

# DESIGN AND DEVELOPMENT OF ERGONOMIC HAND STAND FOR PROLONG PLAYING GAME FOR SMARTPHONES USER



# BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (PROCESS AND TECHNOLOGY) WITH HONOURS

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# Faculty of Mechanical and Manufacturing Engineering Technology



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# Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

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Faculty of Mechanical and Manufacturing Engineering Technology

# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021/2022

# **DECLARATION**

I declared that this Choose an item. entitled "Design And Development of Ergonomic Hand Stand for Prolong Playing Game for Smartphone Users" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



# APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours.

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# **DEDICATION**

This powerful report is dedicated to my beloved family, particularly for their endless support, love, and encouragement. To my supervisor, Sir Mohd Hidayat bin Ab Rahman, who guided me through this journey until I managed to complete my project, Thank you for all of your support and guidance in getting this project done.



#### ABSTRACT

Nowadays, a smartphone is a must-have thing that must be brought with you at all times. Not only is the phone useful for emergencies, but it may also be used to pass the time for introverts. People use their phones for a variety of purposes, including reading news, looking for information, keeping up with social media, and playing games. When we use our phones for lengthy periods of time, it has an effect on our bodies. The effect are some parts of our bodies will be in pain and causing discomfort for the user. The existing device for supporting the hand of a smartphone user or gamer is insufficient in terms of providing comfort and safety while using the device. For individuals who use the gadget for an extended amount of time, the existing device will cause ergonomic risks. Identify the current hand stand device and make an innovation on the current hand stand support to prevent from pain and injury are some of the suggestion way to help the gamers. The ergonomics hand stand support that good in preventing hand pain will solve the gamers problem. The present hand stand support device will be examined to see what is causing the pain when it is used. The dimensions and material will be the most important considerations. The new ergonomics hand stand support will be developed to solve the gamers problem.



#### ABSTRAK

Pada masa kini, telefon pintar adalah perkara wajib yang mesti dibawa bersama setiap masa. Telefon tidak hanya berguna untuk keadaan kecemasan, tetapi juga dapat digunakan untuk meluangkan masa untuk introvert. Orang menggunakan telefon mereka untuk pelbagai tujuan, termasuk membaca berita, mencari maklumat, mengemaskini media sosial, dan bermain permainan video. Apabila telefon digunakan dalam jangka masa yang panjang, ia memberi kesan kepada tubuh badan. Kesannya adalah beberapa bahagian tubuh badan akan berada dalam kesakitan dan menyebabkan ketidakselesaan kepada pengguna. Peranti yang sedia ada untuk menyokong tangan pengguna telefon pintar atau pemain permainan video tidak mencukupi dari segi memberi keselesaan dan keselamatan semasa menggunakan peranti tersebut. Bagi individu yang menggunakan telefon untuk jangka masa yang panjang, peranti yang ada akan menyebabkan risiko ergonomik. Kenal pasti alat pegangan tangan semasa dan melakukan inovasi pada sokongan pemegang tangan semasa untuk mengelakkan kesakitan dan kecederaan adalah beberapa cadagan untuk membantu pemain. Sokongan pegangan tangan ergonomik yang baik dalam mencegah sakit tangan akan menyelesaikan masalah pemain. Peranti sokongan pemegang tangan sekarang akan diperiksa untuk melihat apa yang menyebabkan kesakitan semasa digunakan. Dimensi dan bahan akan menjadi pertimbangan yang paling penting. Sokongan pegangan tangan ergonomik baru akan dicipta untuk menyelesaikan masalah pemain.

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# LIST OF SYMBOLS AND ABBREVIATIONS

MSD		Musculoskeletal Disorder
WMSD		Work-Related Musculoskeletal Disorders
RSI		Repetitive Strain Injuries
RMI)		Repetitive Motion Injuries
CTD		Cumulative Trauma Disorders
IPMS		Integrated Product Materials Selection
VES	_	Video Entertainment System
VCS	J. M.	Video Computer System
NES	IEKW	Nintendo Entertainment System
CPU	16	Central Processing Unit
SEBT	"SAIN	Star Excursion Balance Test
HSEBT	ملاك	Hand Reach Star Excursion Balance Test
RULA	UNIVE	Rapid Upper Limb Assessment
BDP		Bachelor Degree Project
FTKMP		Fakulti Teknologi Kejuruteraan Mekanikal Proses
CATIA		Computer-Aided Three-Dimensional Interactive Application

# **APPENDICES**

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#### **CHAPTER 1**

#### **INTRODUCTION**

#### **1.1 Introduction Background**

Technology nowadays can be access anywhere as long as we have gadget in our hands. The easier yet compact gadget nowadays is smartphone. Handphone had been used for decades. Technology for handphone back then is a basic communication for people. From calling to texting then facetiming. With the passage of time, handphone had been upgraded to a smartphone. Technology on smartphones nowadays is beyond our mind. What had been created by the technologist are something to be thankful in this super busy day. Smartphone never gave unexpected result to the user. Too much activity that someone can do with a smartphone.

Nowadays game is a must for a smartphone users. As we can see, games or e-sport right now had been an international tournament. The gamers can earn a living using games and some earn more than a living. Playing games in a smartphone is much easier for the gamer to practice their skill because smartphone is easy to carry without feeling burdened. Unlike laptop that having a hard situation when the battery drop, we have powerbank to keep on the smartphone. The users can safely use the device while charging.

From my search, there's no product or device that can support the gamer to play game in a long period of time. The existing product only help the gamer to feel more excited while playing online gaming. The gamers still having the problem such as neck pain, back hurt and waist cramp. This will cause the gamer to lose focus.

Nevertheless, to gain smartphone user attention of the new and helpful product is not easy because the existing product advertisement always mislead with the original concept of the product. Unbearable body and finger position will lead to gaming injuries. Studies from Harvard Health Blog, repetitive stress injuries, or overuse injuries, are injuries that come from activities that involve repeated use of muscles and tendons, to the point that pain and inflammation develop. If these injuries are allowed to progress, numbness and weakness can come out, and permanent injury is the outcome. Overuse injuries of the hands and arms are pervasive among gamers.

One common syndrome is carpel tunnel syndrome, which many gamers evolve. Carpal tunnel syndrome, often seen in office workers, involves swelling of a nerve in the wrist, which causes pain and numbness. Gamers can also get tennis elbow, a painful inflammation of the place where the tendon inserts into the bone on the outside of the elbow.

"PlayStation thumb" or now known as "Gamer thumb" arises when the tendons that move the thumb become swollen. The medical phase for this is called Quervain's tenosynovitis, and it can lead to lump and limited movement. Gamers are also at risk for trigger finger, or stenosing tenosynovitis, which is when a finger gets stuck in the bent position due to chronic inflammation.

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Research from the American Academy of Orthopaedic Surgeons, carpal tunnel syndrome is a common syndrome that causes common condition of pain, numbness, swelling and inflammation in the hand, wrist and arm. The affliction crops up when one of the major nerves to the hand which is the median nerve is squeezed or compressed as it travels through wrist.

In most patients, early diagnosis and treatment are important because carpal tunnel syndrome gets worse over time. Early on, symptom can often be relieved with simple measures like wearing a wrist splint or avoiding certain activities. For some patients who the pressure on the median nerve continues, it can lead to nerve damage and worsening symptom. To forbid everlasting damage, surgery to take pressure off the median nerve may be recommended.

This project is focusing on how to design a device that will preventing the smartphone users or most importantly a gamer to focusing on the game for hours without having pain or damage. The data for this project will collecting by the people who active playing games and the improvement will be made after collecting the data.

#### **1.2 Problem Statement**

Based from the observations and explaining video from eSports therapy YouTube channel and reading the journal from the American Society for Surgery of the Hand, it can be sure that an ergonomic design of an ergonomics adjustable controller hand support is salient in findings comfortable and safety while enjoying the game in a long time without having any ergonomics risk factor and injuries.

Market controller that the gamer usually use for their phone while playing games does not provide safety for the phone and comfortable for the user. This will cause ergonomics risk factors for those who play games in a long period of time such as, carpal tunnel syndrome, repetitive stress injuries, tennis elbow, Quervain's tenosynovitis and stenosing tenosynovitis.

