categories: geographic, firmographics and behavioral. The geographic segmentation of the study is the Province of Cebu. Firmographics segmentation considers the industry, location, and annual budget, with local government engineering offices and the mayor's office being the primary target with a target office budget of Php200,000 or higher. Behavioral segmentation considers the willingness to avail the service, interest level in availing the service, and frequency of inspections. Table 1 and Table 2 are the different attributes and segmentation of the target market.

Table 2. Firmographic Segmentation

Attributes	Segmentation
Industry	Local Government Unit
Location	Province of Cebu
Annual Budget	Php 200,000 and above*

Table 3. Behavioral Segmentation

Attributes	Segmentation
Willingness to avail the service	Yes
Interest level to avail the service	A score of 3 and above*
Frequency of inspection	At least 3 times a year*

According to the responses gathered during the interview with the target market, the sales projection above is presented. There are three service options that the business offer: I1P, I2P, and I3P; among the three services, the potential consumers are willing to avail all three, thus the market share value. The consumers are asked on their demand level, as well, on how frequent they are willing to avail the services in a year. Using the data, the demand level is presented in a monthly forecast. The prices have been strategized according to the purchasing capabilities of the target consumers. Average additional distance refers to the estimated additional distance that the consumers are willing to cover for inspection, using the services. The business cover the first 500 meters upon availing any of the services, when consumers want to cover more than that distance, then they will pay an additional fee for each additional 100 meters. Average additional distance has been calculated using the distance that the respondents provided during the interview and averaged out. Further, each of the services have their own additional charges when the distance exceeds 500 meters. These charges are added to the price for every 100-meter increment. Thus, the average additional charge for each service is calculated through multiplying the average additional distance and the additional charge. The average charge is then determined using the addition of the price and average additional charge. Hence, the projected annual sale for each inspection services are calculated through multiplying the average charge with the monthly demand level of the services.

B. Technical Aspect

In Technical Aspect, the business utilizes advanced probe robot technology for drainage inspection. The service is supported by a skilled workforce consisting of an Administrator, Crew/Inspector, Crew/Driver, Data Analyst, and Accountant. The company has the capacity to provide services that exceed the expected monthly demand. The service cycle time is approximately 2.61 days, ensuring timely and efficient inspections. The company has also identified specific hardware and software requirements, including HP laptops, printers, the X5-HT Pipeline CCTV Inspection Robot, and software tools such as Facebook, Messenger, and Microsoft Excel. Quality control measures are implemented to ensure proper execution of services, including data and report analysis, and collecting customer feedback for continuous improvement.

Table 4. Service Capacity

Service Option	Monthly Demand Level	Operator needed	Report Writer needed	Service Capacity
I1P	2	1	1	7 services
I2P	0.5	1	1	5 services
I3P	0.5	1	1	3 services

In summary, the company can provide a service which exceeds the expected monthly demand for the services. For the Inspection 1 Package, the business cater up to 7 services, for Inspection 2 Package, the company can cater 5 services,

and for Inspection 3 Package, the company can cater 3 services monthly. The IPO Framework in Figure 1 summarizes how the business operations are done.

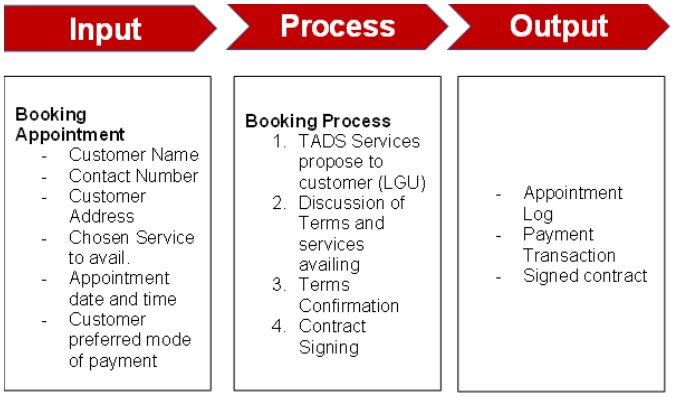

Figure 1. IPO Framework

C. Management Aspect

The management of the business is well-structured, with key roles assigned to ensure smooth operations. The company employs a total of 5 personnel, each assigned to specific positions. The maximum feasible completion time for the pre-implementation stage, as determined by the Gantt Chart, is 227 days from August 2022 to April 2023. The pre-operating cost, amounting to Php 3,026,257.79, covers government permits and licenses, service development costs, equipment and supplies, and advertising expenses. The management team focuses on delivering high-quality services, maintaining strong partnerships with LGU offices, and engaging with customers through the company's Facebook Page. Continuous feedback collection and analysis help drive service improvements and enhance customer satisfaction. The office administrator oversees the operations department and the accounting department for the business. Data analyst and crew are members of the operations division. The inspector and the driver make up the crew. On the other hand, the accountant works in the accounting division.

