Impact of Productivity of Dried Chillies Using Semi-Automatic Cleaning and Straining Machine

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Abstract

The Small and Medium Industries (SME) sector is witnessing rapid economic growth and gaining competitiveness, making it crucial for the country's income and local communities. In this context, the ground chili production industry operated by Syarikat Hijrah Dagang Enterprise in Kuala Terengganu, Terengganu, faces challenges in the manual cleaning and evaporation of dry chili, impacting productivity in terms of time and workforce. The primary issue lies in the labour-intensive process of manually preparing ground chili, involving soaking 20kg of dry chilies for 6 to 12 hours, followed by high-pressure water cleaning to separate seeds and impurities. The cleaning process demands considerable time and effort until the water turns clear. Subsequently, grinding the chili takes additional time, requiring 2 hours to clean and steam 20kg of chili with a workforce of 5 people. To address these challenges, a solution is proposed in the form of a machine that utilizes rotation and high-pressure water jets for cleaning dry chilies. Additionally, the machine facilitates the subsequent evaporation process and the transfer of chili to the grinder through a specially designed door. By implementing this semi-automatic dry chili cleaning and evaporating machine, the study resulted in significant improvements. Specifically, there was a 75% reduction in processing time and a 40% decrease in required manpower, effectively cutting down the overall work process by 67%. This innovative approach brings considerable efficiency gains, streamlining the ground chili production process and positively impacting the company's financials by reducing labour costs and boosting productivity.

Keywords: Dried chilies, cleaning chillies, evaporation chillies

1.0 Introduction

The industrial sector plays a vital role in driving national economic development, with Small and Medium Enterprises (SMEs) particularly contributing significantly to Malaysia's economic growth [1]. SMEs comprise nearly 90% of all manufacturing establishments in the country underscoring their substantial presence in the economy. Recently, there has been a growing awareness of the crucial role and contributions of SMEs, leading to increased attention from various stakeholders. Small and Medium Industries (SMIs) significantly contribute to the country, especially in the Gross Domestic Product (GDP), employment, and exports [2]. Recognizing the potential of SMEs and the challenges, the Ministry of Higher Education (KPT) has initiated efforts to support researchers in higher education institutions (IPT) to develop innovative solutions for troubled SMIs. One such endeavour is the Demand-Driven Innovation Project, facilitated through a Public-Private Research Network (PPRN) research grant, aimed at introducing innovations that aid in the management of struggling SMEs in Malaysia.

By fostering collaborations between researchers and industry, this initiative seeks to address real-world challenges and drive positive impacts on the SME landscape. Researchers and companies are provided with funding opportunities through the PPRN grant, as outlined in the Institutional Level PPRN Implementation Guidelines issued by the Malaysian Ministry of Education. The selected project for this innovation is driven by the challenges expressed by Syarikat Hijrah Dagang Enterprise, a company based in Kuala Terengganu, Terengganu. The focus of this project revolves around the development of a cleaning machine and a ground chili evaporator, intended to increase ground chili production and boost the company's overall productivity. As part of the innovation's assessment, a comprehensive study was

conducted to evaluate the impact on the company's productivity, particularly in terms of the time and manpower required for ground chili preparation. This study aims to gauge the effectiveness of the innovation in enhancing the company's operational efficiency and productivity. Small and medium industries (SMEs) in Malaysia encounter various challenges, including management and product manufacturing issues. Despite their significant role in both the developed and the developing economies, Small-and Medium-sized Enterprises (SMEs) are faced with the greater risk of business failure with past statistics indicating that over half of all new ventures will not enjoy long-term success [3-4].

The present research focuses on an SMEs company specialized in ground chili production, which utilizes dried chili imported from India. According to [5], chilli is the largest spice item exported from India it occupies first position in terms of value. Chillies are exported as chilli powder, dried chillies, pickled chillies and chilli oleoresins. The manual process of ground chili production involves several steps. Firstly, 10 kg of dried chilies are soaked for 12 hours in a barrel to soften them. Subsequently, the chilies are washed in a container with normal pressurized water, requiring rinsing and transferring them to a basket. This cleaning process with tap water is time-consuming and continues until the water becomes clear. According to [6] drying is the important operation, where the water activity of the product is maintained to improve the storage life so that it is not spoilt by microbes. The evaporation of the cleaned chilies then takes approximately an hour, leading to inconsistent results due to uneven evaporation. Furthermore, the workers face challenges while handling the cleaned chilies. They must scoop the chilies into a container and manually lift them to the coarse grinding machine. This repetitive process not only consumes time but also puts a strain on the worker's body posture, potentially leading to long-term adverse effects on the spine (Figure 1 illustrates the manual handling process of

chilies). Prolonged and repetitive stress on muscles, tendons, ligaments, and nerves can have long-term adverse effects on the human body [7]. Addressing these challenges is crucial for improving the efficiency and ergonomics of the ground chili production process, ensuring the well-being of workers, and enhancing the overall productivity of the company.