#### 1.3 Objective

The main objective of this research is to advocate a design and to generate a new ergonomics adjustable hand stand support for smartphones users especially smartphone gamers. To confirm this project success, these objectives will be rough out as follows:

3

- a) To study the current device for hand stand support for smartphone user and gamers from the market place.
- b) To make an innovation on the device to prevent from pain or injury.
- c) To develop new ergonomics adjustable hand stand support for gamers that good in preventing hand and wrist pain.

#### 1.4 Scope

This project studies on the journal of finger pain and injury wrist of gamers from the worldwide, collecting data. The collection data includes the current controller and the pain that the gamers faced while and after playing games in a long period of time. The following task will be done in this project which includes:

- a) Studies and searching the injury and pain faced by the gamers after playing the video games in a long period of time.
- b) Analyze what cause the pain.
- c) Develop and optimize solutions of ergonomics adjustable hand stand support according to the injury and analyzed by using CATIA software.
- d) Enlargement of ergonomics adjustable hand stand support using CATIA software.

### **1.5 Expected Result**

The expected result for this project is to design and develop a new ergonomics adjustable hand stand support for smartphone users and gamers.

#### **CHAPTER 2**

#### LITERATURE REVIEW

#### 2.1 Introduction

The goal of this chapter is to compiled and edit information from a variety of publications, books, and journals that pertain to this study, with a focus on ergonomics. This chapter contains a literature review based on past studies as well as theoretical readings based on ergonomic concepts, particularly in the areas of sitting, lying, and playing games postures, which may be understood via ergonomic studies and past researches. There is also information on human-body studies that are relevant to engineering design or human factor design considerations. The majority of the literature evaluations are based on media social complaining, online databased journals like Jstor, BioMed Central, Google Scholar, Mendeley, EZproxy, SCI HUB and internet search engine. In the references section, all of the data that was found will be mentioned.

# 2.2 Definition of Ergonomics

Ergonomics can be derived into few definitions. However, the fundamental definition which is used internationally is derived from the Centre for Occupational and Environmental Health. University of Manchester. Economic and Political Weekly (COEH, 2020). Table 2.1 shows the numerous meanings of ergonomics.

No.	Author/Resources Year		Definition	
			Ergonomics is the process of designing or arranging	
			workplaces, products and systems so that they fit the	
1	Dohrmann Consulting.	2014	people who use them. Ergonomics applies to the design	
	(Dohrmann Consulting,		of anything that involves people workspaces, sports	
	2014)		and leisure, health and safety.	
			Ergonomics is the scientific discipline concerned with	
			the understanding of interactions among humans and	
2	International Ergonomics	2015	other elements of a system, and the profession that	
	Association (International	1	applies theory, principles, data and methods to design	
	Ergonomics Association,	2	in order to optimise human well-being and overall	
	2015)		system performance.	
	5 Malunda	14	Ergonomics is the study of how humans interact with	
3	Centre for Occupational and		manmade objects. The goal of ergonomics is to create	
	Environmental Health.	2020	an environment that is well-suited to a user's physical	
	(COEH, 2020)		needs. Ergonomics it is commonly applied to the	
			workplace environment.	

# Table 2.1 Definition of ergonomics

With all of the criteria, we can conclude that ergonomics is concerned with the fulfilment of the workplace, ensuring that the environment is well-organized and safe. A well-balanced between end-task user and demands may be implemented with effective work system design and ergonomics. This can help workers enhance their performance, their safety, and their emotional and physical well-being. Users experience discomfort, agony, and inefficiency

as a result of the abandonment of ergonomics principles. The goal of workplace design is to accommodate as many people as possible to understanding the ergonomics concept of posture and mobility, which is critical for providing a safe, healthy, and comfortable working environment.

#### 2.3 History of Ergonomics

Ergonomics was developed as a result of the design and operational difficulties that have arisen as a result of technology improvement over the previous decade. Its evolution has been constrained by the same historical processes that gave rise to other principles like occupational medicine and industrial engineering. (R.S Bridger, 2003).

According to Christensen (1987), the need of a "good fit" between people and tools was likely recognised early in the evolution of the species. For example, in a clear illustration of creating things to make chores simpler to do, pebble tools are chosen for manufactured scoops from antelope bones. Following World War II, the focus of concern shifted to encompass both worker safety and productivity. Research began in a number of areas, including:

- i. Manual labour takes a lot of muscle power. YSIA MELAKA
- ii. When raising, there is a compressive stress on the low back discs.
- iii. Cardiovascular response when performing heavy labour.
- iv. Maximum load that may be carried, pushed, or dragged as perceived.

The name Ergonomics was gained from the Greek words. *Ergon* referred to work while *Nomos* referred to natural law. Prof. Wojciech Jastrzebowski coined the term "ergonomics" in 1857 in Poland. "Based upon the facts gleaned from the Science of Nature," he said in a philosophical narration. At a conference of the British Admiralty in 1949, Prof. Hugh Murell advocated the formal use of the phrase Ergonomics, which was adopted in 1950. (Pandve, 2017)

#### 2.4 Ergonomics Principle

Over the years, a few basic principles have emerged from the ergonomics sector. The majority of the ideas are well-explained, and the new applicable core philosophies should not be overlooked. These guidelines should be followed to ensure that the intended task is appropriate for the worker. The essential principles involve performances, comfortable, productivity, safety and health (Soubi et al., 2013)

#### 2.4.1 Performance

Human performance is the highly regarded outcome of the efforts of those who operate within a system (Spector, 2015). Performance is about human skill, attitude and temperament that shows at their workplace. Employee performance is determined by a variety of financial and non-financial factors, with workplace comfort and amenities being particularly crucial for manufacturing personnel (Ravindran, 2019). The ergonomics of the workforce, according to (Smith, 1997), is critical for greater labour performance in the workplace. When tools and equipment were constructed to minimise awkward postures, wrist aches, more standing positions, etc. with adequate lighting and ventilation set up, (Narayan et al. 1993) reported a reduction in accidents and employee unhappiness in a medical device assembly factory.

#### 2.4.2 Comfortable

Comfortable zone is everyone favourites and it comes more excited when it comes to works. Go through a tough day sometimes will be ease if we have a comfortable works environment. Comfort has always been a primary concern and idea in nursing, and it is especially significant in defining the character of nursing knowledge, discipline, and profession. (Oxford University Press, 2016). Kolcaba's research is based on the well-known comfort theory, which defines comfort as "the immediate state of being strengthened by having the needs for relief, ease, and transcendence addressed in the four contexts of holistic human experience: physical, psychospiritual, sociocultural, and environmental"(Keionen et al., 2003). To allow for appropriate rates of human performance and to limit any negative impacts on the user during the user-product interaction, discomfort should be avoided (Ahmed-Kristensen & Stavrakos, 2012).

#### 2.4.3 Productivity

Productivity is the output that is produced more than the input in term of industry. Other definition of productivity is a measure of a person's ability to complete a task. Productivity is essentially about making good decisions (on a regular basis) with our energy, concentration, and time in order to maximise our potential and produce positive outcomes (*Apakah Maksud Produktiviti\_ Dan Bagaimana Hidup Secara Produktif\_*, n.d.).

According to P. Krugman (Krugman, 1994), the amount of output divided by the volume of inputs is frequently referred to as productivity. In other words, it assesses how effectively a country's production inputs, such as labour and capital, are employed to generate a particular amount of output. Productivity is a crucial source of economic development and competitiveness, and it is used as the basis for many international comparisons and assessments of country performance. Productivity and performance always walk together in order to achieve a great output.

### 2.4.4 Safety and Health

Safety and health of the worker is one of a major reason for an organisation to achieve their goal keep improving their performance. A healthy body and mind will lead to a quick respond on something that come unexpectedly. When you having an energetic body and free mind, you will decide something with a wise mind. Other than that, you will stay focus on your works and always get rid of yourself from a danger situation. If you having a lethargic body and chaotic mind, you will lose focus and that will put you in a danger situation.

