DEVELOPMENT OF A SPIN GRIND DRYER FOR SEAWEED POWDER PROCESSING USING TOTAL DESIGN APPROACH

Submitted in accordance with the requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

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2020

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Sesi Pengajian: **2019/2020 Semester 2**

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for the degree of Bachelor of Manufacturing Engineering (Hons). The member of the supervisory committee are as follow:

……..

(Prof. Ir. Dr. Hambali bin Arep @ Ariff)

ABSTRAK

Penyelidikan ini mengemukakan kaedah pembangunan mesin ‘Spin Grind Dryer’ untuk pemprosesan serbuk rumpair laut menggunakan pendekatan reka bentuk secara total. Oleh itu, reka bentuk dan pembuatan produk yang dicadangkan melibatkan pelbagai aktiviti reka bentuk. Tujuan penyelidikan ini adalah untuk mencadangkan reka bentuk mesin ‘Spin Grind Dryer, yang baru untuk menyelesaikan masalah industri serta memendekkan urutan proses. Proses reka bentuk berdasarkan model atau metodologi Pugh yang merangkumi pelbagai aktiviti reka bentuk seperti pencarian pasaran, penciptaan idea, pemilihan konsep dan reka bentuk terperinci. Untuk menentukan dan menghasilkan idea bagi mengembangkan produk sebelumnya, analisis produk semasa telah dilakukan. Pada tahap penghasilan reka bentuk, Analisis Hierarki Proses (AHP) dan Teknik untuk Urutan Preferensi Prosedur dengan Kesamaan dengan Ideal Solution (TOPSIS) digunakan untuk menentukan konsep reka bentuk terbaik semasa proses pemilihan. Process merancang model 3D yang dipilih dilakukan dengan menggunakan perisian CATIA pada tahap reka bentuk terperinci dan reka bentuk akhir dipilih melalui kaedah AHP dan TOPSIS. Penambahbaikan mesin ‘Spin Grind Dryer’ dari reka bentuk yang sedia ada menunjukkan dengan pengoptimuman sebanyak 22% pada bahagian dan komponen mesin dan pengurangan masa 21% bagi proses pembuatan untuk setiap bahagian menggunakan perisian ‘Additive Manufacturing’. Kaedah Reka Bentuk dan Pembuatan (DFMA) digunakan sebagai medium untuk pengoptimuman reka bentuk. Ringkasnya, dari segi kegunaan, kecekapan dan kemudahan pemasangannya, model baru mesin ‘Spin Grind Dryer’ untuk pemprosesan serbuk rumpair laut jauh lebih baik daripada versi yang sedia ada.

ABSTRACT

This research presented the method of development Spin Grind Dryer for seaweed powder processing using total design approach. Thus, the design and manufacture of the proposed product involved various design activities. The aim of this research is to propose a new design of spin grind dryer for solving industrial problems by shorten the process sequences. The design process is based on the integrated model or methodology of Pugh which includes various design activities such as market search, idea creation, selection of concepts and detail design. In order to determine and produce the idea to develop the previous product, the analysis of the current similar product was carried out. In the conceptual design level, the Analytical Hierarchy Process (AHP) and Technique for Order of Preference Procedure by Similarity to Ideal Solution (TOPSIS) were used to determine the best design concept during the selection process. Designing the selected 3D model were conducted using CATIA software at the detail design stage and final design is selected based on the AHP and TOPSIS method. The improvement of spin grind dryer machine from the existing design is shown with 22% optimization of parts and components and 21% time reduction for slicing each part using additive manufacturing software. Design for Manufacture and Assembly (DFMA) method is used as a medium for design optimization. In summary, in terms of its usability, efficiency and ease of assembly, the proposed new model of the spin grind dryer for seaweed powder processing is much better than the existing version.

DEDICATION

Special dedication to my beloved family especially my father (Md Raizi Bin Yunus), my mother (Siti Zaleha Binti Alias) and my supervisor (Prof. Ir. Dr. Hambali bin Arep @ Ariff) for every support, guidance, concern, understanding and patient. Thanks for everything. I would like to say thanks too to all my fellow friends. Without all your supports, the work and success will never be achieved.

