UNIVERSITI TEKNIKAL MALAYSIA MELAKA

WORKBENCH FOR BURGER PATTY PRODUCTION FOR SME COMPANIES

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B092010113

BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY

(BMKV) WITH HONOURS

2024

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A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (BMKV) with Honours

Faculty of Mechanical Technology and Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2024

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **WORKBENCH FOR BURGER PATTY PRODUCTION FOR SME COMPANIES**

SESI PENGAJIAN: **2023-2024 Semester 1**

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DEDICATION

To my mentors and advisors, thank you for your guidance, expertise, and valuable insights throughout the journey. Your encouragement and constructive feedback have been instrumental in shaping this report. To our colleagues and team members, your collaboration, dedication, and hard work have been the driving force behind the successful completion of this project. Your commitment to excellence and willingness to go the extra mile have truly made a difference. To our friends and family, thank you for your understanding, patience, and constant encouragement during this challenging endeavor. Your unwavering support and belief in our abilities have been a constant source of motivation. Lastly, we would like to express our heartfelt appreciation to all the participants and stakeholders who generously shared their time, knowledge, and experiences, enabling us to gather valuable data and insights for this report. This report is a testament to the collective effort and collaborative spirit of everyone involved. It is dedicated to every individual who has played a part, no matter how big or small, in bringing this project to fruition. Thank you for your contributions, trust, and commitment to excellence.

ABSTRACT

The hamburger workbench is a specialized piece of equipment designed to optimize the preparation and assembly of hamburgers in a food service setting. This abstract provides an overview of the key features and benefits of the hamburger workbench. The hamburger workbench is designed to enhance efficiency, organization, and cleanliness in the hamburger assembly process. It typically consists of a sturdy and hygienic work surface with designated compartments and storage areas for various burger ingredients such as buns, patties, toppings, and condiments. This layout allows for easy access to ingredients, streamlining the burger assembly process and reducing the potential for cross-contamination. One of the main benefits of the hamburger workbench is its ergonomic design, which promotes comfort and productivity for food service workers. The work surface is typically at an optimal height, reducing strain and fatigue during repetitive tasks. Additionally, the placement of ingredients and tools within easy reach minimizes the need for excessive bending, reaching, or searching for items, thereby improving overall efficiency and workflow. The hamburger workbench also prioritizes cleanliness and hygiene. It often incorporates features such as removable and washable components, easy-to-clean surfaces, and integrated waste management systems. These features facilitate efficient cleaning and sanitization, ensuring a hygienic work environment and compliance with food safety regulations. Furthermore, the hamburger workbench promotes organization and consistency in burger preparation. The designated compartments and storage areas help maintain ingredient freshness and prevent cross-contamination by providing separate spaces for different ingredients. This organization facilitates a streamlined assembly process, allowing food service workers to assemble high-quality hamburgers quickly and consistently. In summary, the hamburger workbench offers numerous benefits in terms of efficiency, organization, cleanliness, and ergonomics in the hamburger assembly process. Its design promotes a hygienic and organized work environment while improving productivity and reducing strain on food service workers. By incorporating features that prioritize cleanliness and accessibility, the hamburger workbench enhances the overall quality and consistency of hamburgers prepared in food service establishments.

ABSTRAK

Hamburger workbench adalah peralatan khusus yang direka untuk mengoptimumkan persiapan dan penyusunan burger dalam persekitaran perkhidmatan makanan. Abstrak ini menyediakan gambaran keseluruhan mengenai ciri-ciri utama dan faedah workbench hamburger. Hamburger workbench direka untuk meningkatkan kecekapan, organisasi, dan kebersihan dalam proses penyusunan burger. Biasanya, ia terdiri daripada permukaan kerja yang kukuh dan bersih dengan bahagian-bahagian dan ruang penyimpanan yang ditetapkan untuk pelbagai ramuan burger seperti roti burger, pati daging, toping, dan sos. Susun atur ini membolehkan akses mudah kepada ramuan, mempercepatkan proses penyusunan burger, dan mengurangkan risiko pencemaran silang. Salah satu faedah utama hamburger workbench adalah reka bentuk ergonomiknya yang meningkatkan keselesaan dan produktiviti pekerja perkhidmatan makanan. Permukaan kerja biasanya berada pada ketinggian yang optimum, mengurangkan tekanan dan keletihan semasa tugas berulang. Selain itu, penempatan ramuan dan perkakas yang mudah dijangkau mengurangkan keperluan untuk membungkuk, merentang, atau mencari barang, dengan itu meningkatkan kecekapan dan aliran kerja secara keseluruhan. Hamburger workbench juga memberi tumpuan kepada kebersihan. Ia sering menggabungkan ciri-ciri seperti komponen yang boleh dikeluarkan dan dicuci, permukaan mudah dibersihkan, dan sistem pengurusan sisa terintegrasi. Ciri-ciri ini memudahkan pembersihan dan sanitasi yang cekap, memastikan persekitaran kerja yang bersih dan mematuhi peraturan keselamatan makanan.

Selain itu, hamburger workbench mendorong organisasi dan konsistensi dalam penyediaan burger. Bahagian-bahagian dan ruang penyimpanan yang ditetapkan membantu menjaga kesegaran bahan dan mencegah pencemaran silang dengan menyediakan ruang yang berasingan untuk bahan-bahan yang berbeza. Organisasi ini memudahkan proses penyusunan burger yang lancar, membolehkan pekerja perkhidmatan makanan menyusun burger dengan cepat dan konsisten. Secara keseluruhannya, hamburger workbench menawarkan banyak faedah dalam hal kecekapan, organisasi, kebersihan, dan ergonomik dalam proses penyusunan burger. Rekabentuknya meningkatkan persekitaran kerja yang bersih dan teratur sambil meningkatkan produktiviti dan mengurangkan tekanan terhadap pekerja perkhidmatan makanan. Dengan menggabungkan ciri-ciri yang memberi tumpuan kepada kebersihan dan aksesibiliti, hamburger workbench meningkatkan kualiti dan konsistensi keseluruhan burger yang disediakan dalam kedai makan.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

First and foremost, I would like to thank and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. I would like to extend my appreciation to the Universiti Teknikal Malaysia Melaka (UTeM) for providing the research platform. Thank you also to the Malaysian Ministry of Higher Education (MOHE) for the financial assistance.

My utmost appreciation goes to my main supervisor, Mr. Mohd Khairul Nizam Bin Suhaimin, Universiti Teknikal Malaysia Melaka (UTeM) for all his support, advice, and inspiration. His constant patience in guiding and providing priceless insights will forever be remembered.

Finally, from the bottom of my heart, I express gratitude to my family, for the encouragement, being the pillar of strength in all my endeavors. My eternal love also to all my friends, for their patience and understanding. I would also like to thank my beloved parents for their endless support, love and prayers. Finally, thank you to all the individuals who had provided me the assistance, support and inspiration to embark on my study.

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LIST OF SYMBOLS AND ABBREVIATIONS

℃	-	Celcius
m	-	Meter
SME	-	Smal mediem enterprise
HOQ	-	House of Quality
CAGR	-	Compound anual growth rate
CAD	-	Computer aided-design
SW	-	Solid work

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CHAPTER 1

INTRODUCTION

1.1 Background

SME stands for Small and Medium Enterprises in the business sector. SMEs, which represent a wide variety of firms operating on a smaller scale than huge corporations, are an essential part of the economy. In contrast to their bigger competitors, these businesses often have fewer employees, a lower yearly turnover rate, and comparatively fewer assets. SMEs are important for promoting economic expansion, advancing innovation, and creating job opportunities. They have a reputation for being agile, flexible, and entrepreneurial, which enables them to quickly react to market developments and carve out specialized niches. In the context of burger production, SMEs in this sector are small to medium-sized businesses that focus on the creation, assembly, and distribution of burgers. They provide distinctive flavors, locally sourced ingredients, and individualized experiences that satisfy the wide range of burger enthusiasts' tastes and preferences.

The focus of this research is on burger production for SME owners. In the food sector, the production of burgers has grown in popularity, capturing the interest of millions of people worldwide. Burgers are a popular option for casual eating because of their adaptability and ability to be customized. They also provide a broad variety of flavor combinations. Many small and medium-sized businesses (SMEs) have embraced burger production as a viable business attempt because of the rising demand and the potential for profitability. SMEs are establishing a specialization in the burger industry by

offering high-quality, inventive, and locally sourced remedies that satisfy the appetites of burger fans.

1.1.1 Current demand for burger production

Ever since the hamburger as we know it was introduced in the early 1900s, the burger market has changed dramatically. The 1970s saw a rapid increase in the popularity of burgers due to the rise in demand for convenience foods, the growing popularity of fast food, and the automation of the production process. In the last two decades, the trend towards quality, taste, and customization has resulted in the emergence of the premium burger. Driven by its popularity, fast food chains, cafes, high-end restaurants, and retailers started adding comparable, high-quality burgers to their menus and product ranges.

People are asking for international cuisines in their country more frequently because of the expanding tourist industry and globalization. Many foreign hotels, eateries, and food chains are increasing their geographic reach to provide local clients with high-quality and delectable international cuisines. Customers now have access to information about the cuisine and cultures of various nations and areas thanks to the internet and social media platforms. Among the fast food available globally, burgers hold the highest demand among people. In addition, according to the U.S. Department of Agriculture (USDA), people consume approximately 50 billion burgers each year. Statistics from Knowledge Based Value (KVB) Research also state that most of the fast food consumed by people is also burgers. Figure 1.1 shows the statistic of market share, by product in 2020.

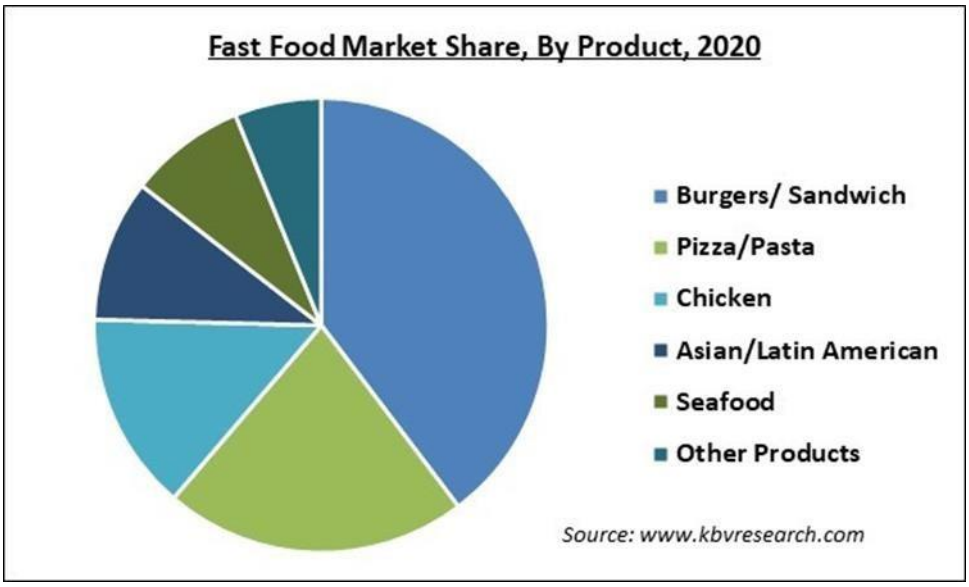


Figure 1.1 Statistic market share

1.2 Problem Statement

The design of the workstation is essential to ensuring effective operations and efficiency in small and medium-sized enterprises (SMEs) engaged in the manufacturing of hamburgers. There are several typical design problems SMEs may experience with their workbenches.

Firstly, the ergonomic factor of the workbench. Creating a workbench design that focuses on employee comfort and safety is essential in promoting a healthy and productive work environment. When workbenches are not designed with ergonomic considerations in mind, small and medium-sized enterprises (SMEs) may unintentionally overlook important factors that can affect the well-being of their employees. This oversight can result in discomfort and potentially lead to musculoskeletal issues for workers. Improper work surface height is one factor that can contribute to discomfort and health problems. If the work surface is too low or too high, employees may strain their muscles or adopt awkward

postures, causing fatigue and increasing the risk of musculoskeletal disorders. (Ojo, Bailey. 2018).

Secondly, limited space at the workstation. SMEs often operate in constrained spaces, which can restrict the size and layout of workbenches. Limited space can lead to cluttered work areas, inadequate storage, and difficulties in organizing ingredients, equipment, and utensils. This issue will lead to inefficient workflow. Thus, a workbench with the best design and size will be built. Workbenches with poor design might obstruct workflow and result in inefficient processes. Bottleneck and longer production times can be caused by problems including inappropriate workstation location, misty work zones, and inadequate tool and ingredient accessibility.

1.3 Research Question

From the problem statement, three research question can be found as below:

a) What are the current practices and methodologies used in workbench setups for small and medium-sized enterprises (SMEs) in the production of burgers?

b) What are the key design considerations and requirements for developing an efficient and ergonomic workbench to the needs of small and medium-sized enterprises (SMEs) involved in burger production?

c) How to perform analysis on the selected design of the workbench in burger production?

1.4 Research Objective

The objectives of this research are as below:

a) To identify the current practice of workbench for SME's burger production

b) To conduct conceptual design of workbench for SME's burger production

c) To perform a SolidWorks design analysis and evaluate the selected design of ergonomic workbench

1.5 Scope of Research

The scope of this research are as follows:

- Workbench of burger production for Small Medium Enterprise owners
- Focus on the conceptual design stage.
- Software such as SolidWorks and Simulation were used during the study.
- Design concept based on HOQ.
- Analysis the selected design

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A workbench according to Cambridge Dictionary is a strong, solid table on which you can work with tools, wood, small machines, and others. It is an essential component of any productive workspace, whether it be in a workshop, laboratory, or digital environment. It serves as a dedicated platform that provides individuals with a functional and organized area to carry out their tasks efficiently. By offering a stable and versatile workspace, a workbench enhances productivity, promotes organization, and enables individuals to focus on their work without distractions. They can be well-completed wood tables for woodworking, metalwork, and project design, or they can be very complex tables for engineering design work, difficult machining, and expanded precision tooling.