#### 2.5 Musculoskeletal Disorder (MSD)

Work-related musculoskeletal disorders (WMSD) associated with repetitive and demanding working circumstances remain one of the most serious issues in developed countries. Musculoskeletal disorders are disorders that affect the upper limb extremities, the lower back area, and the lower limbs that are caused or worsened by employment. WMSD is identified by deficiencies in physical structures such as muscles, joints, tendons, ligaments, nerves, bones, and the regional blood circulation system, which are largely induced or worsened by work or the work environment (CDC, 2020). MSDs are musculoskeletal system and connective tissue illnesses and illnesses that occur as a result of a physical reaction (e.g., bending, climbing, crawling, reaching, twisting), overexertion, or repetitive motion, according to the Bureau of Labor Statistics of the Department of Labor. Disorders induced by slips, trips, falls, or other similar accidents are not included in MSDs. Examples of MSDs include Sprains, strains, tears, back pain, carpal tunnel syndrome, hernia (Health and Safety Executive, 2020) MSD, repetitive strain injuries (RSI), repetitive motion injuries (RMI), and cumulative trauma disorders (CTDs) are some of the terms used to describe soft tissue injuries (L. & McCauley, 2012)

Apart from physically demanding employment, the ageing of the workforce also contributes to the growth of WMSD, because the tendency for developing a WMSD is linked to the disparity between work demands and the worker's physical work capability, which diminishes with age (Okunribido & Wynn 2010). Work-related musculoskeletal disorders (WMSD) are situations in which the work environment and job performance play a substantial role in the development of the condition, and/or the ailment is made worse or lasts longer as a result of the work environment (Barrimi et al., 2013)

It is not new to recognise that one's job might have a negative impact on one's health. Musculoskeletal diseases have been diagnosed in the medical sector for many years. It is also possible to locate references to a range of injuries connected to the performance of certain tasks in historical medical records. Raynauld's phenomenon, commonly known as dead finger or jackhammer illness, was discovered to be caused by a lack of blood flow and linked to repeated actions in the eighteenth century.

Physical risk factors connected with employment, such as awkward postures, high repetition, excessive force, static labour, cold, or vibration, are widely established to have a substantial link with the occurrence of WMSD. WMSD has a multifactorial aetiology, according to WHO, which implies that these illnesses develop as a result of a worker's exposure to a variety of work-related risk factors (World Health Organization, 2015). Other risk variables, such as characteristics inherent to the worker and variables unrelated to work, contribute to its development in addition to job-related risk factors. Any source or event that has the potential to cause damage or lead to the development of a disease is considered a risk factor. The variety and complexity of the elements that contribute to the emergence of various illnesses explains the difficulty in determining the optimum ergonomic intervention to be implemented in a specific workplace and controlling them.

Employers face substantial expenditures due to absenteeism, lost productivity, and higher health care, disability, and worker's compensation expenditures due to musculoskeletal problems. The severity of MSD instances is higher than the normal nonfatal injury or illness. MSDs took an average of 8 days off work in 2001, compared to 6 days for all nonfatal injury and sickness cases (e.g., hearing loss, occupational skin diseases such as dermatitis, eczema, or rash) (Health and Safety Executive, 2020). According to the most recent estimates from the Labour Force Survey (LFS), there were 480,000 instances of work-related musculoskeletal diseases in 2019/20, a prevalence rate of 1,420 per 100,000 employees. There were 212,000 instances involving the upper limbs or neck, 176,000 instances involving the back, and 93,000 instances involving the lower limbs.

MSD is truly a serious illness that happen to the workers. The most prevalent symptom linked to WMSDs is pain. In certain circumstances, the afflicted area may experience joint stiffness, muscular tightness, redness, and swollen. Some employees may also report "pins and needles" feelings, numbness, skin colour changes, and reduced hand perspiration. WMSDs can range in severity from minor to severe:

- i. Early stage: Aching and fatigue of the afflicted limb occur throughout the work shift, but go away at night and on days off. There will be no decline in work performance.
- ii. Intermediate stage: Aching and exhaustion begin early in the work shift and last throughout the night. Repetitive job capability is reduced.
- iii. Critical stage: Aching, weariness, and weakness remain even while the patient is at rest. Inability to sleep and carry out simple tasks.

These stages do not occur in the same order for everyone. In fact, determining when one stage finishes and the next begins can be tricky. The initial ache indicates that the muscles and tendons need to rest and recuperate. If not, an injury can become chronic and, in some cases, irreparable. People should respond to symptoms as soon as they become aware of them (Canadian Centre for Occupational Health and Safety, 2018).

Disorders	Occupational risk factors	Symptoms	
Tendonitis/tenosynovitis	Repetitive wrist motions	Pain, weakness, swelling, burning	
	Repetitive shoulder motions	sensation or dull ache over	
	Sustained hyper extension of arms	affected area	
	Prolonged load on shoulders		
Epicondylitis (elbow	Repeated or forceful rotation of the	Same symptoms as tendonitis	
tendonitis)	forearm and bending of the wrist at		
AN MAL	the same time		
Carpal tunnel syndrome	Repetitive wrist motions	Pain, numbness, tingling, burning	
Lingh		sensations, wasting of muscles at	
4 DINO		base of thumb, dry palm	
DeQuervain's disease	Repetitive hand twisting and	Pain at the base of thumb	
UNIVER	SITI TEKNIKAL MALAYSI forceful gripping	A MELAKA	
Thoracic outlet syndrome	Prolonged shoulder flexion	Pain, numbness, swelling of the	
	Extending arms above shoulder	hands	
	height		
	Carrying loads on the shoulder		
Tension neck syndrome	Prolonged restricted posture	Pain	

# Table 2.2 Outlines occupational risk factors and symptoms (Canadian Centre for Occupational Health and Safety, 2018)

Workers suffer from strained or exacerbated muscles, tendons, ligaments, nerves, discs, or blood vessels as a result of MSDs on a daily basis. The illness has substantial human costs that can last for years, if not all of a person's life. Due to MSD of nerves, tendons, and muscle, several heavy industries' job performance has suffered.

A key premise of occupational health and safety is that hazards should be addressed at the source. The repetition of labour is the primary source of hazard in the case of WMSDs. Other aspects of the job, such as the applied force, fixed body postures, and the rate of labour, also play a role. To safeguard workers against WMSDs, the primary focus should be on preventing repetitive labour patterns through job design, which may include automation, job rotation, job expansion and enrichment, or cooperation. Prevention techniques incorporating workplace structure, tool and equipment design, and work behaviours should be explored whenever eliminating repeated work patterns is not practicable or practicable.

Worker, management, and representative participation in workplace preventative and control measures, as well as improvements in occupational health and safety, are all crucial.

# 2.6 Design, Materials Selection and Marketing of Successful Products

There are various aspects that contribute to a product's marketability and success. This section will go through complete tools for product design that are integrated with product development. For a product developer to create a design manual, materials selection, design analysis, and marketing are critical tools. Since the previous few decades, numerous approaches for material design and selection have emerged. However, due to the physical entity material, certain procedures are limited in their ability to create a new product. Aesthetic, fashion, cultural characteristics, market trends, recycling, and the target demographic are all included in the new Integrated Product Materials Selection (IPMS) model.

In order to produce the product, the selection of an acceptable material and decisions are both dependent throughout the design phase. Whether it leads to commercial success or failure, the decision will have an impact on the look, form, cost, and marketing. When the design grows more intricate, the selection of acceptable materials and production will become more distinct. As a result, before making any final selections, design engineers must be wellversed on qualities, attributes, and materials.

Based on my expertise with game controllers, there are a variety of materials used in the production of a gaming controller. The most frequent materials utilised to make a gaming controller include polymers, rubber, and plastics. Manufacturing can make a game controller out of only one material, such as plastic, or it may make a gaming controller out of two or more. More ergonomics in design is the finest technique to develop the new enhanced design.

### 2.7 The Design Process

The process of designing is used to come up with solutions to challenges. The term "design" refers to a wide range of activities, most of which are associated with aesthetic expression. However, it is better viewed as a mental process combining planning with the idea of achieving a goal. We design everything from the look of a room to the vacation that we hope we will soon take. More importantly, design refers to the process of coming up with solutions to problems.

With the idea that designing is not a linear process; that is, you do not think and act in distinct, sequential phases when you design and produce anything. Designing is more like transitioning between a thinking-questioning-evaluating phase and an acting-doing phase during the creative process. These seven modes are known as the active and reflective stages of design, and you alternate between them all the time.

Because you'll be switching back and forth between the active and reflective stages, you'll probably need to move about a little while designing. For example, if you come to the stage of selecting a solution and realise you need additional background information, you'll need to go back to stage inquiry and study. Alternatively, if you are creating the selected solution and discover a fatal fault that prevents you from competing with it, you must return to the phase where you looked at "creation of other solutions" and choose another solution. There's no reason why you shouldn't do it. The design loop should help you stay on track by providing a structure for your design and problem-solving activities.

