

Business Feasibility Study of the Production of a Simple Digital Distance Measuring Device Based on a Microcontroller

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ABSTRACT

This simple digital distance measuring device based on a microcontroller was developed as an innovative solution to meet the growing demand for efficient, accurate, and low-power measurement tools. The increasing need for flexible and practical instruments underlies this project. Conventional devices are often considered inefficient or inaccurate in certain applications, especially in confined or hard-to-reach areas. Therefore, a new approach is needed that integrates modern technology into a compact, portable, and economical system. The device uses an Arduino Uno microcontroller as the main controller, combined with an HC-SR04 ultrasonic sensor to detect and measure distance in real time. This combination allows for reliable operation with a low margin of error and fast response. The prototype was tested in various environmental conditions, both indoors and outdoors, under different lighting levels. Results showed consistent performance and accuracy, proving its technical feasibility. Additionally, the device's low energy consumption makes it suitable for portable use with limited power sources. Beyond technical development, this study includes a business feasibility analysis, covering market potential, production, environmental impact, and financial viability. The findings suggest that this product is not only technically sound but also economically feasible for small- to medium-scale production. With wide potential applications in industrial, educational, and research settings, this device presents itself as an affordable, efficient, and practical digital distance measurement solution.

Keywords: business feasibility; digital measuring tool; microcontroller; technology innovation.

ABSTRAK

Perancangan alat ukur jarak digital sederhana berbasis mikrokontroler ini dikembangkan sebagai solusi inovatif terhadap kebutuhan pengukuran jarak yang menuntut efisiensi, akurasi tinggi, serta konsumsi daya yang rendah. Kebutuhan pasar yang terus berkembang terhadap alat ukur yang lebih fleksibel, praktis, dan presisi menjadi latar belakang utama proyek ini. Alat ukur konvensional sering kali dinilai kurang efisien dan tidak selalu akurat dalam beberapa aplikasi, terutama dalam pengukuran jarak di ruang sempit atau area yang sulit dijangkau. Oleh karena itu, diperlukan pendekatan baru yang menggabungkan teknologi terkini dalam sistem yang sederhana, portabel, dan ekonomis. Perangkat ini dirancang menggunakan mikrokontroler Arduino Uno sebagai unit pengendali utama yang dipadukan dengan sensor ultrasonik HC-SR04 untuk mendeteksi dan mengukur jarak secara real-time. Kombinasi ini memungkinkan alat bekerja secara efektif dengan tingkat kesalahan pengukuran yang rendah, serta respons waktu yang cepat dan andal. Prototipe telah diuji dalam berbagai kondisi lingkungan, baik dalam ruangan maupun luar ruangan, termasuk kondisi cahaya terang dan redup. Hasil pengujian menunjukkan performa yang stabil dan presisi, membuktikan kelayakan teknis dari rancangan alat ini secara menyeluruh. Selain itu, konsumsi daya perangkat juga relatif rendah, menjadikannya ideal untuk penggunaan portabel dengan sumber energi terbatas. Selain dari sisi teknis, penelitian ini juga melibatkan analisis kelayakan bisnis secara komprehensif. Kajian mencakup aspek pasar, produksi, lingkungan, dan finansial, yang menunjukkan bahwa alat ini layak dikembangkan untuk produksi skala kecil hingga menengah. Dengan potensi aplikasi luas di sektor industri, pendidikan, hingga riset ilmiah, alat ini diharapkan menjadi alternatif pengukuran digital yang efisien, terjangkau, dan aplikatif.

Kata kunci: alat ukur digital; inovasi teknologi; kelayakan bisnis; mikrokontroler.

1. Introduction

Innovation is a strategy to create something new and different from what previously existed. One of the strategies that can be applied is to develop a unique product with the best quality so that it has distinct value in the eyes of customers. (Sardanto & Rahman, 2023)

In various industries such as construction, automotive, and manufacturing, the demand for precise and efficient distance measuring tools continues to grow.

Conventional measuring devices often have limitations in terms of accuracy, flexibility, and energy consumption. Microcontroller-based technology offers a more innovative solution with higher accuracy and lower power consumption.

A microcontroller is a device that represents a modern control system integrated into a single chip. With microcontrollers, the design of control systems can be carried out more efficiently. (Budiarto, 2015).