This report will be more focused on heavy-duty workbench specifically a workbench to prepare a patty. The workbench consists of three important parts which are the cutting machine, grinding machine, and patty forming machine. According to Industrial Quick Search, the first major function of a workbench is to support applications that involve large and heavy tools. Industrial workbenches are used for finishing, assembly, and component repair. Most heavy-duty industrial workbenches can hold a 750 kg load and are designed to support heavy tools and equipment. Thus, the specification and tool selection in designing the workbench is very important to avoid any failure occurring during the operation.

2.2 Burger Business

A business that specializes in the preparation, assembly, and sale of burgers is also known as a "burger business." A grilled or fried ground meat patty, typically made from beef, is sandwiched between two slices of bread or a bun with a variety of toppings and sauces, and is a popular and widely consumed food item. Burger restaurants offer a variety of burger options, including various patty sizes, meat selections (such as beef, chicken, or vegetarian alternatives), and a variety of toppings and sauces, to cater to a broad range of customer preferences. In an effort to satisfy consumers' desires for a quick, flavorful, and filling burger meal, these establishments frequently offer casual dining or delivery service. The patty formation procedure is essential for ensuring uniformity, efficiency, and quality control when making burgers, as it provides businesses with a practical and standardized method for creating patties that meet customer expectations.

2.2.1 Current market

According to Statista's market forecast for the food industry in Malaysia, the revenue in the food market is projected to amount to US$49.51 billion in 2023, with an expected annual growth rate of 7.69% from 2023 to 2028. However, it's important to note that this data encompasses the entire food market and not just the burger segment. When considering the packaged burgers market globally, it is expected to grow at a CAGR of 8.2% during the forecast period of 2023-2028. The market is being driven by factors such as the expansion of the retail market and the increasing demand for plant-based and convenient ready-to-consume products. The growth of the vegan population in countries like the United States

and the United Kingdom has led to an increased demand for vegan packaged burgers in North America and Europe.

Although the information specific to the SME segment in Malaysia is limited, it can be inferred that the growing food market and the global trend toward packaged burgers provide opportunities for SME companies in Malaysia that specialize in burgers. These companies can tap into the rising demand for convenient and plant-based options, catering to consumers' evolving preferences. It is advisable for SME companies in Malaysia interested in the burger market to conduct thorough market research to understand the local consumer preferences, competition, and potential target audience. (*Diaan-Yi Lin, January 26, 2022)*

Additionally, they should focus on product differentiation, quality, and marketing strategies to stand out in the competitive landscape. There are lots of opportunities for SMEs to carve out their own and attract a loyal consumer base as Malaysia's burger industry continues to develop.

2.2.2 Process of burger production

The workbench consists of three important parts to form a homemade patty which are the cutting machine, grinding machine, and forming machine. The process starts which cutting raw meat into small pieces so it will be easy for the meat grinder to grind. Then, the small pieces of the meat will be put in the grinder to grind and form into crushed meat. The crushed meat will be very soft, so it is easier to do the next step, forming the patty. The crushed meat will be put into the forming machine and applied some force to create the perfect desired shape.

Firstly, the process of cutting the raw meat into small pieces. The meat-cutting saw machine is essential to the meat processing business because it makes it possible to cut huge pieces of meat precisely and quickly into smaller, easier-to-handle parts. The process involves several steps and components to ensure safety, accuracy, and productivity. First, the meat-cutting machine is set up and well-prepared for the cutting process. This includes ensuring the machine is clean and stays hygienic, well-maintained, and properly lubricated before running the machine to ensure the performance at an optimum level. The size and type of blade are determined by specific requirements needed for the meat that is being processed. Then, large cuts of meat such as beef are placed on the cutting table and ready for the cut. Guards and pusher plates will be prepared as a safety measure to avoid any accident occurring to the operator and protect the operator's hand and finger.

Once the raw meat is properly positioned, the cutting process begin. The cutting belt that is powered by an electric motor begins to rotate at high speed and the operator will control the movement of the meat to get the desired cut. It is important to control the speed of the cutting belt to avoid creating unwanted shapes, as well as for the operator's safety. This process must be done with extra care and precision. The blade of a vertical cutting saw spins with the assistance of a band, operating on an easy concept. Although the saw is designed to slice through the meat, forcing on it can cause the band to move out of place. So, it will be important to control the speed of the cutting belt. After the meat has been cut into smaller portions, the meat will be transferred to the grinding machine to start the grinding process.

Once the meat is prepared, it is fed into the grinding machine through the feeding tube. The machine is equipped with a powerful motor that drives a series of blades or grinding plates. These blades rotate at high speeds, effectively slicing and grinding the meat into

smaller particles. As the meat passes through the grinding mechanism, it undergoes multiple rounds of cutting and pulverizing, gradually reducing it to the desired consistency. The size of the grinding plates or the configuration of the blades can be adjusted to achieve different textures, ranging from coarse to fine. During the grinding process, it is important to ensure that the machine is operated correctly and safely.

Next, the ground meat mixture is loaded into the hopper of the machine. The machine is designed to handle a continuous flow of meat, ensuring a consistent supply for patty formation. The hopper may have a capacity that allows for bulk loading or a mechanism to feed the meat gradually. As the machine is activated, the ground meat mixture is evenly distributed and compressed within the forming chamber. This chamber is typically equipped with a mold or plate that determines the shape and size of the patty. The machine exerts pressure to shape the meat into a uniform patty, ensuring consistent thickness and diameter.

2.2.3 Current Practice

The current practice of burger production in the burger business involves the use of meat cutting machines, grinding machine and patty forming machine. These machines are designed specifically to cut raw meat, grind and shape ground meat into uniform patties, streamlining the production process and ensuring consistent results. Here is an overview of the current practice of the patty forming process:

1. Preparation of Ground Meat: The process begins with the preparation of the ground meat. Ground beef is the most commonly used meat, although other types of meat or plant-based alternatives can also be used. The ground meat is typically seasoned with salt, pepper, and other spices to enhance flavor.

2. Loading the Machine: The prepared ground meat is loaded into the hopper or feeding system of the patty forming machine. The machine may have different feeding mechanisms, such as augers or belts, to transfer the ground meat to the forming section.

3. Forming the Patties: As the ground meat is fed into the forming section of the machine, it undergoes compression and shaping to form uniform patties. The forming section consists of a mold or die that shapes the meat into the desired patty size and thickness. The machine applies pressure to compress the meat and shape it into a consistent patty.

4. Patty Release: Once the patties are formed, they are released from the machine onto a conveyor belt or tray. The machine may have mechanisms, such as pneumatic or mechanical systems, to ensure the smooth release of the patties without damaging their shape.

5. Stacking and Packaging: The formed patties are stacked and may be arranged in layers with separators to prevent sticking. They are then packaged for storage, transportation, or immediate use. Packaging options include plastic bags, vacuum-sealed packages, or trays with plastic wrap.

6. Storage and Distribution: The packaged patties are stored in refrigerated or frozen conditions to maintain freshness and extend shelf life. They are distributed to restaurants, fast food chains, supermarkets, or other food establishments for use in burger production.

2.2.4 Issues of burger production for SME Companies

Issues of burger production for SME companies can vary depending on the specific context and challenges faced by individual businesses. However, SMEs in the burger production sector may face certain common issues and potential problems. The most problem faced by SME companies is the productivity gap. Small and medium-sized enterprises (SMEs) often face a productivity gap compared to larger companies in the same industry. The productivity difference between SMEs and large companies can vary significantly, reaching up to 80 percent in some sectors and countries. Closing this productivity gap is crucial for SMEs to enhance their competitiveness and overall growth. Due to limited resources, knowledge of best practices, or resistance to change, SMEs frequently struggle to adopt new technology and best practices. The implementation of the SME production also being a concern. Such worries expressed by well-known nations or areas bring to light a number of problems for SMEs and their implementation(Perera & Chand, 2015). SMEs may increase their efficiency, quality, and competitiveness by implementing proven technology and procedures from larger businesses.

2.3 Burger production in SME companies

2.3.1 Issues for the workbench in burger production for SME companies

Issues for the workbench in burger production in SME companies can vary, but there are some potential challenges that these companies may face regarding the workbench. The most common issue faced is the limited space of their stall. SMEs often have limited space for their operations, including the workbench area. This can make it challenging to set up an efficient and well-organized workspace for burger production. Besides, the limitation of equipment also can be an issue faced by SME companies. They may have limited budgets or resources to invest in advanced machinery or specialized tools, which can affect productivity and efficiency. In addition, when handling a workbench with mechanical tools, having good skills is necessary to avoid any accidents happening. Finding skilled workers who are trained in burger production techniques can be a challenge for SMEs. Additionally, providing ongoing training and development opportunities for employees to enhance their skills and knowledge can be a resource-intensive task. Next, food safety and hygiemasne must be taken carefully because it affects the customer's health. Maintaining high standards of food safety and hygiene is crucial in burger production. SMEs may face challenges in implementing and maintaining strict protocols and procedures to ensure the safety and quality of their products. So, the design and material selection for the workbench plays a crucial role to make sure the workbench is easy to clean and free from any dirt. Lastly, cost control. Cost control is a significant concern for SMEs. Managing expenses related to equipment maintenance, labor, and other operational costs is crucial for profitability and sustainability.

2.3.2 Criteria of work bench in burger production for SME companies

The design and criteria of the workbench may be different according to the specific factor of the SME companies. Some criteria that are generally needed in industrial workbench specifically in the food industry. The sturdiness and durability of the workbench play a vital role in running the operation smoothly in a safe condition. They should be made of durable materials such as stainless steel or food-grade plastic that are resistant to corrosion, easy to clean, and maintain hygiene standards. So, it is important to ensure that the workbench is easy to clean to keep the workbench in hygienic standard. They should have smooth surfaces without cracks or crevices where food particles can accumulate. Workbenches should also have proper drainage systems to prevent the accumulation of liquids or food residues. The food sector has an important priority on hygiene and secure manufacturing. Food processing can expose food to bio-contamination. Therefore, maintaining overall quality through the maintenance of a clean environment is a goal to pursue. Air is one of the microbial vectors that is thought to aid in cross-contamination. (Masotti et al., 2019). The suspensions of microscopic solid or liquid particles in the air are defined as aerosols (Ferguson, Cumbrell, & Whitby, 2019).

The ergonomic factor is also the main criterion of the workbench. The factor ergonomics on a workbench can increase the workflow efficiency of burger production. The design of workbenches should promote efficient workflow and minimize physical strain on workers. They should be at a suitable height to allow comfortable working positions and reduce the risk of musculoskeletal injuries. Consideration should be given to the placement of equipment, tools, and storage areas to optimize the production process. Based on the study of human features and interactions between humans, machines, and the

environment, ergonomics aims to guide the design of safe, pleasant, and effective goods and tasks (HFES, 2020). Therefore, the creation of products with an ergonomics-based approach often involves an iterative "design-evaluation-redesign" process that involves several design changes based on user feedback on prototypes. (Kermavnar et al., 2021). Lastly, adequate work surface area. Work benches should provide sufficient space for various tasks involved in burger production, such as meat cutting, meat cutting, and patty forming. The size and layout of workbenches should be tailored to the specific production requirements and space constraints of the SME company. Improving the productivity of SMEs is therefore a worthwhile endeavor. Indeed, SMEs can spur a country's growth. (Abdulaziz Albaz, July 2, 2020).

2.4 Ergonomic for workbench for burger production in SME companies

2.4.1 Definition of ergonomic

The term "ergonomic" refers to the design and arrangement of objects, tools, and systems in a way that optimizes human well-being and performance. It is an applied science with the goal of developing things and settings that work effectively and securely with humans. The goal of ergonomics, commonly referred to as human engineering or human factors, is to improve how people interact with their physical and mental work surroundings.

2.4.2 Ergonomic factor

The ergonomic factors play an important role in running the process smoothly. The use ergonomic principles can improve levels of comprehension of work flow.(Berrio et al., 2022). When considering the ergonomic factors for a workbench in mechanical work, there are several aspects to keep in mind.

i) The height of the workbench- The height of the workbench should be suitable for the tasks performed to ensure proper posture and minimize strain. The ideal height allows the worker to maintain a neutral posture with their forearms parallel to the work surface and their feet flat on the floor or supported by a footrest if needed. The height of the workbench, which is good for detailed work, cutting joinery, and power tool use is between 97cm to 99cm. (RICHARD MAGUIRE, 2013)

ii) The workbench surface- The workbench surface should be sturdy and provide sufficient space for the tasks at hand. It should be large enough to accommodate work materials and tools while allowing for proper workflow and organization. The surface material should be durable, resistant to wear, and easy to clean.

iii) Tool placement and accessibility: Tools and equipment should be positioned within easy reach to avoid excessive reaching, twisting, or stretching. Placing frequently used tools near the primary work area can reduce unnecessary movements and strain on the body.

2.4.3 Material Selection

Material selection plays a crucial role because the performance, cost, and overall quality of a physical product are all directly impacted by the material selection, making it a vital step in the design process. The final product's qualities and characteristics are determined by the material selection; thus, designers must take this into account carefully. The material that has been chosen for this product is stainless steel. The advantage of the stainless steel are shown in Table 2.1 below.