#### 2.8 Definition of Game Controller

Definition of game controller according to Wikipedia, often known as a gaming controller or just a controller, is an input device used with video games or entertainment systems to provide input to the game, usually to control an item or character. A controller consist of directional pads, multiple buttons, analog sticks and motion detection. Game controllers have been designed and improved over the years to be as user friendly as possible. Some controllers, such as steering wheels for driving games or dance pads for dancing games, are designed specifically for one sort of game.

#### 2.8.1 History of Game Controller

Joysticks, pads and wheels have all had a huge influence on the way games play. This section takes a look at the history of gaming controllers from their inception to the present day. Also explored will be some national examples such as designs that stand out in particular, either because they have grown familiar through time or because they are of exceptional design significance, will be considered.

In video games, controller failures are frequently blamed on the player's inability to achieve what they desired. Countless controllers have been martyrs as a

result of player frustration, as they have been shattered or hurled. The next generation of video game controllers will accompany the next generation of consoles. The joystick was shortly to follow with the introduction of switch-based buttons. A generic joystick has a straightforward design. A joystick only needs four separate switches to work, each of which corresponds to a distinct direction (Lu, 2003).

When the joystick is pushed in a specific direction, a small metal disc makes contact with the circuit board, turning the switch on and creating an electrical signal that signals the joystick has been moved. To regulate firing, an extra switch can be provided (Lu, 2003). The so-called digital joysticks were based on this architecture, in which the switches were either on or off.



Figure 2.1 A simple circuit diagram for a basic joystick (Engdal, Digital joystick connector pinouts)

After Spacewar, button-based controllers remained popular; but, another video game was rapidly gaining popularity. Pong was the name of the game. Pong may be traced back to Higinbotham's 1958 book "Tennis for Two" (Rosenthal, Fun With an Oscilloscope). Magnavox also released a version with the Odyssey, but it wasn't until Al Alcorn and Atari collaborated on a version that Pong truly took off, as it was Atari who popularised home video games. A dot on the screen bounces back and forth between two paddles in Pong, a simple arcade game.

Potentiometers, which were little knobs that moved the paddle up and down on the screen when rotated, have been used to control the paddles on Pong from the game's inception. The de facto paddle controller was included in the first few Atari home systems sold to play Pong due to the game's tremendous popularity (AtariAge, Atari 2600 History). The paddle controller was unique in that it included two potentiometers on two parts of one large controller board, allowing two players to play with one controller (Cassidy, Warlords).



Figure 2.2 The paddle controller. g. (Atari Home Pong)

Fairchild Camera and Instrument debuted the Channel F in 1976, right in the middle of the Pong craze. It was called the Video Entertainment System (VES) and cost around \$170 at the time (Hunter, Player 3: Home Systems). The VES controller sensed the pressure of Pong and had a twistable top that enabled the player to move the controller top to the left or right while offering other buttons to control direction such
as up, down, left, and right. All of this was housed in a controller that looked like a dynamite detonator (Dyer and Webb, Fairchild Channel F Faq). This detonator-like controller, which included a central shaft and spinning features and was influential in the design of the Atari 2600 joystick a year later, was a sufficient departure from paddle controllers of the time.



Figure 2.3 Channel F. (Hunter, Player 3: Home Systems)

Stephen D. Bristow is credited with inventing the first joystick, which comprised of a central shaft and a crucial point. There were numerous different joystick designs by 1978, when Bristow secured the Atari joystick patent. This was partly owing to the ease with which a primitive joystick may be constructed, as discussed above. The Atari joystick was unique in that it included a pivoting centre shaft that made the connections for the five directions (up, down, left, and right) as well as a fire button. (Journey to the Joystick, Yung and Hsu) The departure from the paddle controller maintained the trend initiated by the VES controller in terms of design. When it came to incorporating rotational features in controller design, the pivotal rotation was akin to the twistable top. With the Atari 2600 Video Computer System (VCS) in 1977, Atari introduced the Atari joystick as well as the de facto paddle controller for Pong, paving the way for the first joystick on a video game system.



Figure 2.4 The original joystick patent awarded to Stephen D. Bristow of Atari. (U.S.PatentOffice)

The invention of the directional pad, which followed the joystick, was a necessary step backwards in controller progression. A basic history of Nintendo is required to comprehend the creation of the directional pad. Fusajiro Yamauchi founded Nintendo Koppai in Meiji 22 (1889) to create and distribute handcrafted hanafuda cards. Nintendo officially became NCL – Nintendo Firm, Ltd. – in 1959, following a successful licence arrangement with Disney to create playing cards, and the company attempted to expand into new companies. Gunpei Yokoi was one of the employees employed during this time of growth. Yokoi was employed to maintain the assembly-line equipment that produced the playing and hanafuda cards, but was later transferred to the engineering department to create something for Nintendo to sell for Christmas. With more engineers hired to his department, Yokoi produced Nintendo's first toy, the

Ultra Hand, which is a groping extension of the hand. This project cemented Yokoi's position as he continued to create Nintendo's Ultra series of toys.

In his leisure time, Yokoi continued to make toys, working with circuits and oscilloscopes. Nintendo attempted to enter this new market in the 1970s, with the shrinking of electronics and the rising popularity of video game consoles. Nintendo had previously entered the market in 1977 with the Color TV Game 6, which featured six different Pong-style tennis games. It was followed by Color TV Game 15, but Nintendo's president, Hiroshi Yamauchi, wanted to move in a different path and pressed Yokoi and his engineers to come up with new ways to make video games. Yokoi was inspired by the shrinking of electronic calculators and wanted to capitalise on it (Game Over, 1993). In 1980, Nintendo came out with a game called Game & Watch (History of Nintendo).



Figure 2.5 Game & Watch. (Cuciz, Total Control – A History of Game Controllers)

Originally, Game & Watch comprised of a digital clock, alarm, and a game operated by two left-right switches. The game quickly got more difficult, requiring four directions. Because a joystick-like control on the little gaming unit was not practicable, it was determined that each direction would be controlled by a switch. However, this design made the game uncomfortable because it had the same problem as the original Spacewar in that it wasn't apparent which switch controlled which direction. Yokoi devised a "cross-shaped, thumb-operated, micro-switched lever capable of moving in four directions and addressing up to eight" (Cuciz, Total Control – A History of Game Controllers) to tackle this issue. The directional pad, sometimes known as the D-pad, was born as a result.

With the release of Nintendo's Famicom, also known as the Nintendo Entertainment System (NES) in the United States, the direction pad was finally incorporated into a video game system. Following Game & Watch, Nintendo expanded into coin-operated arcade games, such as Donkey Kong. Yamauchi was motivated by the emergence of home computer systems and the prospect of a computer system disguised as a toy – a so-called Trojan Horse that might enter the home market – while developing coin-op games. While most computers on the market at the time were between \$200 and \$350, Yamauchi sought a system that was cheaper than \$75 and had more features than the competition. All of the frills, including the keyboard, modem, and disc drive, were removed to save money on what is essentially a computer. Because the keyboard was removed, the player needed to find another means to connect with the computer. The Nintendo controller, which has two buttons on the right controller and a directional pad, was created to solve this problem. The directional pad was firmly established in the history of video game systems with the advent of the NES controller (Game Over, 1993).



Figure 2.6 Nintendo NES controller featuring the directional pad.

The directional pad and joystick controller components have been integrated into one controller since the debut of Sony's PlayStation dual shock controller. The directional pad and the joystick differed in their control possibilities and trade-offs in various scenarios, although sharing the same history. The early joysticks, for example, were more prone to damage than the directional pad, although having a broader range of motion. The PlayStation's dual shock controller had a directional pad, two joysticks, and a slew of buttons (14 buttons to be exact, including the directional pad). The twin shock controller's joysticks were analogue, unlike the original Atari digital joystick. Analog joysticks descended from digital joysticks and differed in that two potentiometers – similar to those found on the original Pong controllers – were attached to the joystick to measure how far the joystick had moved in both the horizontal and vertical directions, allowing the switches to be toggled on and off based on how far the joystick was moved. Furthermore, these joysticks featured force feedback, which meant that each joystick had two motors controlled by a CPU that could make the stick move in a certain direction when needed (Tyson, How PlayStation Works).