Table 5. Manpower Requirement

Personnel	No. of Workers
Office Administrator	1
Crew/Driver	1
Crew/Inspector	1
Data Analyst	1
Accountant	1
Total Workers	**5**

Based on the table 5, the business has a total of 5 personnel officially hired in the company—one for each of the following positions: Administrator, Crew/Inspector, Crew/Driver, Data Analyst, and Accountant.

D. Legal and Taxation Aspect

The legal and taxation analysis reveals compliance requirements and potential tax implications associated with the project. It is crucial for the business to ensure that it meets all legal obligations, such as obtaining necessary permits and licenses. Additionally, the potential tax implications should be considered and accounted for in the financial projections to ensure compliance and avoid any unexpected financial burdens.

E. Financial Aspect

In the financial aspect, the analysis reveals several key metrics. The payback period is determined to be 3 years and 6 months, indicating the timeframe needed to recover the initial investment. The net present value (NPV) amounts to ₱1,155,087.13, signifying the potential value created by the project. Additionally, the profitability index stands at

1.35, suggesting financial attractiveness and potential value creation. The internal rate of return (IRR) is calculated to be 19.63%, exceeding the required rate of return. This signifies a favorable investment opportunity, as it indicates profitability, lower risk, and attractiveness compared to alternative investments.

F. Socioeconomic and Desirability Aspect

In the socioeconomic aspect, the project's implementation offers several significant benefits. The adoption of probe robot technology for drainage inspection can enhance infrastructure maintenance practices, leading to improved efficiency in identifying and addressing potential issues. This contributes to reducing the risk of flooding incidents, ensuring better water management, and promoting overall environmental sustainability. The service positive impact on the community and the environment aligns with sustainable development goals and reflects a responsible and desirable initiative.

5.3 Proposed Improvements

Based on the findings of the study, the researchers recommend the following:

Primary Recommendations

It is evident from the result of the study that the business is viable and feasible. The Payback Period is 3 Years, 6 Months, and 26 Days with a benefit-cost ratio of 1.51 which is more than the required BCR. Because of its positive outcome, the business's potential market and consumers have the desire to make a purchase. Next, the company's top priority should be its customers' needs. More services should be offered to increase customer satisfaction, which could be a factor in the company dominating the market and gaining an advantage over rivals. Also, the company will have a marketing plan that targets the ideal customer and uses a mix of online and offline marketing channels. Given the accessibility of social media, the business should take client comments and criticism into account to improve the services provided. Further, the proponents recommend for exploration and application of Patent Protection for the business servicing structure and method. This must be done to prevent new competitors from duplicating the company’s business structure. Additionally, licensing should be given focus as the company will gain from potential competitors or adaptors of the business model in the industry. Lastly, as technology continues to develop, the company should invest in the training and development of its employees. To ensure the employees have the skills and knowledge necessary to operate the Drainage Probe Robot correctly and safely. Investing in employee training and development for using the drainage probe robot may benefit the company in various ways. First, the employees will operate the robot more skilfully and safely, reducing the possibility of mishaps or robot damage. Second, the staff will be better equipped to use the technology and understand how to do so efficiently, which could boost output and raise the standard of work. Lastly, investing in staff training can assist in raising morale and job satisfaction, leading to increased employee retention and a more favourable work environment.