Table 2.1 Advantage of the stainless steel

Advantage	Description
Increased strength	Stainless steel alloys used for industrial applications possess high tensile, compressive, and yield strength. This makes stainless steel workbenches capable of sustaining heavy loads, making them ideal for storing and handling heavy castings, machine parts, and metal stock
Durable construction	Stainless steel is highly resistant to corrosion due to its minimum chromium content of 10.5%. This resistance allows stainless steel workbenches to maintain their structural integrity and strength in various environments. They are suitable for heavy-duty use activities that require wear resistance, such as product assembly and material handling
Easy to clean	Stainless steel workbenches are easy to clean, making them suitable for medical settings, clean rooms, and kitchens. The smooth surface of stainless steel does not allow dirt, grime, and chemical residues to adhere.
Heat resistance	Stainless steel is highly heat-resistant with a high melting point between 2,500 and 2,800 °F. This makes stainless steel workbenches suitable for high-temperature work-related activities without worrying about damaging the work surface.
Modern appearance	Stainless steel workbenches not only offer practical functionality but also provide a modern and stylish appearance. Their sleek and contemporary look adds to the aesthetics of industrial and commercial spaces.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Proper product development can ensure a well-built product and systematic development to meet the needs of the objectives it was proposed to solve. Without using proper methods to develop the product, the product also will not be properly adequate with features and functionality to solve the problem. For this project, the workbench for the homemade burger patty, several important variables, including product design, client demands, and development planning, must be taken into consideration to create a product that is better than the one that is currently on the market. The history of the process that the product is needed for, as well as the present state of the product in the market, must be considered while planning the product. In addition, it was important to take into consideration the demands of the consumer because they would have a major impact on how the product was designed and how satisfied the user would be with it. (HOQ use) Finally, during the idea sketching stage of the product design process, consideration will be given to client demands and recommendations together with other limitations to choose the best concept to be finished into a drawing.

3.2 Flow chart

The project is conducted based on detailed processes as shown in Figure 3.1 and Figure 3.2 below.

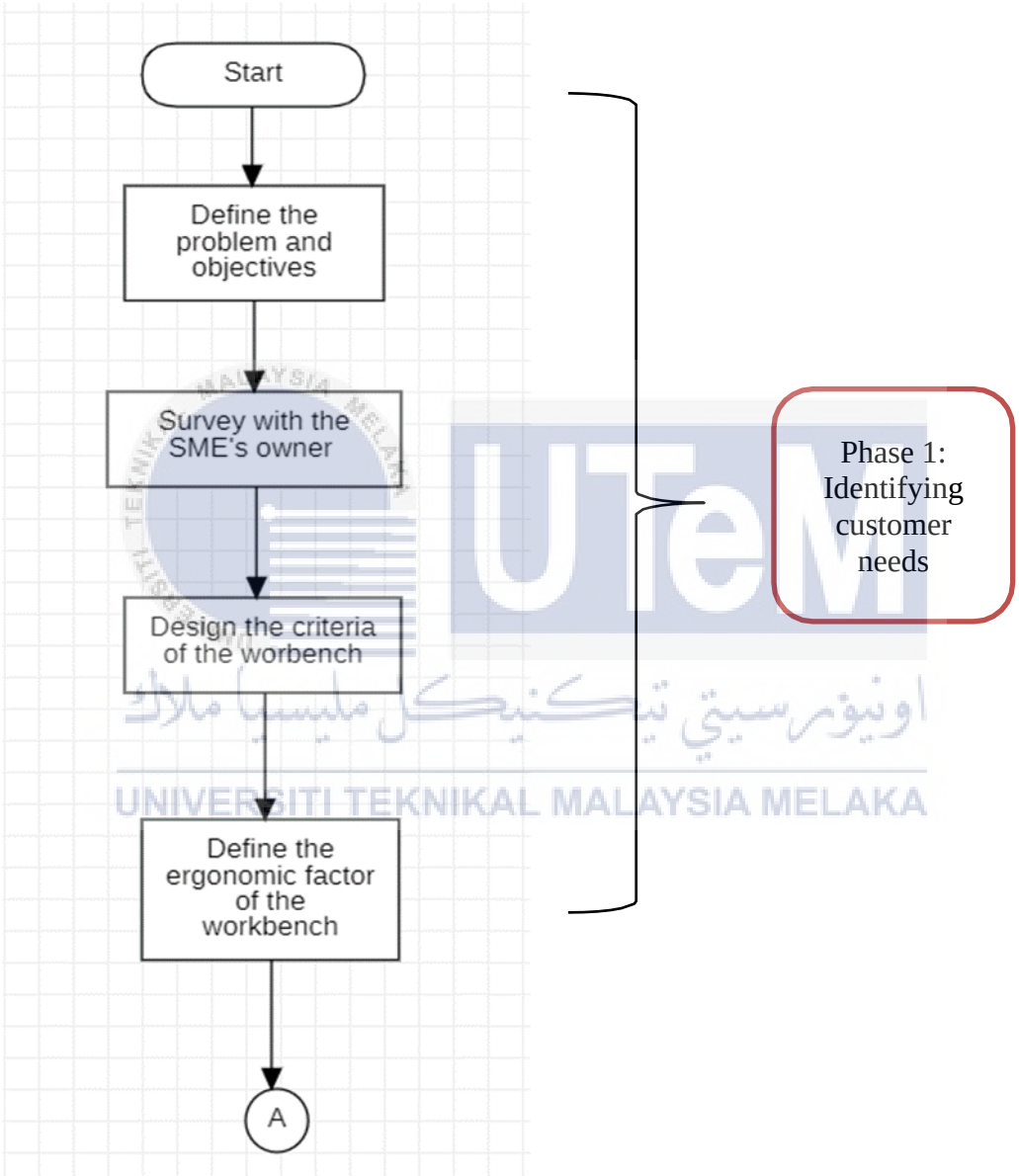


Figure 3.1 Flow chart phase 1

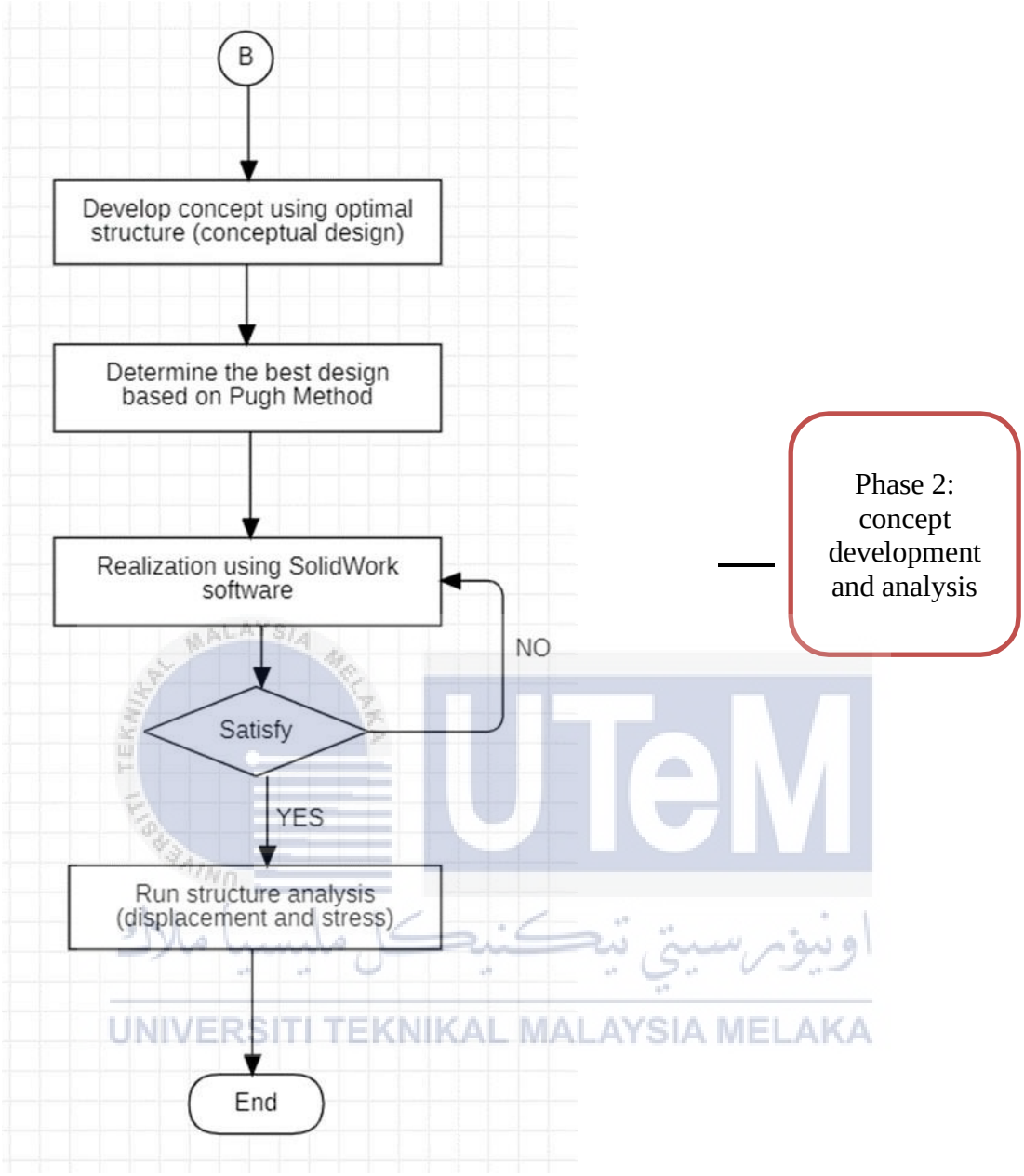


Figure 3.2 Flow chart phase 2 and phase 3

3.3 Brainstorming

The project's brainstorming phase involves defining the challenges encountered by Small and Medium Enterprises (SMEs) and creating conceptual designs to tackle these issues. This brainstorming process acts as a basis for the ongoing development and enhancement of design concepts in the later stages of the project.

3.4 Phase 1: Identifying Customer Needs

Step 1: Conduct Customer Needs Analysis

A customer needs analysis involves understanding the attributes of a product, brand, or service that motivate customers to make a purchase. Customer needs can range from basic requirements like affordable price and good quality to more complex factors such as brand image, alignment with personal opinions, or ethical considerations. Analyzing customer feedback through surveys and other data collection methods is essential to gain insights into their needs.

Step 2: Conduct Audience Research

Conducting audience research using third-party audience pools can provide a broader perspective on customer needs. This approach allows businesses to reach a larger audience beyond their existing customers and gather insights that can inform product development and marketing strategies.

Step 3: Utilize Customer Research Tools

Employing tools like PickFu for customers who need discovery polls can help identify and analyze customer research effectively. These tools enable businesses to ask targeted questions, receive feedback, and gain insights into customer preferences and needs.

Step 4: Implement Social Listening Programs

Social listening involves monitoring online conversations and discussions related to the business, its products, or the industry. By analyzing social media platforms and using tools like Google Trends, businesses can gather supplementary data and gain insights into customer needs, preferences, and trends.

Step 5: Analyze Customer Questions and Data

Reviewing recurring customer questions and analyzing data from customer interactions, such as support tickets or chat transcripts, can provide valuable insights into their needs. By identifying common pain points, goals, and preferences, businesses can better understand and address customer needs

To identify customer needs, businesses employ various methods and approaches. Ensuring that clients are satisfied and loyal depends on accurately assessing their demands. A failure to properly identify customers' needs or indifference to their needs, they will take their business elsewhere. Some steps that are commonly taken to follow the process.

3.4.1 Criteria Survey on Ergonomic Workbench

A criteria survey is a method of gathering information or opinions from individuals based on specific criteria or standards. This type of survey is designed to evaluate or assess certain aspects of a subject, product, service, or situation by asking respondents to provide feedback or make judgments according to predefined criteria. The criteria could relate to various factors such as quality, performance, satisfaction, relevance, importance, or any other relevant dimensions. The process typically involves presenting participants with a set of questions or statements related to the specified criteria and asking them to express their opinions, preferences, or ratings. The results of a criteria survey can provide valuable insights into how well a product, service, or situation meets certain standards. The criteria survey for ergonomics workbench are conducted as below.

I. Objectif survey

An ergonomic workbench survey's objective is to methodically examine and evaluate several aspects of the design and operation of workbenches to make sure they comply with ergonomic standards and provide a safe and pleasant working environment. The purpose of this study is to provide a set of standards for evaluating and contrasting various ergonomic workbenches.

II. Content relevant

The content of the survey is more focusing on the criteria of the workbench required. The development of a user-friendly workstation is the primary objective. This entails putting user comfort first through ergonomic design, maximizing job productivity through workflow optimization, and making sure workspaces are organized for convenient tool availability. To address issues and preferences, regular user feedback

is sought, and within financial constraints, decision-making is guided by cost efficiency.

III. Survey Platform

Microsoft Forms served as the main tool for gathering data for the surveys. Microsoft Forms is an online platform for surveys and data collection that provides an easy-to-use interface for creating, sending, and compiling replies. Using an easily accessible online platform, respondents were able to provide their input in an effective and well-organized manner due to the digital survey approach. Utilizing Microsoft Forms made it easier to administer surveys and improved the entire process for collecting participant feedback and information. The Quick Response (QR) code is also provided for respondents to easily access the Microsoft Form survey. The survey officially endorsed on September 4, 2023, marking the commencement of data collection.

IV. Target Audience

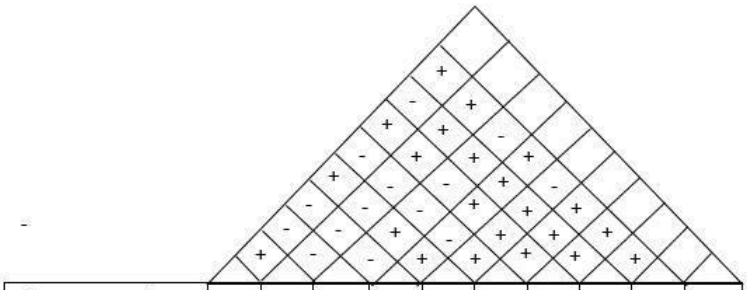
The survey specifically targets Small and Medium-sized Enterprise (SME) burger owners. The purpose of this strategic emphasis is to obtain opinions and ideas from people who run small- to medium-sized burger businesses. The objective is to capture the distinct perspectives, challenges, and preferences that SME burger proprietors may have in their business operations by customizing the survey to this group. To ensure that the information gathered is appropriate and useful for comprehending the dynamics of the SME burger business, the survey's questions and content are tailored to specifically target the issues and experiences that are important to this group.