ACKNOWLEDGEMENT

In the name of ALLAH, the most gracious and the most merciful. Alhamdulillah, all praises to Allah the Almighty, on whom ultimately we depend for living and guidance. First of all, I am thankful to Almighty Allah who made me able and give me enough strength and opportunity upon completing this final year project successfully without difficulty. Without His numerous Blessings, it would not have been possible.

I would like to extend my deepest gratitude to my respected Supervisor, Prof. Ir. Dr. Hambali bin Arep @ Ariff for the great mentoring that was given to me throughout the project. The report is compiled infinitely with all his sophisticated advises, perceptual criticism and patience encouragement. He encouraged and motivated me to give this project purposely and gave me many analytical thoughts to solve all the problems emerging. Again, for his respectful explanations and tolerance, I want to thank him. I would never have been able to achieve this breakthrough without his support. Next, sincere gratitude to all of my colleagues, who helped me complete this study directly or indirectly.

Last but not least, I am sincerely grateful to my beloved family and in particular to my dad and mother who have known and supported me in the hectic times of this year. Without encouragement, inspiration, support and motivation, all my hard work will be nothing. Finally , I wish to thank everyone who were important to this report and to apologize for not being able to mention each of you personally.

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LIST OF ABBREVIATIONS

TOPSIS	-	Technique for Order of Preference by Similarity to Ideal Solution
DFMA	-	Design for Manufacturing and Assembly
DFE		Design for Environment
DFA	-	Design for Assembly
DFM	-	Design for Manufacture
CAD	-	Computer-Aided Design
PDS	-	Product Design Specification
MCDM	-	Multi Criteria Decision Making
AHP	-	Analytical Hierarchy Process
CE	-	Concurrent Engineering
PD	-	Product Development
3D	-	3 Dimensional
PLA	-	Polylactic Acid

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND OF THE RESEARCH

Nowadays, seaweeds are important as a source of raw material for food or additives. Eucheuma cottonii is one of the famous seaweed that used worldwide which contains carrageenan for starch or fibres sources that usually applied for beverages or gelatine. To minimize the costs of production as well as increasing life expectancy, seaweed has been extracted in the form of dry product or powder (Djaeni & Sari, 2015). However current powdering process still using conventional process which is time consuming and complex flow sequences.

Current process adopted by local manufacturers required 7 steps in other to complete the seaweed processing cycle which are washing, cooking, chopping, drying, grinding, sieving and packaging. The process takes time by moving the extract seaweed from one process to another to complete each cycle. This process known as conventional process which follow the sequences to finish the product development seaweed powder. Based on previous process, a new spin grind dryer design is proposed to replace the conventional approach using total design approach including Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method, concurrent engineering, design for manufacturing and assembly (DFMA) and Design for environment (DFE) to achieve better result in term of optimization and processes.

According to Pelegrina et al. (2018), TOPSIS is one of the method to obtain ranking of alternatives from latent criteria. Simple mathematical form measured the relative performance of system or design in term of simplicity, rationality, comprehensibility, good computational efficiency and ability (Ewa, 2011). The method is one of the decision making tools that helps to improve the machine design.

Concurrent engineering has been used in various organization because of its systematic approach for simultaneous work on product and related process which is not limited to the manufacturing field (David Juarez, 2015). The method is the most reliable process to increase the demand, faster respond and for shorter product life cycle. Concurrent engineering is used to combine the machining process for seaweed powder processing and reducing the sequence flow that will gives positive result in term of cost and production time.

Design for Manufacture and Assembly (DFMA) is a design approach that focuses on ease of manufacture and efficiency of assembly. The manufacture and assembly will be more efficient, time consuming and lower cost when the design has been simplified. DFMA combines of two methodologies, which is Design for Manufacture (DFM) and Design for Assembly (DFA). In addition, the DFA technique can be applied during the conceptual design phase when decisions greatly affect production costs (Favi et al., 2016). DFMA is one of the approach to optimize the process from traditional process to the new product design that applied to the product system.