Secondary Recommendations

- Additional research should still be considered to expand the scope, assess the data, and develop information supporting the company's feasibility. Given that the researchers completed the market profile and demand study of other sectors should also be considered.
- To expedite the early operation of the businessand ensure a swift launch, it is recommended to focus on compressing the critical path activities without compromising the quality or functionality of the services provided. By implementing efficient project management strategies and optimizing resource allocation, it is possible to reduce the duration of pre-implementation activities and accelerate the timeline for the company's operations.
- To meet the growing demand, more personnel will be required in accordance with the expansion of the service and to modernize the business's perks and incentives.
- Also, the researchers advise that if the company grows in the coming years, it should have a website or an app to serve customers more quickly and make it easy for them to go through the Products Offered, Services and Packages, and Customers' Feedback.
- For marketing the services, the company can focus on utilizing more Offline marketing methods such as tradeshows or engineering exhibits. Further, building partnerships with local authorities, contractors, and plumbing professionals could help in generating referrals and increasing awareness to other sectors and potentially increase customers.

- Explore partnerships with relevant stakeholders in the drainage industry like plumbing companies, constructions firms, and private entities. The collaboration may involve referral programs, joint marketing initiative, or strategic alliances.
- Additional services using the drainage probe robot could be explored in future research to expand the servicing solutions without needing to utilize another technology.
- An Agile approach as start-up could be considered by future proponents to generate an ROI within six months and determine if such approach is feasible.
- Future proponents should identify the MVPs for the first phase of the drainage probe robot utilization, and the enhancement of the product.

6. Conclusion

The business concept of providing servicing solutions for drainage inspection using a robot probe robot is focused on this feasibility study. The company's initial target market are the Engineering Offices of the Local Government Units of the province of Cebu. These offices are responsible for maintaining, inspecting, and restoring the functionality of drainage systems within their areas of responsibility. Thus, they are the priority customers. However, the company envisions to become the leading service provider of not only the LGU offices but private entities – such as resorts, villages, etc., as well.

Further, the utilization of drainage probe inspection robot is a novel method in providing inspection services to such target market. The use of drainage probe inspection robot becomes a sustainable solution as there will be a minimal need of human labor yet yields more efficient, reliable, and comprehensive data compared to manual inspection. This will lessen the cost of labor, material, and medical costs for the LGU, as there will be no more casualties due to the inspection. The company's service solution is safer, quicker, and reliable, making it a better option for the customers to achieve their goals.

The following significant conclusions of the study are highlighted below:

1. The study is feasible and viable according to the financial aspect results. According to the results, the payback period of the business is by 3 years and 6 months. The net present value presents a indicates a high and positive NPV of ₱1,155,087.13. Further, the profitability index is greater than 1.0 with a calculated value of 1.35. The internal rate of return of the company is also valued at 19.63% which exceeded the baseline of 15%. However, in the first year of the business, the company is at a loss of ₱75,461.22 and begins earning positively by the second year. Moreover, the benefit-cost ratio of the business is calculated to be 1.51 which posits a positive net present value to the firm and its investors as it is greater than 1.0.
2. The cost exceeds the limit of ₱700,000.00. The pre-operating cost of the business is set at ₱3,300,000.00. Since this is a partnership, the five owners equally contributed an amount of ₱140,000.00. With the contribution of the partners alone, the business will not be feasible. However, the company will issue a bank loan of ₱2,600,000.00.
3. On the projected financial performance of the company, the total loaned amount, along with the interest, is paid by fifth year. The loan is payable by 5 years and made up of 20 installments. Every installment, the company pays ₱171,745.38.
4. There are three servicing solutions that the business offers to the customers. There is Inspection 1 Package, Inspection 2 Package, and Inspection 3 package. All of which, according to the interview with the potential customers, suit their needs and addresses their pain, one of which is being able to inspect even the hard-to-reach portions of the drainage systems.
5. The pricing strategy is based off the range of prices that the potential customers choose from during the interview. The prices are generated through getting the maximum of the range that got majority of votes from the customers. This way, the prices are still within the threshold that customers are willing to pay, and since the business is without high competition count in the market, they use this as their leverage to position the pricing.
6. The projected demand level of each service is calculated through determining the market share value of the business and the frequency of the customers for availing the services. The highest expected demand level is from Inspection 1 Package, while Inspection 2 Package and Inspection 3 Package has similar expected demand level on the first year.

7. Based on the projected demand level, the number of employees required for the business to efficiently operate is determined, as well. There will be five employees within the company. One operator of the robot drainage crawler, one analyst, one accountant, one driver, and one administrator.
8. The business will rent a virtual office to serve as the official business address of the company. The virtual office is in AppleOne Equicom Tower, Mindanao Avenue, Biliran Rd, Cebu City, 6000 Cebu. The virtual office will have a rent of ₱4,450.00 monthly.

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