V. Overall impact

The survey had a major impact on our comprehension of the topic. The survey's methodical collection and analysis of responses provided useful data on several topics, such as quality, performance, satisfaction, and relevance, among others. In addition to identifying areas of strength, the data collected has also highlighted certain areas that require improvement. These conclusions play a critical role in directing strategic planning and decision-making procedures.

3.4.2 House of Quality

The House of Quality (HOQ) is a tool used in quality management and product development. It consists of a matrix that aligns customer requirements with design characteristics. Technical requirements and customer needs are assessed, and their interactions are examined. Important ratings and goal values are assigned to order requirements and establish performance levels. Technical needs are affected directly by design characteristics. The HOQ aids in ensuring customer satisfaction, efficient communication, and informed design choices. The House of Quality for the product are shown as below in Figure 3.3.



Improvement Direction											
	Importance Weight	Robust construction	Work surface material	Storage organization	Ergonomic design	Workbench dimension	Customization option	Material cost	Simple Design	Safety	Total
Sturdy & durable	5	9	9	1	3	3	1	3	3	9	
Stability	5	9	1	3	9	9	3	1	1	9	
Storage size	3	3	1	9	3	9	1	3	1	1	
Workbench size	4	1	1	9	3	9	1	9	3	1	
Aesthetic design	2	1	1	3	1	3	3	3	1	1	
Mobility	3	1	1	1	3	3	3	3	3	3	
Cost	4	9	3	3	3	9	3	9	3	3	
Safety features	5	9	9	1	9	1	3	3	1	9	
Raw Score		187	119	109	149	179	69	131	63	165	1171
Relative Weight		16	10.2	9.3	12.7	15.3	5.9	11.2	5.4	14.1	100
Rank Order		1	6	7	4	2	8	5	9	3	

Figure 3.3 House of Quality for the workbench

3.5 Phase 2: Concept developement

Concept development is a crucial stage in the design process, and one approach that aids in this process is conceptual design. Conceptual design involves the generation and exploration of ideas, allowing designers to explore a range of possibilities and develop a deep understanding of the problem at hand. It goes beyond mere aesthetics or functionality and delves into the essence of the design challenge. By employing conceptual design, designers can investigate various concepts, experiment with different forms, materials, and technologies, and refine their ideas to create innovative and meaningful solutions. Furthermore, conceptual design encourages designers to consider multiple perspectives and

challenge assumptions. They analyze the context, research user needs, and desires, and gather insights from various sources. This holistic approach allows for the integration of diverse factors, such as sustainability, ergonomics, cultural relevance, and market trends. By considering these factors during concept development, designers can create solutions that are not only aesthetically pleasing but also functional, user-centered, and aligned with the desired outcomes.

The conceptual design is based on one of the SME's owners of a burger stall consultation. The issue faced by the SME's owner is considerable and the solution for the issue has been discussed. Three conceptual designs using optimal structure were proposed, and one will be chosen. Then, the conceptual design will be realized using CAD software (SolidWorks). This iterative process helps to identify strengths and weaknesses in the concepts and facilitates informed decision-making. It enables researchers to refine and evolve their ideas, gradually converging toward the most promising concept that best addresses the design challenge.

3.5.1 Conceptual design

The conceptual design phase stands as a crucial cornerstone in the overall project development process, acting as the bridge between abstract aspirations and tangible realization. This phase, integral to various creative domains such as product design and architecture, entails a comprehensive understanding of high-level requirements through engagement with stakeholders and end-users. Following this, the process delves into a realm of creative ideation, where designers and teams brainstorm without constraints, fostering innovation and unique concept generation. Sketching and prototyping then translate these

abstract ideas into visual representations, allowing for early identification of design flaws and iterative refinement. Amidst this creative exploration, practical constraints such as budget and time are also considered, ensuring the balance between visionary concepts and feasibility. Regular client feedback and iteration refine concepts to align closely with the client's vision. Additionally, risk assessment, setting the design language, and effective documentation are integral components of this phase. By influencing subsequent stages, mitigating ambiguity, enhancing creativity, identifying problems early on, and facilitating client collaboration, the conceptual design phase plays a pivotal role in shaping the trajectory of the entire design journey. Ultimately, the success of the subsequent stages hinges on the strength and clarity of the conceptual foundation laid during this critical phase.

3.5.1.1 Design 1

For design 1, the workbech with rectangular shaped was designed and the machine was arrange in a straight line. It is a compact and a save space design. The material of the workbench is stainless steel which quiet a strong material and easy to maintain. The design is based on sketching as shown in Figure 3.4 below.

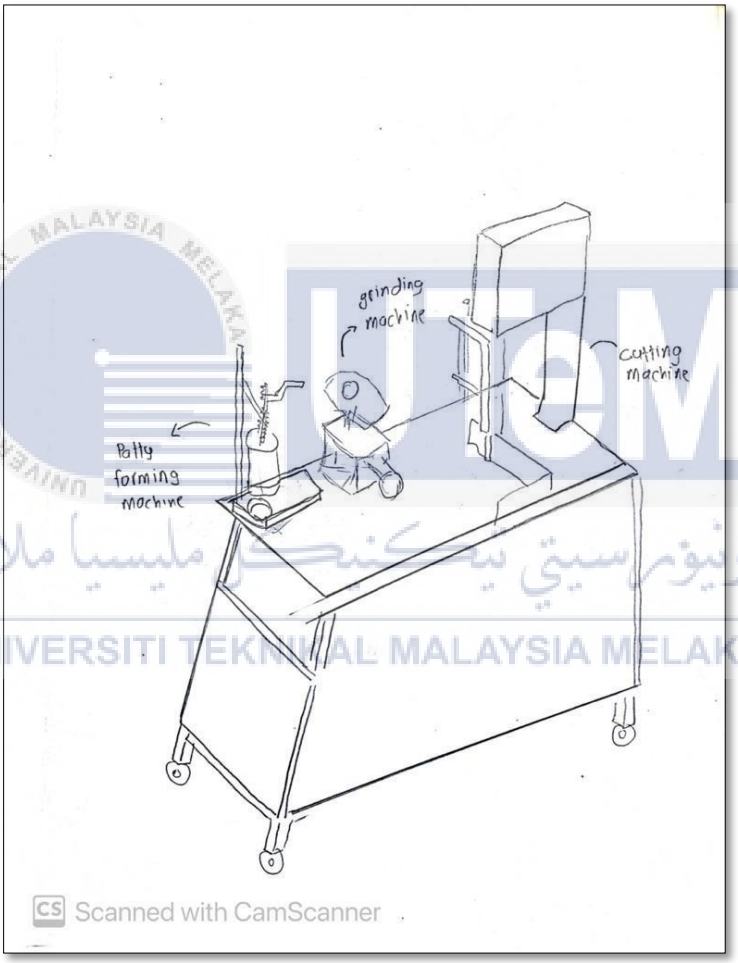


Figure 3.4 Design 1

3.5.1.2 Design 2

For design 2, the workbench in a U-shaped and the machine was arrange at each side. The workbench come with a bigger size and easy to store many machinery tools. The workspace for the operator is in the middle of the workbench. This workbench also made of stainless steel. The design is based on sketching as shown in Figure 3.5 below.

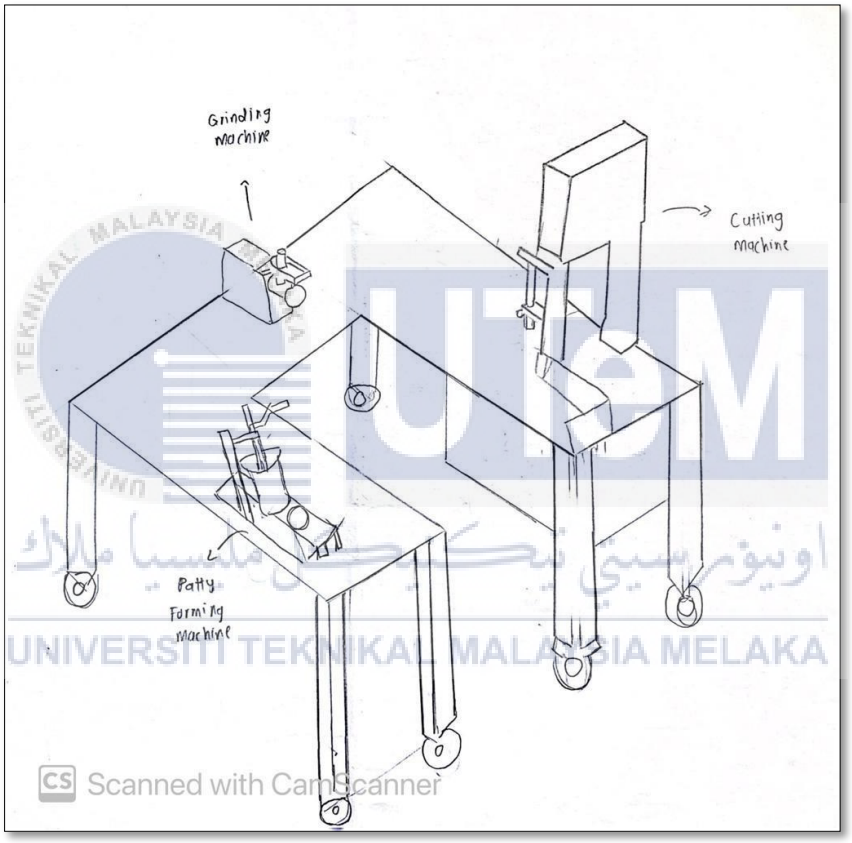


Figure 3.5 Design 2

3.5.1.3 Design 3

For design 3, the workbench was designed in a L-shaped and the arrangement of the machine is more practicle. The operator can reduce the movement of the body due to the arrangement of the machine and the shape of worbench. This can increase the efficiency of the workflow. The design is based on sketching as shown below.

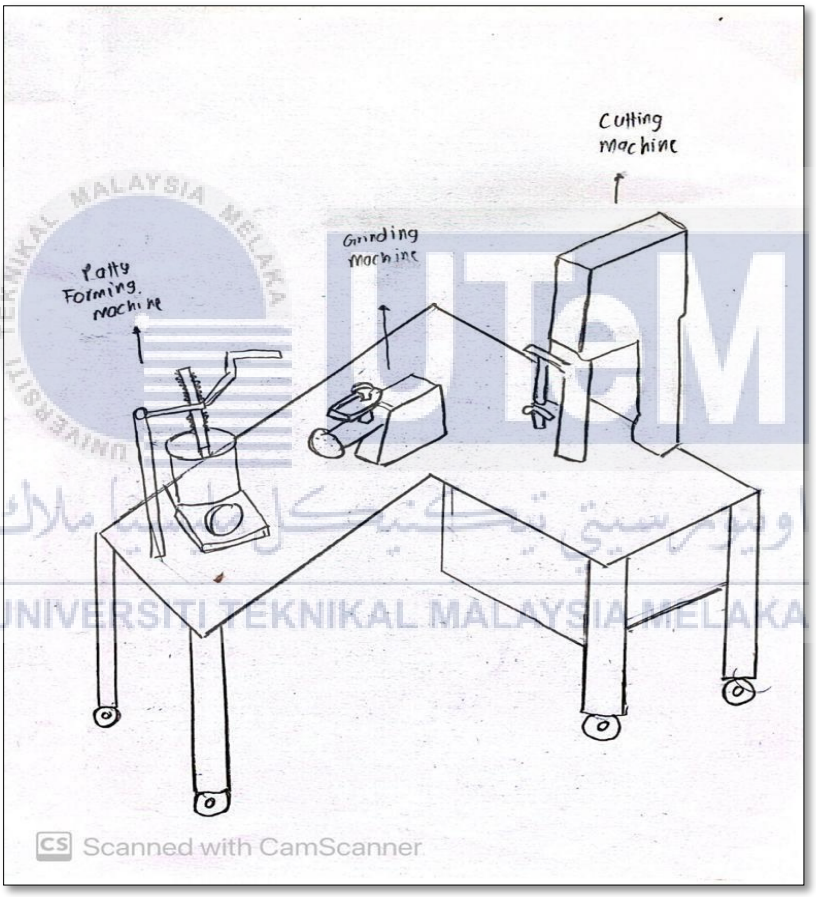


Figure 3.6 Design 3

3.5.2 Pugh method

A Pugh matrix is a method for deciding between multiple concepts for a new process, product, or service. It was initially used to compare and choose between several product or process designs based on client requirements and the current baseline design. The Pugh matrix is commonly used to choose the most suitable option among product or process designs. However, it may also be utilised to establish a hybrid solution by combining the best attributes of numerous alternative concepts. Pugh can also be used instead of the solution-selection matrix to choose the best solution for a problem-solving project. Table 3.1 below shows the Pugh Method used for choosing three design for workbench. In this Table 3.1 also shows a few of criteria in the project should be considered has a good product for market.

Table 3.1 Table of Pugh method for workbench design

Criteria	Weight	Design 1	Design 2	Design 3
Ergonomic	9	0	-1	1
Save space	7	1	-1	0
Workflow	8	0	0	1
Strength	9	1	1	1
Easy to clean	7	1	0	0
Mobility	6	1	1	1
Ease of use	8	0	1	1
Aesthetic design	3	-1	1	1

Table 3.2 below shows the summary of the Pugh Method

Table 3.2 Summary of Pugh Method

	Design 1	Design 2	Design 3
Total of 1's	4	4	6
Total of 0's	3	2	2
Total of -1's	1	2	0
Overall weight score	26	16	50

Therefore, based on Table 3.2 shows the overall weighted score of best idea is Design 3. So, Design 3 was chosen as the design product to develop and market the product to industry.