a) Soaking process

b) Washing process

c) Evaporating Process

(Source: Enterprise Hijrah Trading Company)

Figure 1: Manual handling process of chilies

2.0 Methodology

The research methodology encompasses the techniques and approaches utilized to fulfill the study's objectives and goals. Employing a systematic research methodology ensures that the study is directed towards its intended objective. The development of this innovation involved eight distinct phases, carefully executed by the researchers. Since innovation is crucial in R&D aspect, SMEs owner may diagnose their current business position and

strategically plan intended changes by enhancing their operational capabilities [8]. According to [9], Three phases are identified, each with their own characteristics and types of activities: the pre-design, the design and the post-design phase. In the initial phase, the focus is on identifying the problems faced by consumers. The ability to forecast consumer demand accurately is of great importance to companies in the consumer market [10]. The second phase is dedicated to defining the precise objectives of the study to be pursued. The third phase involves data collection, component design, prototype production, and product simulations using AutoCAD Inventor software to ensure the project's functional success. Upon successful functioning of the prototype mechanism, the appropriate materials for machine production are selected. The ground chili cleaning machine is a semi-automatic device with a user-friendly control panel featuring an on/off switch. The machine incorporates a cleaning drum, boasting a diameter of 806 mm and a length of 1220 mm, with a capacity of up to 20 kg of dry chilies per washing session. The cleaning drum's movement is facilitated by an AC motor, while a water pump with a flow rate of 34 l/min ensures high water pressure during the cleaning process. The rotation rate and water pressure are adjustable, catering to the user's specific requirements. The washing process employs filtered water from the water tank filter to guarantee superior product cleanliness. A specially designed door facilitates easy loading of chilies into the cleaning drum and retrieval of the processed chilies after completion. Additionally, the machine features a watertight door to minimize water spillage. Remarkably, this versatile machine seamlessly integrates two processes into one which enabling both the cleaning and evaporation of dried chilies with efficiency and convenience.

The subsequent phase involves the design, development, and fabrication of the product. The fabrication process entails creating a cylindrical cage, driven by a motor, for cleaning the soaked dried chilies. This cage is constructed

from perforated stainless-steel sheet, ensuring effective washing while maintaining chili quality. The motor's speed is adjustable, enabling precise control during the washing and steaming processes. A high-pressure pipeline, equipped with multiple outlets, expels water to remove foreign matter or dirt, complemented by a rapid water reservoir. Water pressure is governed by a pressure device, with a water reservoir tank and pump designed to maintain the desired pressure level. The pump's activation during the washing process is controlled by an on/off switch. The water tank reservoir is positioned beneath the machine for chili cleaning, allowing water removal through the designated pipeline.