With sensors, it is possible to measure a quantity digitally, such as distance measurement using ultrasonic sensors. (Hudati et al., 2021)

The development of microcontroller and ultrasonic sensor technologies has enabled the creation of more compact, affordable, and easy-to-use measuring tools. However, challenges remain in adopting this technology, particularly in terms of production costs and market competitiveness. Therefore, a comprehensive business feasibility study is needed to assess whether the development of this tool is technically, economically, and strategically viable. Entrepreneurial marketing, which emphasizes the importance of building and developing networks that support the business—such as suppliers, managers, investors, advisors, trade associations, local governments, and public authorities—plays a critical role in the success of small businesses. (Pamuji, 2018)

In addition to technical and marketing aspects, financial factors are also key in this business feasibility study. Based on financial analysis, the project has a Net Present Value (NPV) of IDR 18,864,288, indicating long-term profitability. The product's Break-Even Point (BEP) is estimated at 127 units, with the BEP achieved in less than two years. The Internal Rate of Return (IRR) of the project is higher than the 10% discount rate, showing that the project is financially viable and offers an attractive investment prospect.

This study aims to design and evaluate a microcontroller-based digital distance measuring device by considering technical, marketing, financial, and environmental aspects. Thus, this research can contribute to the development of more efficient and sustainable measuring tools in various industrial sectors.

2. Theoretical Framework

The theoretical framework in this study aims to understand the concepts and theories relevant to the business feasibility of producing a microcontroller-based digital distance measuring device. The main aspects examined include business feasibility studies, technological innovation, marketing aspects, financial aspects, and environmental considerations.

Business Feasibility Study

A business feasibility study is a comprehensive analysis of a project to determine whether it is viable to be carried out. In SWOT analysis, nine business elements are interconnected: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partners, and cost structure (Enji & Beni, 2023).

These nine elements are analyzed to simplify problem identification and mapping, making them easier to understand and allowing for the creation of strategic management that can be quickly and easily communicated through business ideas and concepts.

Technological Innovation in Distance Measurement

The use of microcontrollers in distance measuring systems has rapidly evolved. An example of microcontroller-based technology is Arduino, which is described as an open-source physical computing platform. Arduino is not just a development tool; it is a combination of hardware, a programming language, and an advanced Integrated Development Environment (IDE). (Domingus Ngani et al., 2023).

Microcontrollers play an important role in industrial automation, enabling the design of more accurate and efficient devices. Additionally, the use of ultrasonic sensors in measuring devices has been proven to improve measurement accuracy. (Niswatul Khasanah, 2023)

Marketing and Digitalization Aspects

Marketing innovation is crucial in introducing new products to the market. Business systems that previously applied conventional or traditional approaches are now transitioning to digitalization. (Arifiyani & Pramaditya, 2023). Marketing innovation is particularly essential for maintaining the product's existence in specific user segments, often referred to as niche markets. (Umar, 2022)

Financial Aspects

The implementation of sound financial management also affects profitability and resilience to economic risks. (Prasasti, Intan. Ameli; Sitohang, Hesekei; Fauziah, 2022) ROI, NPV, and IRR analyses are key indicators in assessing a project's profitability. A thorough financial evaluation can help mitigate investment risks and improve business competitiveness. (Prasasti, Intan. Ameli; Sitohang, Hesekei; Fauziah, 2022).

Accurate profit estimation must consider various factors and should be conducted transparently and objectively. This will ensure that the ROI calculation produces factual data that can be used as a business foundation. A variety of reasons can cause actual numbers to differ from estimated figures. Errors in estimating costs and returns can propagate through the ROI formula and result in inaccurate evaluations. (Botchkarev, 2015). A higher NPV indicates that the business has strong prospects. The NPV model is commonly used to maximize return; as the NPV value increases, so does the return. (Zhang, 2022).

Environmental Aspects

In the technology industry, environmental aspects are a major concern. (Nurbaiti et al., 2021) emphasized the importance of managing electronic waste and energy efficiency in business operations. Therefore, business strategies must include sustainable approaches to reduce negative environmental impacts. An environmentally friendly identity is critical regardless of the type of business—retail, manufacturing, or service-based. (Blazovich et al., 2013).

Eco-friendly businesses are a relatively new field. Unlike conventional entrepreneurship, which focuses mainly on economic gain, sustainable entrepreneurship is based on the idea that entrepreneurs can generate economic, social, and ecological value through their business activities. (Rahayu, 2024)

3. Methodology

This study uses a descriptive approach with a quantitative method, using a business feasibility study (BFS) as the conceptual framework to evaluate the feasibility of producing a microcontroller-based digital distance measuring device. The main steps in this research include:

Literature Review

Secondary data were collected from journals, books, and relevant scientific publications to understand the technical, marketing, financial, and environmental aspects of the project.

Prototype Development

The design and construction of the digital distance measuring device were carried out using a microcontroller, ultrasonic sensor, and data processing software.

Testing and Validation

Testing was conducted in various environmental conditions to assess the accuracy, energy efficiency, and reliability of the measuring device.

Feasibility Analysis

Feasibility evaluation was performed using SWOT analysis, financial analysis (ROI, NPV, and IRR), and market analysis to determine the business prospects of the developed product.