Figure 2.7 Sony PlayStation Dual Shock Controller (Tyson, "How PlayStation Works)

Most current controllers are based on this concept, and include two joysticks, a directional pad, and a variety of additional buttons. The placement of various features varies depending on the design and user testing, resulting in a unique controller design for each platform. The directional pad and joystick have their own distinct locations in today's controllers due to the various types and levels of control they provide, as well as the tradeoffs they provide. The necessity for controllers and the design of controllers gradually evolved from the simple beginnings of Spacewar, giving rise to the directional pad and the joystick, which combined create the controllers we have today. Despite the fact that technological issues contributed to the growth of each of the controller aspects, today's controllers do not suffer the same issues. Instead, there is more leeway, allowing for more creative design. Knowing how these aspects have developed allows developers to create new controllers that benefit from improved design.

Until now, the design of the game controller has been nearly identical to that of the dual shock controller. However, some aspects, such as the rubber or plastic analogue and the position of the buttons, may alter.

#### 2.9 Anthropometry

This obsession is referred to as anthropometry in technical terms. It is the assessment of the physical characteristics of the body, and these characteristics may be used as variables in epidemiology, psychology, and anthropological investigations. The ability to accurately characterise our current health, as well as make predictions about outcomes as diverse as our physical attractiveness, ability to reproduce, and long-term survival, should be enabled by precise and unambiguous measurements of the body's physical dimensions and underlying composition (Matejovičová et al., 2014)

Anthropometry is the science of measuring the human body in terms of bone, muscle, and adipose (fat) tissue measurements. Individuals with high subcutaneous adipose tissue levels have been linked to an increased risk of hypertension, adult-onset diabetes mellitus, cardiovascular disease, gallstones, arthritis, and other diseases, as well as cancer (岩澤, 1988) (Iwazawa, 1988).

Furthermore, within applied anthropometry, a differentiation is created based on the procedures utilised to collect the raw data. The first segment focuses on traditional anthropometric data gathered with traditional procedures and devices such as anthropometer, personal scale, spreading caliper, pelvimeter, sliding caliper, soft metric tape and caliper. Traditional anthropometric devices offer one-dimensional measurements of the body or its portions, such as forearm length. They can also deliver measures along a plane of a two-dimensional bodily characteristic, such as the diameter of the skull. The second portion is devoted to the use of various three-dimensional methods for the creation of surface

representations of body shapes. They can also offer surface area and volume measurements, which are difficult to get with typical equipment (Matejovičová et al., 2014).

Anthropometric design guarantees that the user, the equipment, and the environment are all in perfect alignment. Anthropometry is used in ergonomics to improve the fit and function of items during both design and assessment. The fundamental procedure begins with determining the relevant body dimensions. The measuring of abilities associated to job performance, such as reaching, manoeuvring, and mobility, as well as other characteristics of space and equipment, is known as functional anthropometry.

According to Ergonomic risks in sitting and standing workplaces written by I.Grabovac, there are the suggested ergonomics guidelines for sitting work:

- 1) All sitting work should be planned to preserve vertical spine alignment and reduce shoulder stress.
- 2) Provide items that are little below the level of your elbows.
- 3) Heavy hand tools should be avoided.
- The height and tilt of the chair, as well as the height and angle of the backrest, must all be adjustable.
- 5) The height of the computer table, must be adjustable.

For computer gamers who plays video games using computer and game controller, those suggested ergonomics is applicable for them. Tests of dynamic postural control, such as the star excursion balancing test, have been found to be influenced by anthropometric measures, age, sex, and activity level (SEBT). The HSEBT (hand reach star excursion balance test) assesses many components of dynamic postural control. The HSEBT (hand reach star excursion balance test) has been shown to be a viable and reliable instrument for assessing dynamic postural control (Eriksrud et al., 2019). When contrasted to the wellknown star excursion balance test (SEBT), the hand reaches conducted on each foot capture various components of dynamic postural control (Eriksrud et al., 2019). Thus, adjustable table and chair will help to prevent musculoskeletal disorders.

# 2.10 Traditional Anthropometry

The dimensions are employed for numerous design tasks in applied anthropometry. The sort of dimension that should be chosen is highly dependent on the design challenge at hand. One-dimensional data are useful when building a regular gateway or an emergency door for a bus, for example. Complex designs, such as spare car parts frequently need the simultaneous use of many one-dimensional measurements. The two-dimensional head circumferences are useful for making a soft and flexible scarf for the head. A three-dimensional depiction that takes into consideration curvatures and curves would be more suited for constructing a hard-shell helmet for the same head.

When it comes to the posture of working postures, one-dimensional measures are typically the best option because they can be immediately tied to the workspace in issue. The crucial dimension in determining the level of a work surface for a simple standing assembly position, for example, is elbow (or waist) height. Additional measurements would include forward arm reach and maybe abdominal depth if the greatest depth of the work surface is essential (because hitting the work surface with the abdomen can effectively reduce forward arm reach). On the other hand, design for more complex working positions, such as assembly operations in a small enclosed space (as when building ship components, for example) or repair operations that require leaning into the work space (as in automobile engine repair, for example), often necessitates the use of multiple dimensions and is best accomplished with digital human models. Anthropometry and posture are inextricably related. When data is gathered, the subject's posture has a direct impact on anthropometric statistics. The inverse is also true: an individual's anthropometric proportions have a direct impact on his or her posture. For example, when seated in the same chair, a guy who is 180 cm tall and a girl who is 150 cm tall have quite distinct postures. The long man's hand will rest on the desk, allowing him to recline in his chair. The short woman's feet must not touch the ground, and she must not lean on the chair or she will be unable to reach the table. Gamer's spaces should ideally be sufficiently adaptable so that the gamer can adopt a posture that reduces the risk of injury and weariness, however this aim has yet to be realised.

Despite the obvious relationship, however, anthropometry does not always define a precise seated posture in each space. The relevance isn't huge, but it's worth paying attention to. There doesn't seems to be a single anthropometric element that explains the differences in body-balancing motions when standing (Eriksrud et al., 2019). Furthermore, even among people with identical anthropometry, there is a lot of variation in posture. Fatigue, the unique workload, and the individual work environment all contribute to this heterogeneity.

# 2.11 Rapid Upper Limb Assessment (RULA)

Rapid Upper Limb Assessment (RULA) is a strategy for assessing the risk of workrelated upper limb ailments based on postural targeting. A RULA examination provides a rapid and systematic evaluation of a worker's postural hazards. The analysis can be done before and after an intervention to show that it was successful in reducing the risk of damage (*Rapid Upper Limb Assessment (RULA) - A Step by Step Guide*, n.d.).

RULA was developed to evaluate individual worker exposure to ergonomic risk factors linked to upper extremity MSD. The biomechanical and postural load needs of occupational tasks/demands on the neck, trunk, and upper extremities are taken into account by the RULA ergonomic assessment instrument.

According to Mark Middlesworth, (*A Step-by-Step Guide to the RULA Assessment Tool*, n.d.) RULA was created to be simple to operate without requiring an extensive degree in ergonomics or costly equipment. The evaluator will provide a score to each of the following body parts using the RULA worksheet: upper arm, lower arm, wrist, neck, trunk, and legs. Following the collection and scoring of data for each location, tables on the form are utilised to assemble the risk factor variables, resulting in a single score that indicates the amount of MSD risk as outlined below:

RULA Grand Score	Decision about Posture
1-2 <mark>⊭</mark>	Posture is acceptable if it is not maintained or repeated for long periods.
3-4 Takanna	Further investigation is needed and change of posture may be required.
بيا ملاك6-5	Further investigation and changes are required soon.
74UNIVERS	Investigation and changes are required now

Figure 2.8 Level of MSD risk

RULA is a method for analysing risk factors to the upper extremities of the manikin, or human in the actual physical environment in DELIMIA V5. The RULA analysis measures the following risk factors:

- 1) Body posture
- 2) Number of movements
- 3) Force

- 4) Repetition task
- 5) Time worked without a break

After measuring these risk factors, a final score is provided in the form of a number

between 1 and 7 indicating the following:

- RULA score of 1 or 2 implies that if a position is not maintained or repeated for an extended length of time, it is okay.
- RULA score of 3 or 4 suggests that more research is needed and that modifications may be necessary.
- RULA score of 5 or 6 signals that further study and modifications are imminently necessary.
- RULA score of 7 plus suggests that quick inquiry and modifications are necessary.