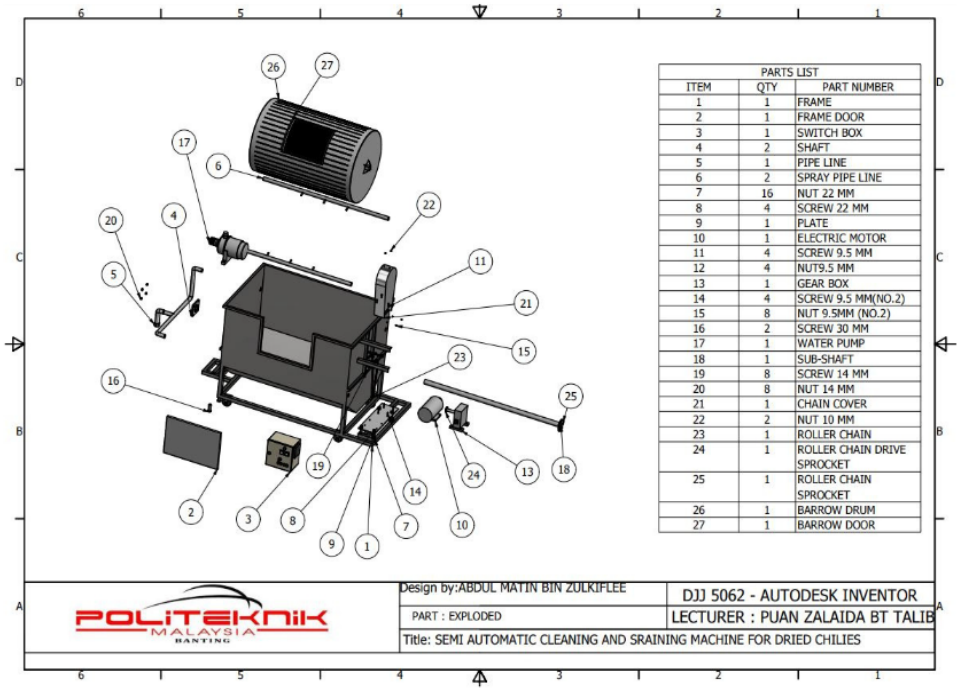

Figure 2: 3D model of a machine

Additionally, another pipeline facilitates the drainage of excess water during the dry chili washing process. Subsequently, the cylindrical cage facilitates. The 3D model of a machine shown in figure 2. In the final phase, a specially designed door is incorporated to streamline the production process after evaporation. Subsequently, the machine undergoes testing and trial runs using 20 kg of

dried chilies soaked for 12 hours. The high-pressure water, optimal for chili cleaning, is carefully adjusted. Detailed records of the experimental results are maintained. In the pursuit of product refinement, an enhancement is introduced: a sprinkler water channel is integrated to amplify the washing water's impact within the machine. This enhancement aims to further optimize the cleaning efficiency of the system.

3.0 Result and Discussion

The analysis produced two research findings regarding the improvement of chili cleaning and productivity in chili production. The impact on the chili cleaning process is presented in Table 1, considering the number of workers, work process, and time required to clean 20 kg of chili. The data for this analysis was obtained from the Final Feedback of the Industrial Project within the PPRN initiative, using a productivity survey conducted by Syarikat Hijrah Dagang Enterprise.

Table 1: Percentage of increase and decrease in the work. process of cleaning chilies

Criteria	Before innovation	After innovation	Percentage Increase/ Decrease
Number of employees	5	3	40 % (decrease)
Work process	3	1	67% (decrease)
Time for 20 kg (minutes)	120	30	75% (decrease)

(Source: Enterprise Hijrah Trading Company)

Table 1 illustrates the decrease in the number of workers required for ground chili production. Before the innovation, five (5) workers were needed, while after implementing the machine, only three (3) workers were sufficient, resulting in a 40 percent reduction in the workforce. This innovation leads to cost savings due to reduced employee salary

expenses. The table also displays the reduction rate of employees based on the streamlined work process. Before the development of the machine, three (3) work processes were required. First, soaking 20 kg of chilies in a barrel for 10 hours. Second, lifting the 20 kg barrel and pouring the chilies into the filter. Third, cleaning the chilies under running water until the water becomes clear. With the new machine equipped with pump and motor technology, these three (3) works processes are combined into one (1) efficient process. Now, only one worker is needed to handle soaking, pouring, and washing within the machine, reducing the work processes by 67 percent. This technological innovation not only reduces the need for manpower but also minimizes the risk of worker's hand injuries during chili handling, promoting a safer and healthier work environment, and increasing employee motivation.

Table 2: Percentage of increase and decrease in productivity rate

Criteria	Before innovation	After innovation	% Increase/ Decrease
Total production per month	100kg/ month	150 kg/month	150% (increase)
Profit per month	RM8000/ month	RM12000/ month	150% (increase)

(Source: Enterprise Hijrah Trading Company)

According to Table 2, the production rate of ground chili has increased to 150 percent per month, leading to a 150 percent increase in the company's profit as well. This improvement is due to the company's ability to produce 8 groups (batches) of ground chilies per month, compared to the previous 5 groups (batches). The innovative machine has simplified the washing process, enabling this increase in production. As a result, the company can now produce 400 kg per month for 20 working days, meeting 62.5 percent of the market demand compared to the previous

37.5 percent. Consequently, the production profit rate has risen significantly to RM 32,000 per month from the previous RM 8000 per month.

4.0 Conclusion

Adopting the latest technological changes, especially IR4.0 technology, is highly encouraged for small and medium industries (SME) to enhance their production processes. The innovative semi-automatic machine introduced in this study replaces manual labour by streamlining the soaking, cleaning, and evaporation of dried chilies. This technological advancement significantly increases the production rate of ground chili. Consequently, this machine development positively impacts the company's productivity, sales, and profits. The integration of technology in industrial manufacturing is crucial as it contributes to the overall improvement of SMEs and the country's economy. SMEs are vital actors for enhancing innovation, competitiveness, entrepreneurship and the establishment of an effective innovation system for developing countries.

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Author Contributions

R. Ramli: Original idea of study and conceptualization, Methodology, Writing original draft preparation; **Y. Talib:** Data curation, Software, Validation, Supervision; **A. S.**

Buang: Software, Validation, Touch-up writing, reviewing and editing.

Conflicts of Interest

The manuscript has not been published elsewhere and is Not under consideration by other journals. All authors have approved the review, agree with its submission, and declare no conflict of interest in the manuscript.

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