Meanwhile, design for environment (DFE) is needed in design or drawing to reduce the overall impacts that give to human health and the environmental. By utilizing this method environmental performance will enhance due to the choice of low effect materials, clean production technologies and has insignificant effect on the environmental for the final product. Total design approach is important for optimizing a new design of spin grind dyer machine to achieve customer need and satisfaction.

1.2 PROBLEM STATEMENT

For this research, the production of seaweeds powder using new machine of spin grind dryer is expected as an outcome using total design approach. According to the Market Insights, commercial seaweed market is projected to exceed $87 billion by 2024 due to the rising demand for seaweeds powder. The production of seaweed increases significantly from 60,000 tonnes in 2006 to 261,000 tonnes in 2015. Meanwhile in Malaysia seaweed production reached the highest level at over 330,000 tonnes in 2012 (Fatima et al., 2018).

When the productivity of making seaweeds powder increasing according to the demand, some process in making seaweeds powder need to be revised while improving the productivity, quality and reducing time. However, manufacturers still depending on conventional process which takes a lot of times and affect the quality of powder itself.

The existing processes has limitation which required long processing time of making seaweed especially during the drying process. Drying is one of the important processes in making a high-quality seaweed powder. Basically, the objective of the drying process is to obtain high moisture removal efficiency at a reduced processing time (Bono et al., 2011). The production is still using the conventional drying process such as drying with the help of sunlight which will take 2-3 days depending on weather conditions (Suherman et al., 2018). Drying is one of the critical process in making seaweed powder while keeping its quality.

The processing time is one of another problems when several machine and equipment is used such as grinding, drying and cutting to produce same product which is seaweeds powder. Reduced time in product development process, higher product quality, lower cost in manufacturing process and fulfilment of customers' requirements are the key factors to determine the success of a company and produce excellent products, the concept of Concurrent Engineering must be implemented (Hambali et al., 2009).

Lastly, same problem happens when there is a local company in Malaysia who using conventional approach that has less quality of seaweeds powder and time consuming for

overall process. The process need to go through according to the steps of processes that keep the productivity low and the several design approach need to be applied for improving the design system.

1.3 OBJECTIVES

In this research, the main objective of the study is to propose a new design of spin grind dryer using total design approach. However to achieve the main purpose of the project, several objectives are addressed within the project timeline which are:

a) To study the existing product in the current market
b) To evaluate the best proposed design using TOPSIS and AHP method
c) To optimize the proposed design using DFMA

1.4 SCOPE

Within the product development process, the scope of the project is limited until optimizing the design using DFMA. The proposed design are focusing on the literature review of developing spin grind dryer machine in seaweed powder production using total design approach regarding to the prior art design. The best proposed design is evaluated using integrated TOPSIS method and AHP method while handling the product design development. Optimizing the proposed design will be done by using DFMA for the best result. DFMA method is one of the best guideline for handling instrument and application to optimize and simplified the product instead of reducing the production cost (Barbosa & Carvalho, 2013).

1.5 SIGNIFICANT STUDY

The proposed design of the spin, grind dryer machine will give high benefits to the industry especially in seaweed powder production. The design concept and development will have a different shape and more improvement. This work will also develop the market's existing product and refine the product design to be more practical and effective. Furthermore, the proposed design will reduce production time that may lead to the company profits. The process sequence will be reduced which significantly improves overall design development time.

CHAPTER 2
LITERATURE REVIEW

In this chapter, product development process is reviewed using total design approach based on previous invention of seaweed powder production. The information gain may be in form of journals, books, articles and website. The literature summarised including previous invention idea on traditional and conventional method of seaweed powder process, total design approach, concept selection, TOPSIS method, concurrent engineering and design for manufacturing and assembly (DFMA).

2.1 OVERVIEW OF SEAWEED

Seaweed was identified into three wide groups based on its characteristics and pigmentation which are brown, red and green (McHugh, 2003). Three groups known as Phaeophyceae, Rhodophyceae and Chlorophyceae by botanist respectively. Firstly, brown seaweeds are usually large with range from 20 meters long and thick for the giant kelp, leather-like seaweeds from 2–4 meters long and smaller species 30–60 centimetres long. Then, red seaweeds are usually smaller than brown seaweeds ranging from a few centimetres to about a metre in length.