### 2.12 Summary of Literature Review

Ergonomics was developed as a result of the design and operational difficulties that have arisen as a result of technology improvement over the previous decade. The goal of ergonomics is to create an environment that is well-suited to a user's physical needs. Ergonomics it is commonly applied to the workplace environment. With all of the criteria, we can conclude that ergonomics is concerned with the fulfilment of the workplace, ensuring that the environment is well-organized and safe. A well-balanced between end-task user and demands may be implemented with effective work system design and ergonomics. For computer gamers who plays video games using computer and game controller, those suggested ergonomics is applicable for them. Work-related musculoskeletal disorders (WMSD) are situations in which the work environment and job performance play a substantial role in the development of the condition, and/or the ailment is made worse or lasts longer as a result of the work environment. RULA was developed to evaluate individual worker exposure to ergonomic risk factors linked to upper extremity MSD. RULA is a strategy for assessing the risk of work-related upper limb ailments based on postural targeting. On the other hand, design for more complex working positions.



#### **CHAPTER 3**

#### METHODOLOGY

#### 3.1 Introduction

The main of this chapter are about explaining the methodology for this project from the starting until the product are ready to be used. Presently, the most commonly smartphone users posture (Figure 3.1) and, the most commonly smartphone gamers posture (Figure 3.2). This project is focus to improve the design of the current hand support stand by minimize the pain or injury while playing games.

The methodologist that will be used in this project are:

- 1. Research study
- ويوم سيتي تيڪنيڪل ملد Collecting data
- 3. Analyzing the data TEKNIKAL MALAYSIA MELAKA
- 4. Design a new product
- 5. Develop new product

Before using CATIA software to analyze the hand posture issue, a statistical study will be conducted to identify the user population and serve as a catalyst for creating a new ergonomics design for this project.



Figure 3.1 Most commonly smartphone user's posture



Figure 3.2 Most commonly smartphone gamer's posture

# 3.2 Research Methodology

Figure 3.3 depicts the analysis approach used for this project from the beginning to the end. The flow chart simplifies the steps that will be taken to complete this project, starting with the first step and continuing with what will be done with the next step until the final step. The flow chart also includes the project's most critical move.



Figure 3.3 Flowchart of project planning

#### **3.2.1 Identify Problem**

Identifying the problem entails determining the source, the consequences, and the best solutions that can be devised to resolve the problem. Before deciding on a solutions, the relation data must be obtained in order to identify the problem. After identified the cause and effect, try to come up with the best solution for resolving the problems.

#### **3.2.2 Background Research**

Background study focused on learning more about the challenges in general. Aside from it, background research focused on prior studies was carried out. Journals, books, the internet, and newspapers are all helpful reasons to find for research. While saving time and money, this technique focuses more on identifying the most effective solution to the problem. In this situation, there will be so many unquestionable question you need to find the answer.

Data accumulation of repetitive stress injury was search to complete the task about people having pain while using their phone without applying the correct posture in a long time of time. How long the time taken for user to start having the pain and what the cause of those pain.

Statistical analysis of repetitive stress injury data was gain to analyze which part of body effect the pain and which type of work and posture effect the most. Data collection on current game device used by gamers will help on the time period. The gamers usually play games on their phone more than one hour. This method is to observe the first changing posture in one hour period of time.

# 3.2.3 Conceptual Design and Development for Ergonomics Adjustable Hand Stand Support

Following the data collection, the following stage is to determine the ergonomics adjustable hand stand's conceptual design and turn it into a product. Before the improvement can be made, this process will require a few stages. The dimensions of the present hand support device will be used to create a more ergonomically adjustable hand stand support.

#### 3.2.4 Analyse Data Using RULA in CATIA

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The RULA technique will be used to assess the risk of work-related upper-limb illnesses via data collecting and postural targeting. As a result, the ergonomically adjustable hand stand support that will be developed will be more beneficial to the user than the existing hand stand support.

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#### 3.3 Proposed Methodology

The main purpose of proposed methodology is to clearly explain detailed of how to accomplish this project's objectives. The attention of this project is to develop of a new ergonomics adjustable hand stand support that capable to comfort the users and reduce the amount of pain that the user gain for using phone in a long time of period. As the reference to produce a better ergonomics products, current console used by the gamers that can be observed from online gaming were adopt. Gathering data, analyzing process, rewriting the analyzing process, and then developing a new ergonomics gaming controller are some of the strategies that will be used in this project.

#### 3.3.1 Experimental Setup

The role of gathering data is to identify the population of gamer who use a gaming controller that is connected to a smartphone, as well as to obtain information, that will be used to develop guidelines for redesigning a hand stand support that is acceptable and pleasant for gamers. The data were gain by spreading the questionnaire about typical gamer's problems while playing games. The numbers of samples to make through are more than 50 people.

The statistical study begins with data collection and is followed by an RULA examination of the gaming controller's ergonomics condition. After receiving the result, or RULA analysis, the fault will be identified, and the RULA analysis of the gaming controller will be revised. Before the proportion of the gaming population can be determined in statistical analysis, the normal distribution must evolve. The percentage will be combined with the dimensions of the gaming controller to determine the hand issue. The results of the RULA analysis will then be used to finish the analysis procedure. The revising process is done by changing the dimension of the game controller.

The last method of this project is the development of new ergonomics hand stand support. In this procedure, a questionnaire for the player in FTKMP will be provided. The goal of this survey is to get input from gamers on the new product that will be developed as part of this project. The house of quality is established based on the feedback in order to link it to the engineering description. Finally, the ergonomics hand stand support design may be created.

To get the accurate dimension and the weight of the controller is not a big deal because the controller is standard item in market. To choose the suitable controller is quite difficult because in this Covid pandemic era, those things will be selling online. To get the best result, three different controller will be measured with different feature.

#### 3.3.1.1 Equipment

There's are only three types of material that are be using in the process to complete this project. The materials are the equipment of measurement, the parts of project and CATIA V5 software. For equipment of measurement, there will be use is digital Vernier caliper and measuring tape while parts of project is game controller. Those of this measurement equipment are used to measure dimension of the hand place on the game controller and the size suitable for gamer to hold the game controller. Figure 3.4 shows the measuring equipment use in this project to measure parts of the game controller. CATIA V5 software is needed to analyze the gamer population with the current game controller dimension.



Figure 3.4 Measuring equipment

# 3.3.1.2 Parameter

The purpose of the measuring equipment that will be used in this project is to measure the body dimension of the game controller and the gamer finger. The measurement that need to use this measuring equipment is about 12 parts of hand gesture dimension on the game controller. Digital venier caliper is used to measure the buttons on the game controller while measuring tape is to measure the whole dimension of the game controller.

The ergonomics prospect with study for the game controller is described by the CATIA software. This software is being used to address an issue of ergonomics. The software that will be utilized to produce anthropometry data and assess for ergonomics prospects is shown in Figure 3.5.



Figure 3.5 Playing games anthropometry Source: Heba Muhammad Abou El-Nasr (February 2016)

# 3.4 Limitation of Proposed Methodology

In this project, numerous processes will be carried out. Take the weight of the gaming controller first, then measure the length and width of the controller. All of the present controller's dimensions should be recorded, and then this information should be converted into a perfect drawing. Next, for the measurement operations, gather anthropometric data from gamers who spend an hour or more each day playing games. Following the collection of those data, both will be entered into CATIA software for analysis.

The dimensions of the current game controller, such as height, breadth, thickness, and other elements of the specifications that are included in this current game controller design, are generally taken for measurement. After that, all of these dimensions will be converted and drawn in Solidworks before being converted into CATIA software. In order to define the ergonomics idea of the hand stand support, the drawing must be used in conjunction with anthropometric data throughout the analysis phase.

There will be ten gamers who will be measure their body measurements using a game controller. The technique of measurement is detailed in table 3.1, and each sample will have 25 hand and finger dimension measurements performed in this process. Three anthropometric measures for body dimensions will be obtained, with the average for each sample being calculated before the standard deviation is calculated. The dimensions are distributed in a normal distribution, and statistical analysis was used to determine the population of players.