Interviews and Surveys

Primary data were collected from potential users and experts in the fields of technology and business to obtain feedback regarding product development.

4. Results and Discussion

Results

The testing of the microcontroller-based digital distance measuring device showed that the tool had an average deviation of less than 1 cm when measuring distances up to 2 meters. Stability testing was conducted under various lighting and humidity conditions, and the results indicated that the device maintained accurate operation without significant interference.

Power consumption testing demonstrated that the device was energy-efficient, with an average power usage of 0.5 watts during continuous operation. Additionally, responsiveness testing showed that the device could respond to changes in distance within an average response time of 29.155 ms at a distance of 5 meters, increasing proportionally with greater distances.

Based on the analysis of test results, the measuring tool proved to be reliable in terms of high accuracy, low power consumption, and stable operation. Therefore, this tool is considered suitable for mass production and marketing to industries requiring precise and energy-efficient distance measurement devices.

Discussion

Literature Review

The initial stage of the research was conducted through a literature review to collect secondary data from various sources, such as scientific journals, books, and relevant publications. The purpose of this stage was to gain a deep understanding of the technical, marketing, financial, and environmental aspects related to the development of a microcontroller-based digital distance measuring device. Technical information covered the working principles of ultrasonic sensors, microcontroller programming, and hardware-software integration. Meanwhile, the literature review was also used to identify market trends, business challenges, and environmental considerations in the development of portable technology products.

Prototype Development

After the literature-based planning, the design and assembly of the prototype were carried out. The device was developed using an Arduino Uno microcontroller as the main control unit and the HC-SR04 ultrasonic sensor to measure distances in real time. Software was developed to process data from the sensor and display the results immediately. The design took into account user-friendliness, energy efficiency, and device size to ensure portability and applicability across various sectors.

Testing and Validation

The device was tested using a prototype built with an Arduino Uno microcontroller and an HC-SR04 ultrasonic sensor as the main component for distance measurement. The device was subjected to several scenarios to assess its accuracy and stability.

Accuracy Testing

Measurements were conducted by comparing the device's readings to those of a standard measuring tool such as a digital meter. The tests were performed at various distances, ranging from 10 cm to 200 cm at 10 cm intervals, to collect deviation data.

Stability Testing

To assess consistency, testing was performed under various environmental conditions, such as indoors with normal lighting, outdoors with bright lighting, and in high humidity environments.

Energy Consumption Testing

Power consumption was measured to determine the device's energy efficiency during continuous use. The device was tested using a 3.7V lithium-ion battery, and the duration of usage before battery depletion was observed.

Responsiveness Testing

The device's responsiveness was tested by detecting a moving object at a specific speed. The

sensor's response time to changes in object position was recorded.

Table 1. Responsiveness Test Results

Distance Change (m)	Response Time (ms)
5	29.155
10	58.309
15	87.464
20	116.618
25	145.773

Marketing Innovation Aspects

Targeting Niche Markets

Marketing efforts are focused on niche segments in the construction, automotive, and precision technology industries that require accurate measuring tools. Case studies and testimonials from industry users are used to enhance the product's appeal.

Customer Education

Customers are provided with comprehensive information through educational content, such as articles, demonstration videos, and webinars. These materials explain how the device works, its advantages over other products, and real-world applications.

Marketing Digitalization

E-commerce platforms and digital applications are utilized to increase product visibility. SEO optimization is also carried out to ensure that customers can easily find the product online.

Strategic Partnerships

Collaborations are formed with construction companies, technical equipment distributors, and technology influencers to expand market reach.

Customer Experience

Personalized services such as technical consultations and free training are offered to enhance customer satisfaction and brand loyalty.

Feasibility Analysis

To assess business potential, a feasibility analysis was conducted using a SWOT approach to evaluate the product's strengths, weaknesses, opportunities, and threats. Additionally, financial analysis using ROI (Return on Investment), NPV (Net Present Value), and IRR (Internal Rate of Return) methods was performed. The results indicate that the project has promising development prospects, with a positive return on investment and suitability for small- to medium-scale production.

SWOT Analysis

Strengths

Technological Innovation: The use of microcontrollers in distance measuring tools enables the application of advanced technology that enhances accuracy and

functionality, providing a competitive advantage in a growing market.

Customization and Flexibility: Microcontrollers allow for customization of both hardware and software, enabling the product to adapt to various applications and customer needs, making it more flexible than legacy solutions.

Team Experience: If the development team has strong experience in electronics and microcontrollers, it can speed up product development and reduce time-to-market.

Production Efficiency: Automation technology and 3D printing can improve production efficiency, reduce costs and time, and enhance product quality.