CHAPTER 4

RESULT AND ANALYSIS

4.1 Introduction

This chapter will be taking a closer look at the results and analysis of the ergonomic workbench. This part of the report will go through the outcomes observed after putting the workbench into action. It will be thoroughly examining its performance, functionality, and overall user experience, aiming to provide meaningful insights into how well the ergonomic design has fared. Through a careful analysis, the goal is to bring attention to key findings and observations, giving more delicated understanding of the real-world impact and success of the implemented ergonomic solutions.

4.2 Survey Result On Ergonomic Workbench

The survey aimed to understand user satisfaction and preferences, emphasizing the role of ergonomic design in fostering comfort, efficiency, and well-being at work. The findings, drawn from experienced backgrounds, offer a concise overview of the impact and importance of ergonomic workbenches in modern workplaces. This highlights key trends and observations, underscoring the value of creating healthier and more productive workspaces through ergonomic solutions.

Based on the survey conducted, a diverse demographic of participants, including both males and females engaged in various business areas, provided valuable insights into the ergonomic aspects of burger patty preparation workbenches.

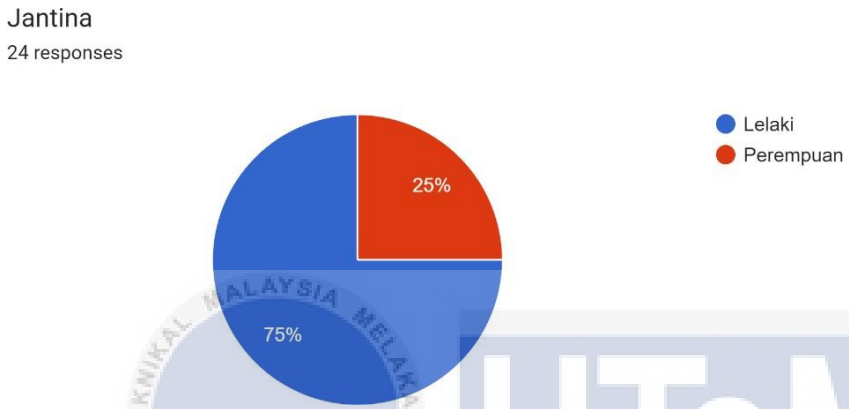


Figure 4.1 Gender Response

Figure 4.1 above show the survey included responses from 24 participants, with a gender distribution of 75% male and 25% female. This indicates a predominance of male perspectives in the findings, highlighting the need for a more balanced representation in future surveys to ensure a comprehensive understanding of ergonomic considerations for burger patty preparation workbenches.

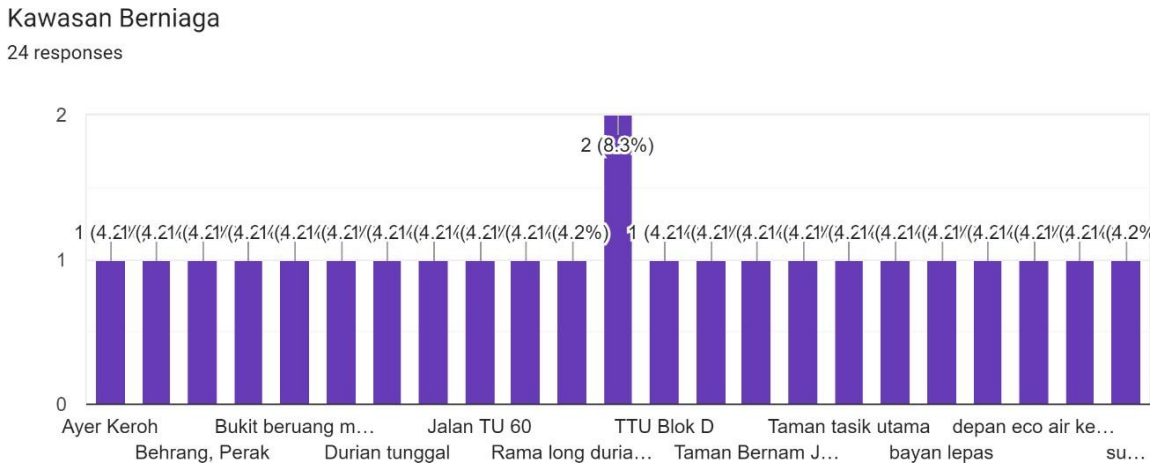


Figure 4.2 Area of Survey

Figure 4.2 above show the area of survey. The conducted survey specifically targeted business areas in three prominent regions: Penang, Perak, and Melaka. However, the survey's primary focus was directed towards the business landscape in Melaka, aiming to capture more nuanced insights from this particular region. In exploring the ergonomic aspects of workbenches used for burger patty preparation, respondents from diverse backgrounds and income brackets in Melaka provided valuable feedback.

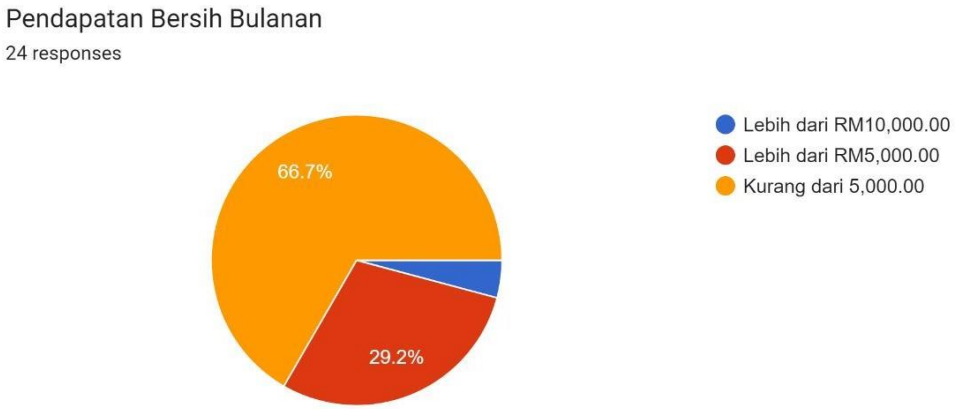


Figure 4.3 Monthly Net Income Response

Figure 4.3 above show monthly net income response of respondents. 16 respondents stated in the survey results that their monthly net income was relatively low, indicating a group that faces financial restrictions. On the other hand, 7 participants reported net monthly incomes greater than RM5,000, indicating a moderate level of financial capability among some of the participants. One notable responder revealed a monthly net income well above RM10,000, highlighting the wide range of income levels among those who completed the survey.

Figure 4.4 Amount of Respondent Use Workbench

Figure 4.4 above shows the number of respondents that use workbench for patty production. Out of the survey participants, it was observed that 16 individuals do not utilize a workbench for the preparation of burger patties, while 8 respondents reported actively incorporating a workbench into their burger patty production processes. This disparity in usage patterns suggests a notable divergence in the adoption of dedicated workstations for burger patty preparation among the surveyed individuals.

The 16 respondents who do not utilize workbenches may engage in alternative methods or work practices, potentially influenced by the scale of their operations, available space, or personal preferences. Understanding the reasons behind this non-utilization could shed light on diverse workflows within the burger patty production domain.

On the other hand, the 8 individuals who reported using workbenches for patty preparation likely recognize the benefits associated with such dedicated workspaces. Workbenches can contribute to organizational efficiency, cleanliness, and overall workspace optimization.

Figure 4.5 Ergonomic Response

Figure 4.5 above shows ergonomic response. Among the 24 respondents, a substantial 20 individuals expressed dissatisfaction with the current workbench used for burger patty preparation, asserting that it lacks ergonomic features. This feedback suggests a prevalent concern among the majority regarding the comfort and suitability of the existing workbenches for the specific task. These respondents might be experiencing discomfort or inefficiency in their patty-making activities, highlighting the need for improvements in the ergonomic design of their workstations.

On the contrary, a smaller but notable group of 4 respondents indicated contentment with the ergonomic qualities of their current patty-making workbenches. This suggests that, for a minority, the existing workbench design aligns with their comfort and usability standards. These individuals may have workbenches that cater well to their needs, providing a supportive and ergonomic environment for efficient patty preparation. These divergent opinions underscore the subjective nature of ergonomic preferences and highlight the importance of tailoring workbench designs to meet the varied needs of users.

Figure 4.6 Height of Workbench Response

Figure 4.6above shows height of workbench response. In analyzing the survey responses pertaining to the current suitability of workbench height for burger patty preparation, a nuanced picture emerges. Out of the 24 respondents, 6 individuals unequivocally affirmed the adequacy of the present workbench height, indicating a level of contentment with their current setups. Conversely, 9 respondents expressed dissatisfaction with the existing workbench heights, signaling a notable proportion dissatisfied with the ergonomic aspects of their workstations.

Of particular interest is the fact that 9 respondents remained uncertain about the suitability of their workbench heights. This uncertainty underscores a potential gap in awareness or clarity regarding ergonomic considerations among a significant subset of participants. It raises questions about the communication or understanding of ergonomic principles in the context of workbench design for burger patty preparation.

Figure 4.7 Storage of The Workbench Response

Figure 4.7 above shows storage of the workbench response. Among the respondents, a notable revelation emerged concerning storage space around their workbenches for burger patty preparation. A substantial 18 participants expressed a deficiency in adequate storage, highlighting a prevalent concern in the current setups. These individuals reported facing challenges due to insufficient storage for equipment and raw materials in the vicinity of their workbenches. This inadequacy could potentially impede their efficiency and organization during patty preparation activities.

Conversely, a smaller yet significant portion of the respondents, totaling 6 individuals, conveyed that they possess ample storage space around their workbenches. This positive feedback indicates that a subset of participants has successfully addressed the storage requirements in their work environments, potentially contributing to smoother and more organized patty preparation processes. These respondents, having sufficient storage, are likely to experience enhanced convenience and productivity in their workstations.

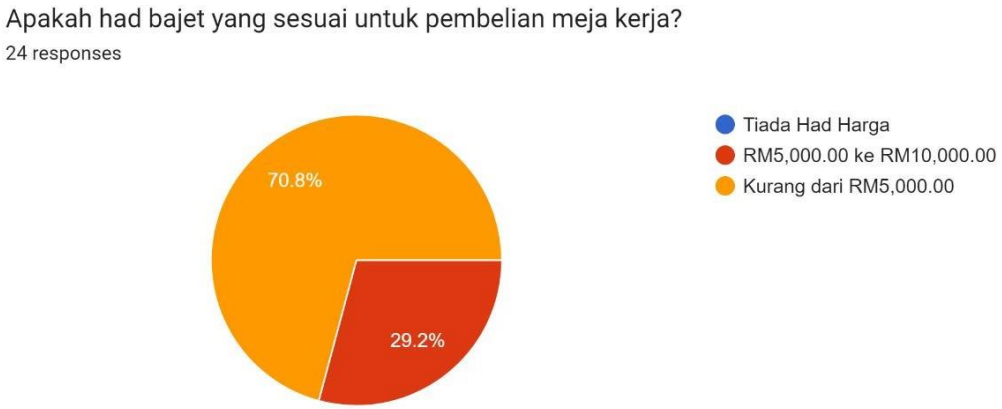


Figure 4.8 Workbench Budget Response

Figure 4.8 above shows workbench budget response. Out of the 24 respondents, a significant portion, comprising 17 individuals, indicated a preference for a lower budget when considering the price of a workbench, specifying a limit of RM5000. This group's emphasis on a cost-effective solution suggests a keen awareness of budget constraints and a preference for more economical options in their pursuit of an ergonomic workbench for burger patty preparation.

Conversely, 7 respondents demonstrated a willingness to allocate a higher budget, falling within the range of RM5000 to RM10000, signaling a segment of the surveyed population that places a premium on investing in a workbench with additional features, enhanced durability, or customized specifications. This subset's inclination towards a relatively higher budget underscores a recognition of the potential benefits associated with a more advanced and tailored solution, indicating a willingness to invest in the long-term comfort and efficiency of their workspace.

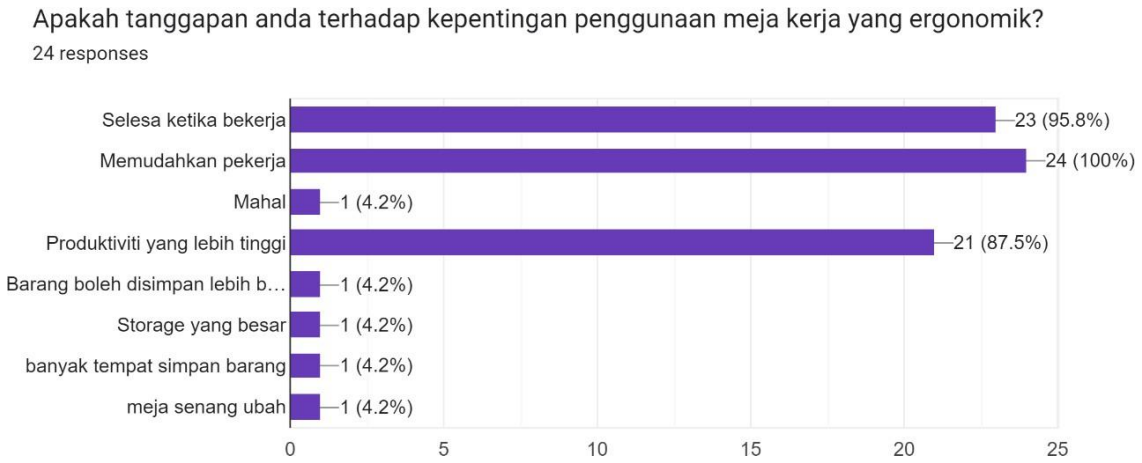


Figure 4.9 Ergonomic Workbench Response

Figure 4.9 above shows ergonomic workbench response. Among the 24 respondents, a noteworthy 23 individuals expressed that feeling comfortable during work is a crucial aspect of ergonomic factors associated with workbench design. Furthermore, all respondents unanimously agreed that a workbench contributing to the ease of tasks is an integral part of ergonomic considerations.