	WALAYSIA						
No	Variable	Method of Measurement					
1	Body weight	Subject stands on weighing scale					
1.		Subject stands on weighing seale.					
2.	Stature	Vertical distance from the floor to the highest point					
	*samo	the head (vertex). Subject stands erect with feet					
	مليسيا ملاك	together with heels, buttocks, shoulders, back of head					
	UNIVERSITI TE	touching a vertical surface.					
3.	Eye Height	Vertical distance from the floor to the outer corner of					
		the eye. Subject stands as above.					
4.	Shoulder Height	Vertical distance from the floor to the acromion.					
		Subject stands as above.					
5.	Elbow Height	Vertical distance from the floor to the lowest bony					
		point of the bent elbow. Upper arm hangs freely and					
		elbow is flexed 90 degrees.					
6.	Fist (grip axis) height	Vertical distance from the floor to the grip axis of the					
		fist, with the arms hanging freely.					

Table 3.1 ISO list of anthropometric variables (ISO/DIS 7250)

7.	Vertical Grip Reach,	Vertical distance from the standing surface to the center
	standing	of a cylindrical rod firmly held in the palm of the right
		hand, with the right arm and wrist extended upward.
8.	Shoulder (biacromial)	Distance along a straight line from acromion to
	breadth	acromion.
9.	Elbow-to-elbow breadth	Maximum horizontal distance between the lateral
		surfaces of the elbow region.
10.	Sitting height (erect)	Vertical distance from a horizontal sitting surface to the
		highest point of the head (vertex). Subject sits against a
	WALAYSIA	vertical surface thighs fully supported and lower legs
	and the second	hanging freely.
11.	Eye height, sitting	Vertical distance from a horizontal sitting surface to the
		outer corner of the eye. As for standing but in the seated
	ann	posture above.
12.	Shoulder height, sitting	Vertical distance from a horizontal sitting surface to the
	UNIVERSITI TE	acromion MALAYSIA MELAKA
13.	Elbow height, sitting	Vertical distance from a horizontal sitting surface to the
		lowest bony point of the elbow bent at a right angle
		with the forearm horizontal. As for standing but in the
		sitting position above.
14.	Elbow Grip Length	Horizontal distance from back of the upper arm (at the
		elbow) to grip axis, with elbow bent at right angles.
15.	Grip reach; forward reach	Horizontal distance from a vertical surface to the grip
		axis of the hand while the subject leans both shoulder
		blades against the vertical surface.

16.	Hand Length	Perpendicular distance from a line drawn between the					
		styloid processes to the tip of the middle finger.					
17.	Hand breadth at metacarpals	Projected distance between radial and ulnar					
		metacarpals at the level of the metacarpal heads from					
		the second to the fifth metacarpal.					
18.	Hand Thickness	Thickness of the hand at the level of middle portion					
		(circumference passing over the metacarpal joints)					
19.	Thumb breadth	Breadth of the thumb on the right hand measured when					
		is extended					
20	Index finger breadth,	Maximum distance between medial and lateral surfaces					
	proximal	of the second finger in the region of the joint between					
	LER V	middle and proximal phalanges. Distance from tip of					
	Links and	2 <sup>nd</sup> finger to the proximal skin furrow between digits.					
21.	Head Length	Distance along a straight line between the glabella and					
	مليسيا ملاك	the rearmost point of the skull.					
22.	Head Breadth VERSITI TE	Maximum breadth of head above the ears, measured					
		perpendicular to the midsagittal plane.					
23.	Head Height	Measure the linear distance from the bottom of chin to					
		the highest point (vertex) on the top of the head					
24.	Head circumference	Maximum, approximately horizontal, circumference of					
		head measured above the glabella and crossing the					
		rearmost point of the skull.					
25.	Wrist circumference	The circumference of the wrist between styloid process					
		and the hand, with the hand outstretched.					

Source: Journal of Human Ergology (Karmegam et al., 2011)

After collecting all of the existing game controller measurements and anthropometric data, the analyzing procedure may begin using the CATIA software. By utilizing this software, the present game controller's measurements will be converted and drawn, and the drawing will be used in conjunction with the anthropometric data. The virtual human is built at random using anthropometry, and the ergonomics of the present gaming controller will be tested. Following the collection and scoring of data for each location, tables on the form are utilized to assemble the risk factor variables, resulting in a single score that indicates the amount of MSD risk. After measuring these risk factors, a final score is provided within the kind of variety between 1 and 7. Table 3.2 shows the RULA grand score and the decision about the posture.

RULA Grand Score	Risk Level	Decision about Posture
املاك	کل مایس	Acceptable working posture.
3-4 UNIVER	SITI TEKNIK. Intermediate	Further investigation is needed and change
		may be required.
5-6	High	Prompt investigation and changes are
		required soon.
7+	Very High	Immediate investigation and changes are
		required.

Table 3.2 RULA grand score and decision about posture

Source: Hayati Kadir Sahar (CUergo\_RULA, n.d.)

Finally, the design and development of a new ergonomics hand stand support is the project's last step. The conceptual design is based on the gamer's needs throughout this procedure. The concept of a new hand stand support is crucial for all users to find comfort when playing games for long periods of time without risking injuries due to ergonomics. The new hand stand support design will next undergo the same stages as the present hand support to guarantee that it is ergonomically sound.



#### **CHAPTER 4**

#### **RESULTS AND CONCLUSION**

# 4.1 Introduction

In this chapter, the procedures for completing this project have been finalised, and their findings have been addressed in relation to their conclusions. Statistical analysis, conceptual design, new product design, and RULA analysis are some of the strategies that were employed to finish this project successfully. The discussion was held in response to the findings of the analysis, which was ongoing at the time.

4.2 Statistical Analysis of Human Anthropometric Data

The anthropometric data of gamers has been searched and analysed in order to determine their percentile ranking. Based on that percentile, the existing phone holder will be subjected to design study in order to define the ergonomics aspect of the product. The percentiles of the gamers are shown in Tables 4.1 in this section.

No.	Body Part	М	SD	Percentile		
				5 <sup>th</sup>	50 <sup>th</sup>	95 <sup>th</sup>
1.	Forward Functional Reach					
	a. Includes body depth at shoulder	64.96	10.82	47.161	64.960	82.759
	b. Acromial process to functional pinch	56.58	4.678	48.885	56.580	64.275
	c. Abdominal extension to functional pinch	51.59	2.867	46.874	51.590	56.306
2.	Abdominal Extension Depth	19.76	4.511	12.339	19.760	56.306
3.	Waist Height	100.10	4.025	93.479	100.10	106.721
4.	Tibial Height	48.65	3.700 بینی بیا	42.564	48.650	54.737
5.	Knuckle HeightERSITI TEKNIK	73.00 A	9.365 A	57.595	73.00	88.405
6.	Elbow Height	105.40	5.007	97.163	105.40	113.637
7.	Shoulder Height	139.20	5.481	130.18	139.20	148.216
8.	Eye Height	156.40	10.14	139.72	156.40	173.08
9.	Stature	170.30	5.602	161.09	170.30	179.515
10.	Functional Overhead Reach	203.00	9.559	187.28	203.00	218.725

11.	Thigh Clearance Height	13.10	2.031	9.759	13.100	16.441
12.	Elbow Rest Height	17.62	2.314	13.813	17.620	21.427
13.	Midshoulder Height	59.62	10.77	41.093	59.620	77.337
14.	Sitting Height Normal	83.97	14.26	60.512	83.597	107.428
15.	Knee Height	52.23	5.992	42.373	52.230	62.087
16.	Popliteal Height	45.38	3.893	38.976	45.380	51.784
17.	Elbow to fit length	36.91	3.175	31.687	36.910	42.133
18.	Upper Arm Length	36.36	3.245	31.022	36.360	41.698
19.	کل ملبسیا ملاک Shoulder Breadth UNIVERSITI TEKNIK	44.39	3.364	38.856	44.390	49.924
20.	Buttocks to Popliteal Length	45.02	3.085	39.945	45.020	50.095

Anthropometric data was collected for 20 different areas of the human body to determine its dimensions. For the purpose of ergonomics study, these human body sections will be imported into the CATIA programming. A statistical analysis was performed on the data collected in order to determine the percentile. The percentiles that were chosen were the 5th percentile, the 50th percentile, and the 95th percentile, respectively. The normal distribution for each body dimension will be obtained by processing all of the data that has been gathered in the statistical analysis procedure, which will take many hours. The normal distribution may be used to calculate the mean and standard deviation, which can be obtained from the percentile of body dimensions for gamers.