Weaknesses

High Initial Development Cost: The upfront investment required for prototype development, research, and production equipment can be a major barrier for new businesses.

Technical Complexity: Developing a microcontroller-based distance measuring device requires deep technical understanding, and design and testing complexity may increase the risk of technical failure.

Component Dependency: Dependence on specific components such as microcontrollers and sensors may lead to problems if there are supply shortages or fluctuations in raw material prices.

Need for After-Sales Support: Ensuring adequate technical support and customer service is important, but it also adds to operational costs and complexity.

Opportunities

Growing Market Demand: Increasing demand for more accurate measuring tools across industries (construction, automotive, electronics) presents a significant market opportunity.

Emerging Technologies and Innovations: Continuous advancements in microcontroller and sensor technology create opportunities for further innovation, such as feature enhancements and integration with other systems, including the Internet of Things (IoT).

Global Market Potential: Expanding into international markets can increase revenue potential. Countries with rapidly developing construction and manufacturing sectors could be targeted.

Environmental Awareness: Developing products with a lower environmental impact or using recyclable materials can attract environmentally conscious customers.

Threats

Intense Competition: The distance measuring tool market is highly competitive, with many established players. New entrants may face challenges in competing on price and technology.

Rapid Technological Changes: The fast pace of advancement in microcontroller and sensor technologies may render products obsolete if innovation lags.

Regulations and Compliance: Adhering to environmental regulations, quality standards, and international compliance can be challenging, especially for new companies unfamiliar with global market regulations.

Economic Fluctuations and Raw Material Prices: Economic instability and fluctuations in raw material costs can affect production expenses and profit margins. Rising component prices may increase costs and impact retail pricing.

The SWOT analysis of the microcontroller-based distance measuring device business shows significant potential in terms of technological strengths and market opportunities. However, the company must be prepared to address weaknesses such as high initial costs and technical complexity, as well as threats from tight competition and rapid technological change. With the right strategy to leverage strengths and opportunities while mitigating weaknesses and threats, the business can tap into a broad market and achieve long-term success.

Financial Analysis

Revenue Projection

Selling price per unit: IDR 500,000
Production cost per unit: IDR 200,000
Net profit per unit: IDR 300,000
Number of units sold: 50 units
Total revenue: IDR 25,000,000
Total production cost: IDR 10,000,000

Break-Even Point (BEP)

Initial capital: IDR 38,000,000
Net profit per unit: IDR 300,000
$$BEP = \frac{\text{Modal awal}}{\text{laba bersih}} = \frac{38.000.000}{300.000} \approx 127 \text{ units}$$

ROI (Return on Investment)

$$ROI = \left(\frac{\text{Annual net profit}}{\text{Initial capital}} \right) \times 100\% \dots (1)$$

Initial capital: IDR 38,000,000
Annual net profit: IDR 15,000,000
$$ROI = (15.000.000 / 38.000.000) \times 100\% = 39,47\%$$

NPV (Net Present Value)

$$NPV = \sum_{t=1}^n \left(\frac{C_{ft}}{(1+r)^t} \right) - I \dots (2)$$

C_{ft}: Cash flow in year *t*
r: Discount rate (10%)
I: Initial capital (IDR 38,000,000)
Total discounted cash flow: IDR 56,864,288
$$NPV = \text{Rp}56.864.288 - \text{Rp}38.000.000 = \text{Rp}18.864.288$$

IRR (Internal Rate of Return)

$$IRR = r_1 + \left(\frac{NPV_{r_1}}{NPV_{r_1} - NPV_{r_2}} \right) (r_2 - r_1) \dots (3)$$

Using interpolation with $r_1 = 10\%$ and $r_2 = 20\%$

IRR is obtained at a value higher than the 10% discount rate, indicating that the project is financially feasible.

5. Conclusion

The development of a microcontroller-based distance measuring device offers various advantages and significant opportunities in the rapidly growing technology market. By leveraging microcontrollers, companies can develop products with high accuracy, high flexibility, and the ability to be customized according to customer needs. This technology allows the integration of advanced features and adaptation to various applications, making it a potentially attractive product for many industries, including construction, automotive, and electronics.

However, success in this business requires careful attention to several key aspects. First, it is important to consider the high initial expenditures, including development, production, and marketing costs. Second, attention to environmental and legal aspects is essential to ensure regulatory compliance and reduce negative environmental impact. Third, SWOT analysis shows that although there are significant opportunities, the company must be prepared to face challenges from intense competition, rapid technological changes, and economic fluctuations.

This project proves that the microcontroller-based digital distance measuring device is a feasible and innovative solution. With continued development, this tool has the potential to become a better alternative to traditional devices. It is recommended to focus on developing IoT-based features and expanding into global markets to increase competitiveness.

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