Additionally, 21 respondents associated the notion of high productivity with ergonomic factors in the design of workbenches. This consensus highlights the participants' belief that an ergonomically designed workbench can significantly contribute to enhanced productivity in their burger patty preparation activities.

Furthermore, the survey included additional insights provided by four respondents, focusing on the storage capacity around the workbench. These participants emphasized the importance of having sufficient storage space for tools and raw materials, shedding light on an often overlooked but crucial aspect of ergonomic design.

Figure 4.10 Ergonomic Criteria of Workbench Response

Figure 4.10 above shows the ergonomic criteria of workbench response. The survey findings underscore the consensus among 23 respondents who identified appropriate height as a pivotal characteristic of an ideal workbench for burger patty preparation. This emphasizes the significance of ergonomic considerations in ensuring that the workbench aligns with users' comfort and facilitates efficient work processes. Additionally, the unanimous agreement among 23 participants on the importance of expansive storage space indicates a shared concern for organizational efficiency and accessibility of tools and raw materials during patty making activities.

Furthermore, the input from 16 respondents emphasizing the importance of affordability in workbench selection highlights a practical consideration in the decision-making process. Lastly, the resounding agreement from 24 respondents recognizing the correlation between an ideal workbench and heightened productivity underscores the broader impact of ergonomic design on work efficiency.

4.3 Implementation of conceptual design

4.3.1 Meat Cutting Machine

The conceptual design of the meat cutting machine must be carried out by turning the abstract plan into a concrete, workable reality. This stage consists of several possible steps to realize the intended design. To maintain the machine's effectiveness, accuracy, and safety when cutting meat, a variety of parts and technologies are incorporated throughout the installation. To achieve the precise specifications mentioned in the conceptual design stage, this might entail choosing and integrating cutting mechanisms, control systems, and safety measures. The design of the meat cutting machine is shown in Figure 4.1 below.

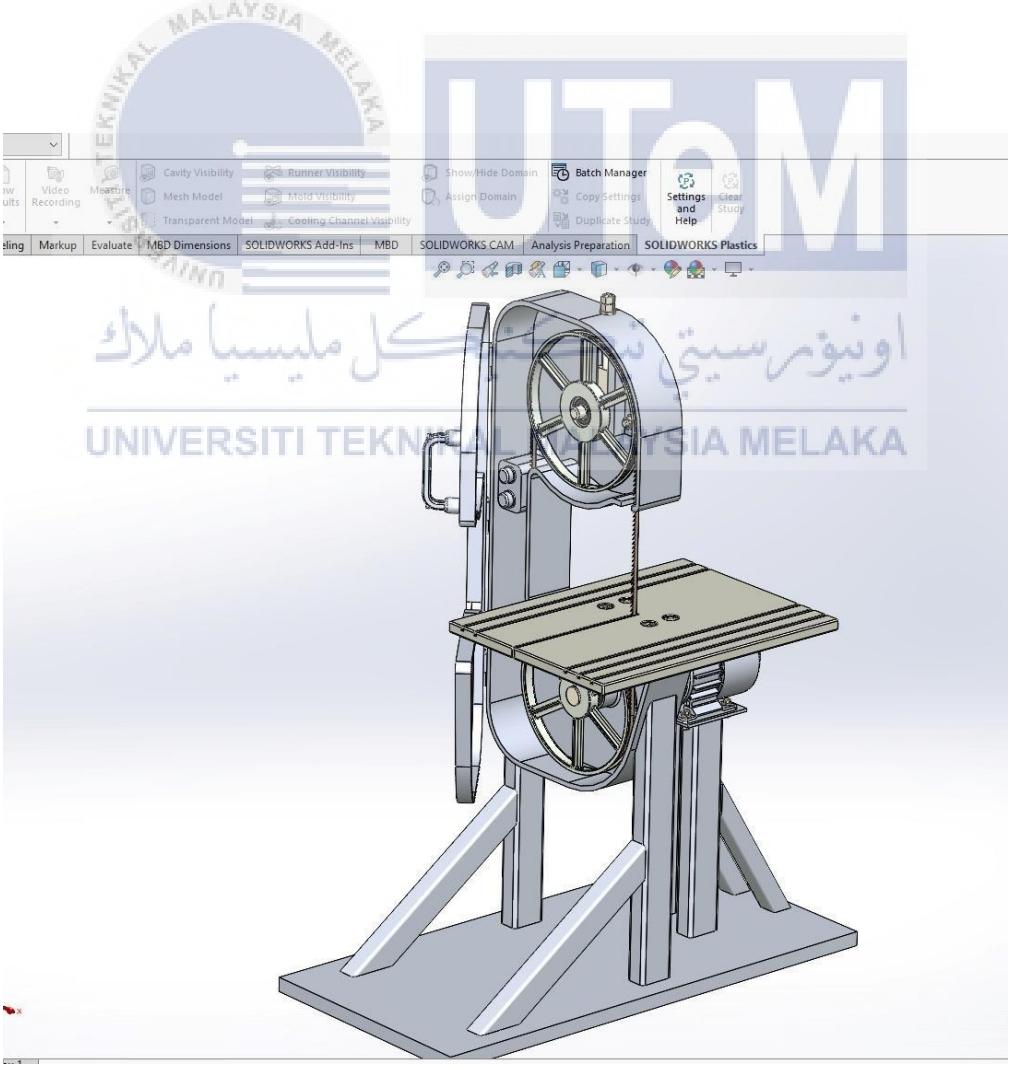


Figure 4.11 Meat Cutting Machine

4.3.2 L-Shaped Workbench

The L-shaped workbench's conceptual design is put into practice by converting the intended ergonomic aspects into a real and useful workstation. Ergonomics, which prioritizes user efficiency and well-being, is essential to this process. Ergonomic concepts are included in the design to maximize user comfort and productivity. The L-shaped arrangement is thoughtfully designed to encourage a natural flow of movement, allowing users to move between positions with ease. The workbench may be made to suit a range of user preferences and body types regarding the customizable features, which reduces the possibility of strain or pain when working for lengthy periods. Furthermore, the placement of tools and accessories is strategically organized to enhance accessibility and minimize unnecessary movements. This thoughtful arrangement contributes to an ergonomically sound environment, promoting a healthier and more efficient workspace. The design of the L-shaped table are shown in Figure 4.2 below.

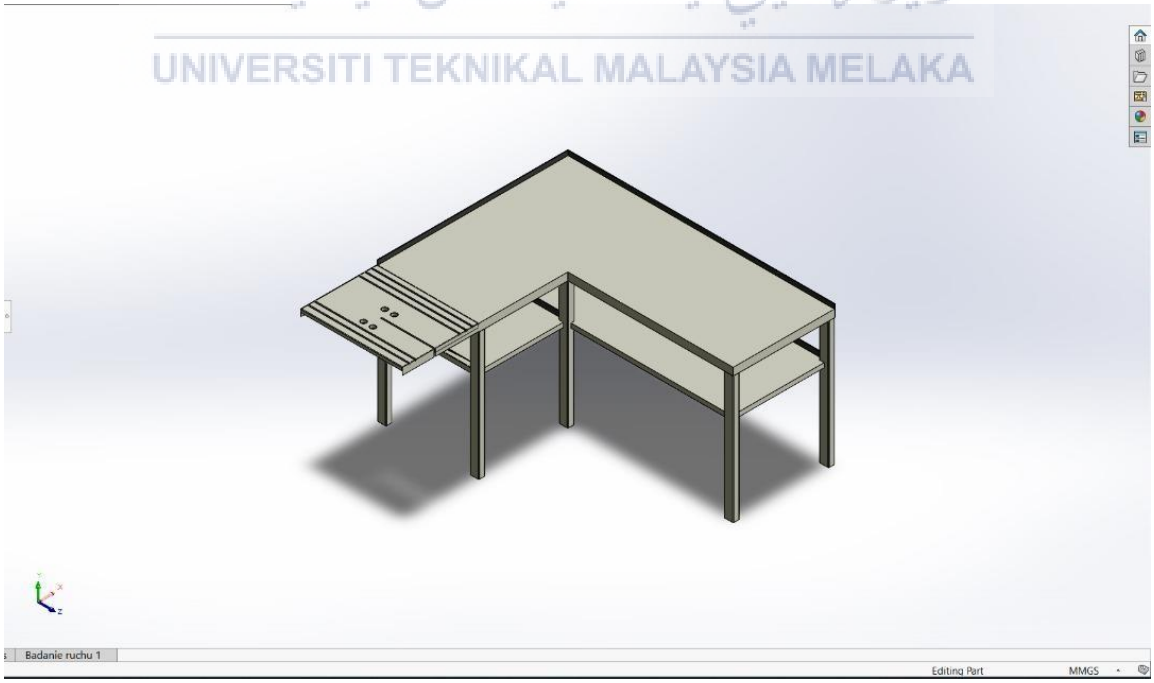


Figure 4.12 L-Shaped Table

The burger patty production station is meticulously designed for burger chefs seeking optimal efficiency in patty preparation. With a robust capacity to withstand high pressure, up to 40N/m2, this station ensures a resilient platform for intensive burger patty production. Its customizable size caters to the diverse needs of customers, SMEs, and vendors, allowing for a tailored solution that seamlessly integrates into varying kitchen layouts.

Standing at a height of 1065mm, the station prioritizes ergonomic design, promoting user comfort during extended work periods. The spacious dimensions, measuring 2100mm x 2094mm, contribute to an organized workspace by facilitating the storage of a greater quantity of ingredients and tools. This not only enhances operational efficiency but also maintains a clutter-free environment.

The station's benefits extend beyond its structural resilience, emphasizing comfort, ergonomics, and increased storage capacity. Its user-friendly design, coupled with the ability to accommodate diverse spatial requirements, positions it as an ideal solution for enhancing the burger patty production process.

4.3.3 Wheel

The implementation of the conceptual design of a wheel on an L-shaped workbench introduces a significant enhancement to both mobility and functionality. By integrating wheels into the design, the workbench gains increased flexibility, allowing users to easily reposition it within a workspace. This mobility factor is particularly advantageous in dynamic environments where adaptability and quick configuration changes are crucial.

The addition of wheels to the L-shaped workbench facilitates seamless movement, enabling users to transport tools, materials, or the entire workbench itself effortlessly. This not only enhances operational efficiency but also contributes to a more ergonomic and user-friendly work environment. The design sketching is shown in Figure 4.3 below.

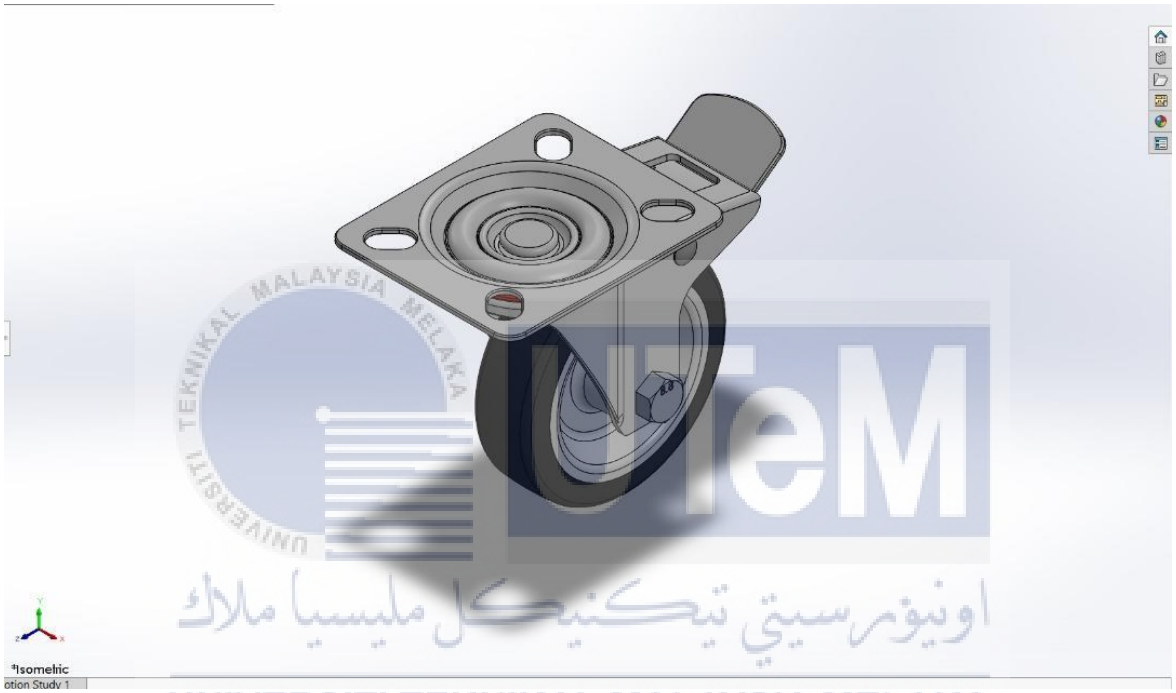


Figure 4.13 Wheel

The mobile workbench has been ingeniously designed to provide seamless mobility and adaptability in various work environments. Facilitating easy movement, the workbench features a set of seven wheels on each leg, each with a diameter of 86.25mm. This configuration ensures optimal stability and weight distribution while allowing the workbench to be effortlessly maneuvered in any direction.

A notable safety feature includes the ability to lock the wheels, ensuring the workbench remains stationary when needed. This is particularly crucial for tasks requiring stability, emphasizing the commitment to workplace safety. The benefits extend beyond mere mobility, focusing on the convenience for workers to adapt the workbench's position according to the spatial requirements of the environment. This adaptability enhances efficiency and productivity by allowing for quick adjustments based on workflow needs.

4.4 Assemble Process Intergration

4.4.1 Assembly

For the assembly process of the workbench, the various components such as meat cutting machine, L-shaped table and wheel are carefully combined to create a functional and efficient workbench. The meat cutting machine plays a crucial role as it is the initial process in making a patty. The plate of the meat cutting machine were extended to form the L-shaped table. The L-shaped table was designed with a suitable capacity to place a meat grinder machine and patty forming machine. Furthermore, the L-shaped table also been added extra compartment to place any tool are equipment needed. Lastly, the wheels also were added to each of the table's leg to ease the movement of the table. The design of the final assembly is shown on Figure 4.4 below.

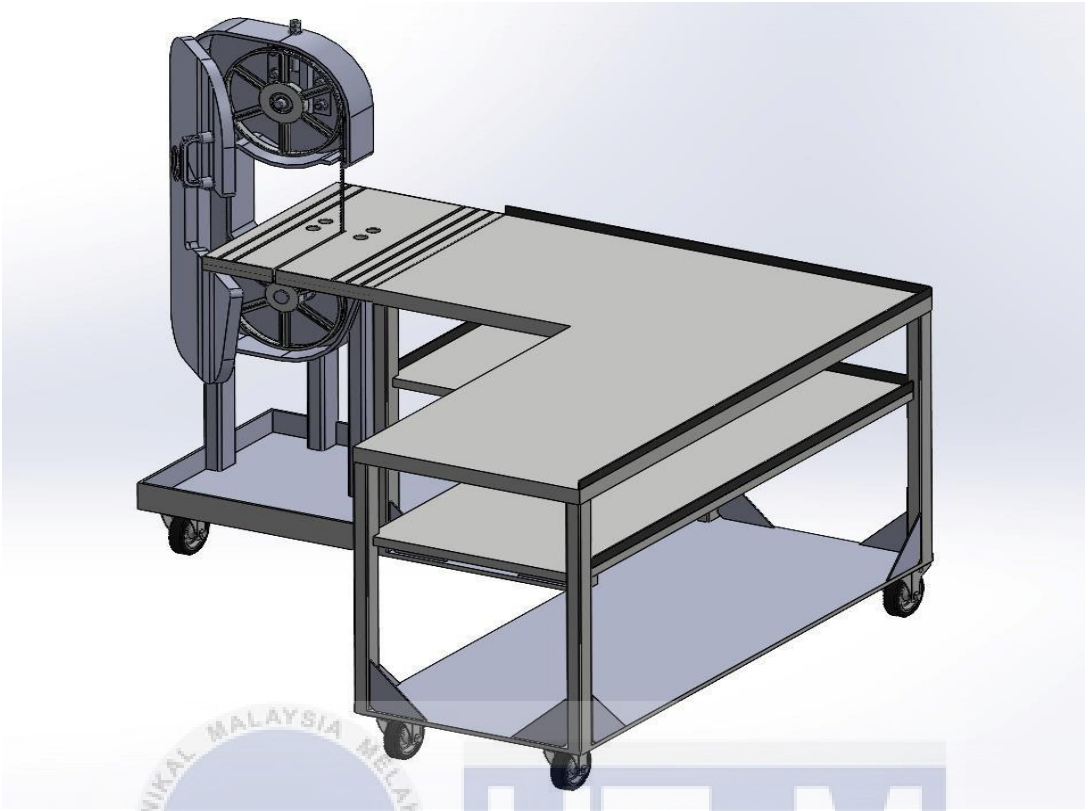


Figure 4.4 Finalize assembly

4.5 Concept analysis

The concept analysis was run into CAD software (SolidWorks) to identify the displacement, stress, and frequency of vibration of the product. Concept analysis of displacement, stress, and frequency vibration is essential in understanding the behavior of mechanical systems and structures subjected to dynamic loads. Displacement refers to the distance and direction of movement experienced by a point or body in response to an applied force or vibration. It helps quantify the extent of movement or deformation, allowing engineers to assess the integrity and performance of the system under consideration. Stress, on the other hand, measures the internal resistance or force within a material that arises due to applied loads. By analyzing stress distribution and magnitude, researchers can determine whether a component or structure can withstand the applied forces without exceeding its

material limits. Stress analysis aids in identifying potential failure points and designing optimal strength and durability .

4.5.1 Product Analysis

The ergonomic workbench, meticulously crafted for the specialized needs of Small and Medium-sized Enterprises (SMEs), is ingeniously tailored for the streamlined production of burgers. This innovative solution encompasses the entire process, seamlessly guiding the transformation of raw meat from the initial cutting phase to the precision shaping of patties.

Leveraging the advanced capabilities of SolidWorks, robust computer-aided design (CAD) software allows for a thorough and comprehensive analysis of the product. This CAD-driven approach empowers engineers and designers to delve into the intricate details of the workbench, evaluating its functionality, efficiency, and overall design.

4.5.1.1 Structural Analysis

Structural Analysis : Using SolidWorks, the structural integrity of the machine can be evaluated through finite element analysis (FEA). This analysis helps identify areas of high stress, potential weak points, and structural optimizations to ensure the machine can withstand the forces generated during operation.

I. Von Misses Stress Analysis

The Von Mises stress analysis, is a technique used in engineering and materials science to evaluate the safety and stability of a structure subjected to complex loading conditions. It is particularly applicable to situations where multiple types of stresses act simultaneously on a material. The Von Mises criterion is often used to predict yielding of ductile materials. According to this criterion, yielding begins when the Von Mises stress at a point in a material reaches a critical value. This criterion simplifies complex stress situations into a single value, making it easier to compare to a material's yield strength.

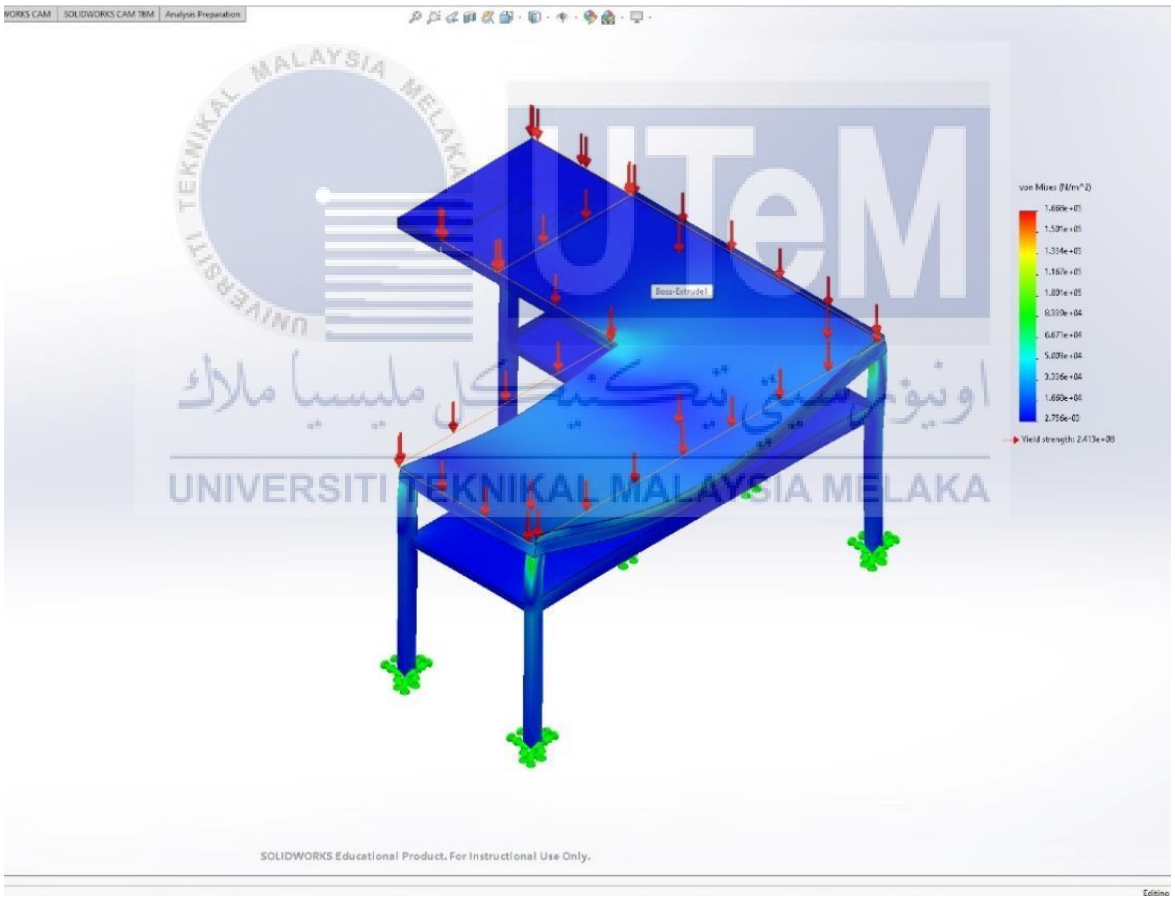


Figure 4.14 Von Mises Analysis

From Figure 4.14 above, the break down the results of the von Mises stress analysis were verified. The areas of the structure that experienced high stress concentrations are at the corner of the workbench that attched to the leg. The areas where stress levels were within acceptable limits were at the surface of the workbench. The visual aids such as stress contour plots were used to illustrate these findings.

II. Displacement Analysis

Displacement analysis refers to the examination and quantification of the movement or change in position of an object, structure, or system over a specific period. It is a crucial aspect of engineering, physics, and various scientific disciplines, providing insights into the behavior and performance of materials and structures under different conditions.
In structural engineering, displacement analysis is commonly used to study the deformation or movement of structures subjected to loads. This analysis helps engineers understand how structures respond to external forces, allowing them to assess the safety and integrity of the design. It involves measuring the relative changes in position or shape of different points within a structure.

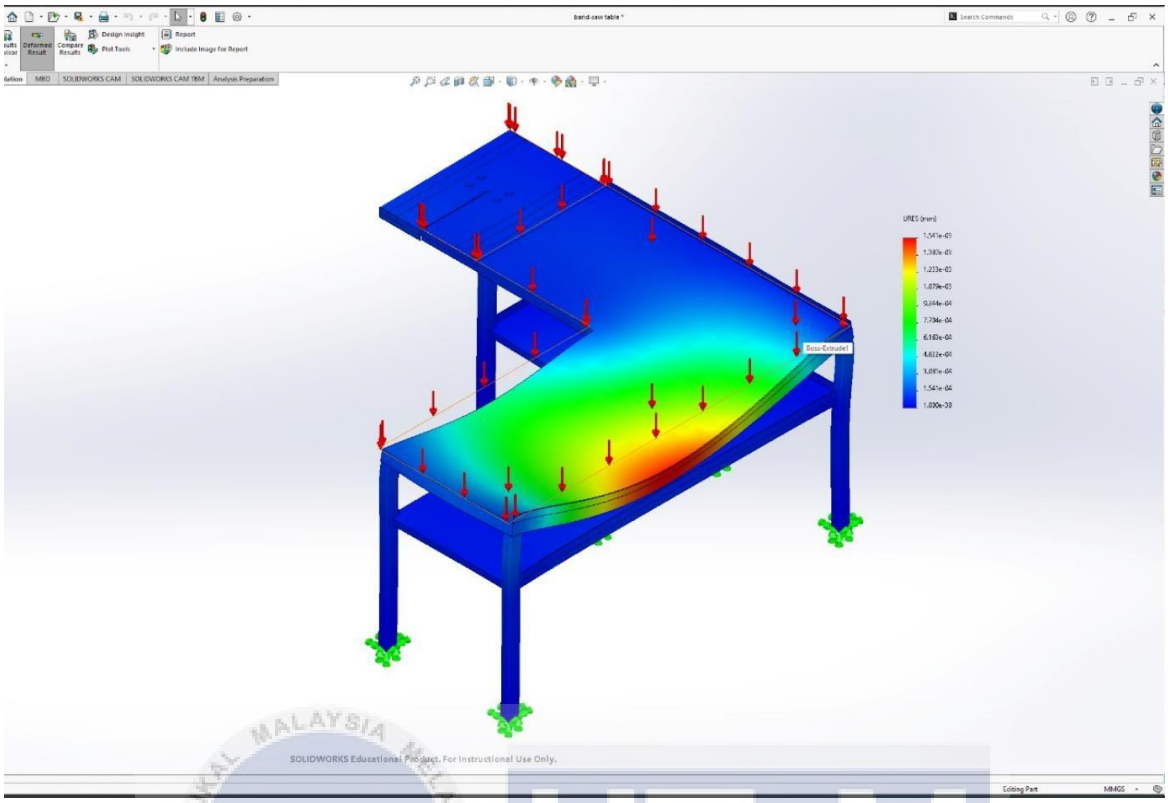


Figure 4.15 Displacement Analysis

Figure 4.15 above present the results of the displacement analysis. It identify areas where significant displacement occurred which is at the middle of the L-shaped table that have a curvature which is the weak point. The structural integrity of the hamburger workbench is crucial for its functionality. A well-designed workbench should withstand the weight of ingredients and tools, ensuring durability and safety. Visual representations, like displacement plots, can illustrate stress distribution, helping assess potential weak points and refine the design for optimal structural stability.

III. Strain Analysis

Strain analysis is a scientific method employed to measure and quantify the deformation or distortion of an object or material under the influence of external forces. This analysis is crucial for understanding how materials respond to various stressors, helping engineers, scientists, and researchers assess the structural integrity, performance, and durability of components in each system. The process involves measuring changes in the shape or size of a material, often expressed as a ratio of the deformed state to the original state.

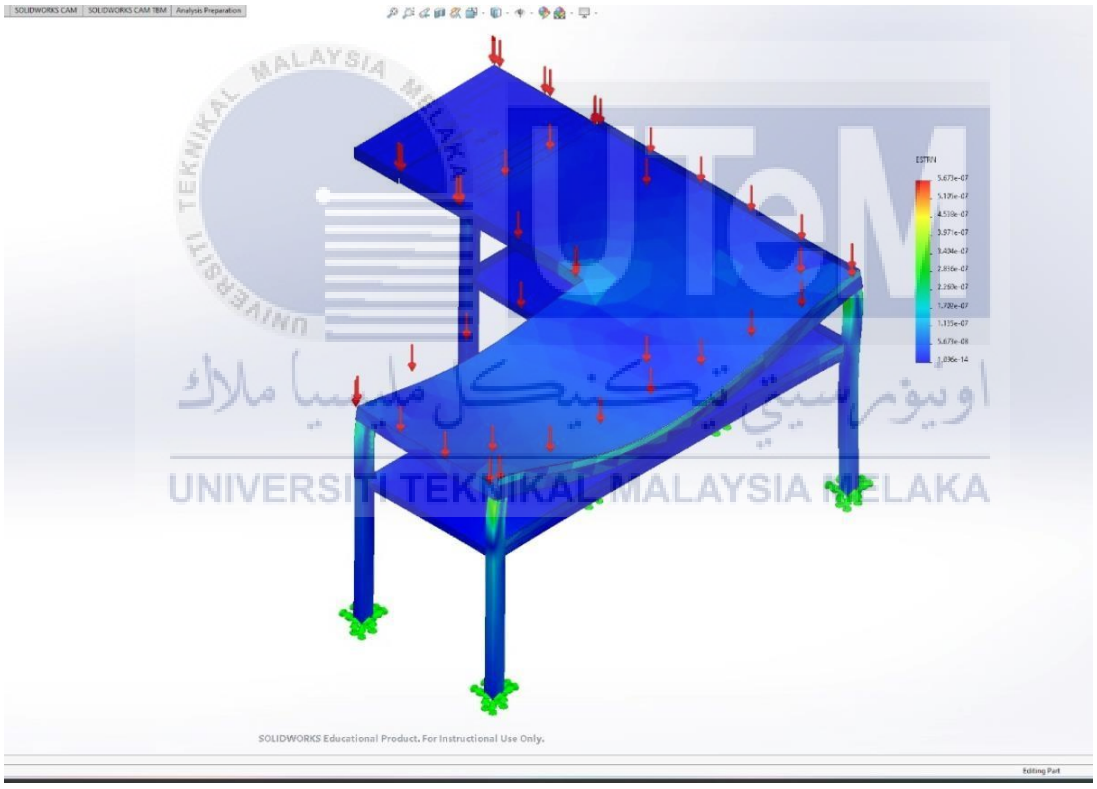


Figure 4.16 Strain Analysis

Figure 4.16 shows the strain analysis for the L-shaped table. The obtain strain values at the middle of the L-shaped table shows a weak point and cause curvature. Thus, the area have a high distribution of strain.

Figure 4.14, Figure 4.15, and Figure 4.16 offer a detailed insight into the structural analysis setup for the ergonomic workbench, strategically incorporating fixed geometry at each leg to ensure stability during simulations. This fixed foundation becomes pivotal in evaluating the overall structural integrity and performance of the entire system. The primary focus centers on the L-shaped table, a core component constructed from durable cast stainless steel, chosen for its corrosion resistance and robust mechanical properties, emphasizing longevity in the demanding burger production environment.

To simulate real-world scenarios, a force of 40N is applied to the top surface, precisely targeting the area where the workbench bears the load from machinery like grinders and patty formers. This downward force mimics the pressures encountered during burger production, allowing engineers to assess load distribution and structural response. The strategic choice to analyze the top surface, a critical interface between the workbench and its legs, ensures a thorough understanding of its behavior under external forces.

SolidWorks facilitates a meticulous examination of stress distribution and deformation, enabling designers to refine the workbench based on identified weaknesses. This data-driven approach validates the design and contributes to continuous improvement, ensuring the workbench not only meets but exceeds the demanding requirements of burger production, reflecting a commitment to optimal performance and sustained reliability.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter concludes this thesis by presenting a summary of the work carried out to achieve the objectives of the project study. It discusses the overall project results including the limitations and stability of the project. This chapter also gives suggestions for future works that can be continued along with a summary at the end of this chapter.

5.2 Summary of Research Objectives

This section explains the results of the project objectives as stated in Chapter one of this thesis. The main objective of this paper is to identify the current practice of workbench for SME's burger production. All three objectives are achieved by learning all the things related to the work that needs to be done while completing this project.

5.2.1 Research Objectives 1

Objective 1: To identify the current practice of workbench for SME's burger production.

For this purpose, a survey was conducted to assess current workbench practices in SMEs engaged in burger production. Positive feedback received has significantly influenced the design process, shaping a workbench that aligns with the specific needs and preferences identified during the survey, ultimately enhancing efficiency and functionality in burger production.

5.2.2 Research Objectives 2

Objective 2: To conduct conceptual design of workbench for SME's burger production.

For the second objectives is to conduct conceptual design. The conceptual design will integrate insights from the SME burger production survey, emphasizing ergonomic factors. Utilizing SolidWorks, the design will prioritize user comfort, efficiency, and safety. This approach ensures the development of a practical and user-friendly workbench tailored to the unique needs identified in the survey.

5.2.3 Research Objectives 3

Objectives 3: To perform a SolidWorks design analysis and evaluate the selected design of ergonomic workbench.

Finally, evaluating and analysis the proposed design of an ergonomic workbench involves assessing the functionality, efficiency, and effectiveness in achieving its intended purpose. A comprehensive structural analysis was conducted, encompassing von Mises stress, displacement, and strain analyses to evaluate the performance and integrity of the system under various conditions.

5.3 Conclusion

In conclusion, the successful accomplishment of these objectives signifies a holistic approach to improving SME burger production. The synergy between survey insights, ergonomic design criteria, and structural analysis forms a comprehensive strategy that not only acknowledges the current state of the industry but actively works towards enhancing its operational efficiency, ergonomics, and structural integrity. This integrated approach is poised to contribute significantly to the advancement and sustainability of SMEs engaged in burger production.

The successful attainment of the three stated objectives marks a significant achievement in advancing the understanding and enhancement of SME burger production practices. Firstly, the completion of a comprehensive survey on the current practices of SME burger production provided valuable insights into the existing workflows, challenges, and preferences within this sector. This information serves as a foundational resource for subsequent improvements.

Secondly, the successful design of ergonomic workbench criteria based on the survey responses from SME burger owners reflects a commitment to addressing specific needs and preferences identified within the industry. By incorporating these criteria, the aim is to enhance the efficiency, comfort, and overall functionality of workbenches used in burger production, catering to the unique requirements of SMEs in this field.

Lastly, the execution of structural analysis on the designed workbench, including von Mises stress, displacement, and strain analyses, signifies a robust approach to ensuring the practicality and reliability of the proposed design. This analytical phase delves into the

structural integrity, stress distribution, and deformation characteristics of the workbench under various conditions, facilitating the identification and resolution of potential issues.

5.4 Contributions

This project research have described to support SME's company owner in burger patty production in developing new work life style to produce a burger patty. The implementation of this project could provide several facilities and benefits. These include the proposed workbench design aims to address critical aspects of patty production, providing multifaceted benefits for operational efficiency. Firstly, it contributes to the seamless production and maintenance of patties by offering a dedicated and organized workspace. The incorporation of essential components such as cutting and grinding machines streamlines the production process, ensuring precision and consistency in patty preparation. This not only enhances overall productivity but also facilitates a structured approach to meet varying production demands.

Secondly, the workbench design facilitates an increase in storage capacity. Adequate storage around the workbench ensures efficient organization of tools, equipment, and raw materials, contributing to a more streamlined workflow. This expanded storage capability is instrumental in accommodating the diverse requirements of patty production, enabling workers to access essential items promptly and enhancing overall workspace organization.

Furthermore, the ergonomic considerations embedded in the workbench design play a pivotal role in promoting the well-being of workers. By minimizing musculoskeletal complaints in various parts of the body, the workbench contributes to a healthier and safer working environment. The ergonomically optimized design helps reduce strain on workers, fostering better posture and comfort during prolonged operational hours.

5.4 Limitations

Several challenges and limitations were encountered during the course of this project. The first notable limitation was the inability to fabricate the proposed product due to the expansive scope of the job. The complexity of the design and resource constraints hindered the physical realization of the envisioned workbench. Additionally, the inability to adjust the height of the workbench emerged as a significant limitation, potentially impacting its ergonomic suitability for a diverse user base.

Moreover, the project faced constraints in terms of the analysis that could be conducted due to limitations within the chosen software. The software's capabilities restricted the depth and breadth of the structural analysis, potentially leaving certain aspects unexplored. Furthermore, not all surveys could be conducted face to face, introducing potential biases or limitations in gathering firsthand, detailed insights from participants. These challenges collectively underscore the need for careful consideration in the interpretation of results and the acknowledgment of the study's limitations in shaping future research directions. Despite these constraints, the project contributes valuable insights, and the identified limitations pave the way for more targeted and refined investigations in subsequent studies.

5.5 Future Works

Future work for this project encompasses various recommendations derived from the encountered limitations and project findings. Firstly, the fabrication and development of a prototype should be pursued collaboratively with manufacturing partners to overcome the constraint of the extensive job scope. Introducing an adjustable height mechanism into the workbench design stands as a crucial enhancement for future iterations, ensuring greater ergonomic adaptability to diverse user preferences. Exploring the utilization of more

advanced structural analysis software is recommended to provide a more in-depth examination of the workbench's structural integrity, stress distribution, and deformation characteristics. Additionally, expanding face-to-face surveys with SME burger producers will contribute to a richer understanding of their preferences and challenges, guiding more nuanced design solutions. Incorporating hands-on user testing sessions with prototypes and seeking direct feedback from potential end-users can inform iterative refinements based on practical usability. Finally, exploring the integration of smart technologies, such as IoT sensors or automation features, is suggested to further enhance the functionality and efficiency of the workbench, aligning with current industry trends and potentially increasing productivity in burger patty production. These recommendations collectively aim to address limitations and guide a more comprehensive and user-centric approach in the future development of ergonomic workbenches for SME burger production.

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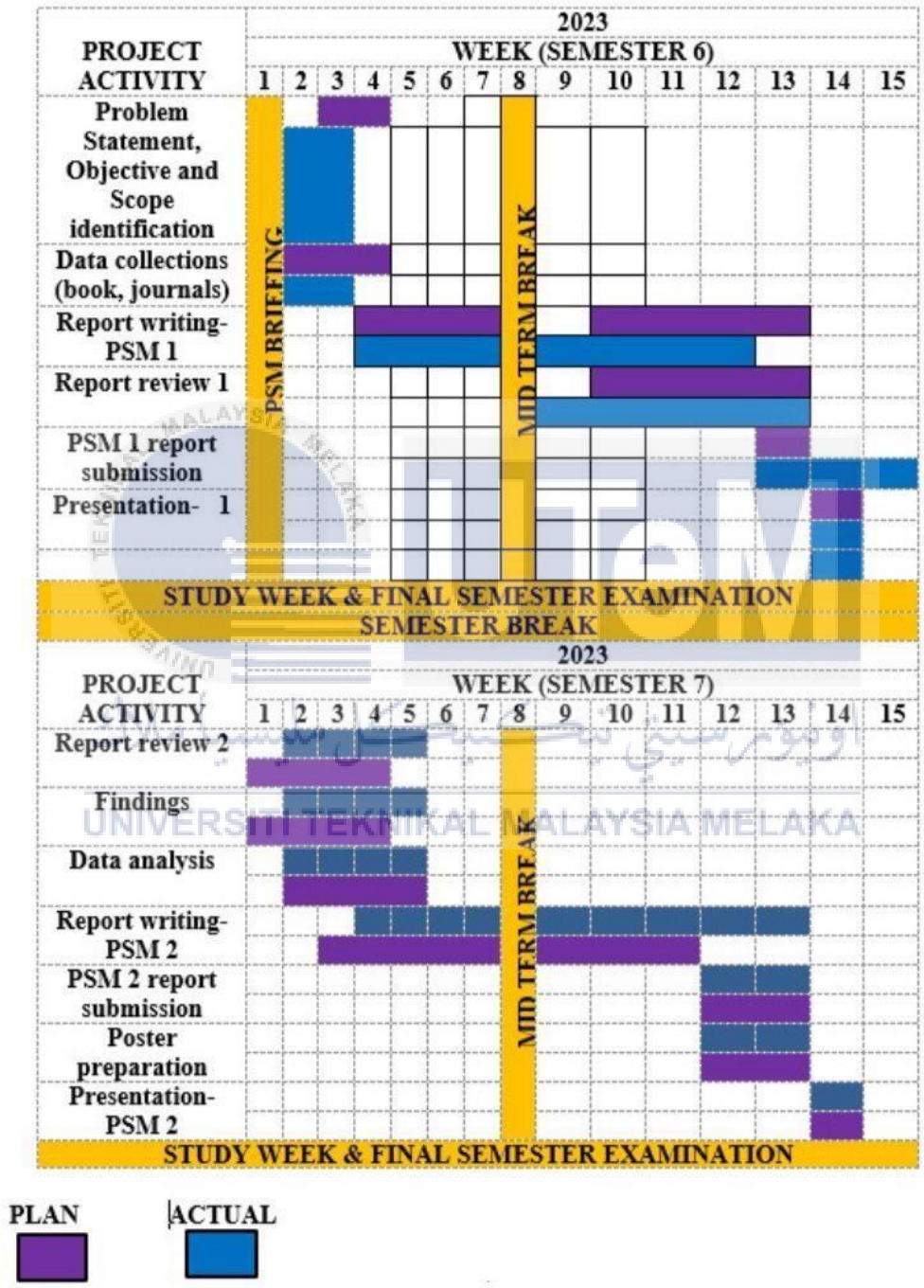
APPENDICES

APPENDIX A Gantt Chart of the project



APPENDIX B Design Drawing Detail