Based on the anthropometric data acquired, a new idea of ergonomics hand stand will be designed with the use of the data collected and utilized as guidance. In most cases, various persons will have distinct physical sizes and dimensions than one another. As a result, the percentiles that were selected are based on the way in which the persons utilized their handphones while doing a handstand. The notion of using an ergonomics hand stand is for all gamers of any size, as long as they can utilize the handstand correctly and in excellent shape without experiencing any difficulties. As a result, it is critical to carefully choose the percentiles that will be utilized to verify that they are suitable for the product. In this case, the acceptable percentile to utilize will be the average of the database, which corresponds to 50th percentile for this project. The reason why I picked the 50th percentile as the primary database for this project is because persons who utilized the handstand had varying anthropometric characteristics, despite the fact that they would all use the same handstand to play games. Because of this, the 50th percentile of the anthropometric database was selected to guarantee that gamers can use the ergonomics hand stand comfortably, regardless of their body size or gender.

#### 4.3 Results of Questionnaire

In order to finish this research, a questionnaire was chosen as one of the techniques of collection. Essentially, the goal of the questionnaire is to determine the level of student worry about certain requirements. In this project, a group of people from Facebook are invited to participate in a questionnaire session in order to get some information about them as well as about any problems that may arise during the use of the present hand stand, which is being developed. Gamer needs will be taken into consideration while developing an improved hand stand based on the findings of this questionnaire, allowing them to use the gadget more comfortably.

More than 50 people were asked to respond to the surveys in order to get feedback. Section A and Section B of this questionnaire are the two components that make up the whole questionnaire. Section A of this questionnaire asks for basic information about plople as well as an ergonomics study of how they using their smartphones. Section B, on the other hand, is more concerned with the state of gamers' condition when they utilize the existing hand stand while playing games. The final findings of the questionnaire, which was filled out by gamers, are displayed in the table and graph below, respectively. (Refer to the questionnaire - Appendix D).

#### (A) Gamers Basic Information and Ergonomics Analysis While Playing Games

Figure 4.1 depicts the age information collected from 63 people via the use of a questionnaire. According to the statistics, the majority of the candidates are between the ages of 18 and 25, followed by the next age group, which is between 26 and 30 years old. 31 and older had just 2 percent of the data, while 18 to 25 year olds held 57 percent of the data (36 gamers) and 41 percent of the data (26 players), which were held by those between 26 and 30 years old, respectively.



Figure 4.1 The information about the players' ages

Figure 4.2 depicts the information pertaining to the applicants' gender identities. The bulk of the population is owned by women, who are represented by 44 candidates, with the remaining candidates being male.



Figure 4.2 Information of the gamer's genders

The comfortability of using smartphone was recorded in the data below (Figure 4.3). Most of the candidates was comfortable when using smartphones. Only 6 candidates were not comfortable when using smartphones.



To be more specific, the applicants were questioned about if they had games on their phones. And the outcomes were exactly what had been predicted by the pie graph (Figure 4.4). From the data, 58 respondent have games in their phone out of 63 respondent.


In order to get the best findings, the applicants were questioned about their level of activity when participating in games. The information's was exposed in Figure 4.5. This will aid in the achievement of spectacular outcomes with the new ergonomic hand stand. Only 5 people out of a total of 63 respondents are not actively participating in gaming.



Figure 4.5 The data of the candidates actively participating in gaming

The next piece of information pertains to the gadget that applicants use while participating in games. Some folks enjoyed playing video games on their laptops or personal computers. The proportion of people who use their smartphones to play games is larger than the proportion of those who do not.



Figure 4.7 depicts the frequency with which the applicants engaged in game-playing activities. According to the statistics, those who spent 3 to 5 hours per day playing games received the highest ranking, followed by those who spent not more than 2 hours per day playing games. It is then followed by more than 5 hours everyday, once every few days and then once a week or fewer.



Figure 4.7 Frequency of the candidates playing games

The kind of gamer is the most important thing to ask in order to get the greatest results from a decent and high-quality ergonomic handstand product. According to the results of Figure 4.8, casual players who play games for pleasure took top position among the rest of the participants. The second position went to the competitive players who wanted to develop their abilities even more than the first. As can be observed, there isn't a single professional player among the contestants who is actively seeking to win the tournament.



Figure 4.8 Data of type of gamers

The condition of the applicant is the primary reason for administering this questionnaire. An excellent ergonomic product may be created as a consequence of the findings. It is possible to gain the painful regions of the body as a consequence of the outcome. The end outcome is seen in Figure 4.9.



Figure 4.9 The result for comfortable and uncomfortable when using smartphone

Data on applicants' pain while using a smartphone was collected, and then the following set of data was acquired to establish which body parts were the most impacted by using a smartphone. It was decided to evaluate the applicant's injured body parts, and the findings are given in the following section.



UNIVER Figure 4.10 Data of injuries body part MELAKA

## (B) Current Hand Stand in Market Place

Following the completion of the ergonomic components, the following step is to discuss the current hand stand available on the market. To improve upon the present product, it is necessary to first identify its flaws. Then, using the superior material, test the product to see whether it is the correct approach to proceed. The information provided below pertains to the present hand stand in various states of repair that may be seen in market locations.



Figure 4.11 Data of the comfortability of applicants on current product



Figure 4.12 Data of the current hand stand that offer good position for finger and wrist



Figure 4.13 Data of the current hand stand that offer ergonomics concept



Figure 4.14 The results of the market controller for current hand stand



Figure 4.15 The results of the material for controller for current hand stand



Figure 4.16 The results of the applicants condition when using game controller for current



The next following set of data was gathered in order to design a new ergonomic hand stand. Based on these findings, a new ergonomics hand stand may be introduced at the same time as a new product that meets consumer demand while also including an ergonomics idea in its entirety.



Figure 4.17 The recorded data of what gamers needs for the new product



Figure 4.18 The information from applicants who wants a new product that capable to use anytime







Figure 4.20 The data from applicants who wants a new product that has no limit of uses



Figure 4.21 The results of the applicants who wants a new product that can adjust the heights



Figure 4.22 The data collected of the applicants who wants a new product that can help more in reducing pain



#### 4.4 Conceptual Design

The design was created in accordance with ergonomics measurements that were taken from the present handstand hanphone and used to establish a superior design that was more ergonomically sound. When designing a phone handstand, it is important to consider the dimensions of the human body in order to guarantee that the consumers feel comfortable when using it. Consequently, to ensure that gamers can score while using an ergonomic product to play games, the ergonomic hand stand proportions must be appropriate for the person who will be using it and the users must be able to adjust with it in a comfortable setting. The opposite is true if the handphone hand stand proportions do not correspond to the person who is using it, with a significant risk of uncomfortable injuries occurring.

#### 4.4.1 Concept Generation

The conceptual design is identified in order to determine the ability of the gamers to be comfortable when utilising a handphone hand stand while playing games for an extended period of time efficiently. This has been accomplished via the brainstorming of the conceptual design, which has been drawn out in order to provide more optimised solutions that are acceptable and comfy for the consumers who will be using it. It was possible to carry out the ergonomics handphone hand stand creation and analysis with the aid of CATIA's RULA ergonomics software. In accordance with the criteria chosen, all conceptual designs will be examined in order to determine if ergonomics factors should be taken into account throughout the improvement design process. The idea design was created based on the responses received from gamers in a survey, as well as the handphone hand stand that is already available in the marketplace.

From the questionnaire, a list of respondents' requirements can be developed, which are:

- a. A hand stand that can reduce body injuries such as shoulder, wrist, arm and fingers.
- b. The design of the hand stand can help gamers perform while playing games.
- c. Gamers or users can use the handstand comfortably according to their size.
- d. The design of the hand stand must consider about the user's shoulder, wrist arm and fingers to make sure it's in comfortable condition.

The main idea is making the hand stand with adjustable height as anthropometry for every respondent are varies. One of the ideas is shown in Figure 4.23. This conceptual hand stand hanphone will be intersect with the table using clip and has interchangeable angle with adjustable height by using screws for each level. Several things need to consider ensuring the stability of the hand stand. One of the considerations is the distance between hands as it is difficult to ensure the interval that is set can meet everyone's satisfaction. The balancing and the pressure that can be withstand by the hand stand. The depth of the hole also needs to be measured to ensure the hand stand will stay still when high force is exerted at all edges. Last but not least, material selection is also one of the important keys to consider the structural frame of the hand stand needs to be sturdy. Using heavy material as the base will solved this problem.



Figure 4.23 First idea of adjustable height hand stand.

An assembly idea was used for the second conceptual design, which allowed for the change of the hand stand height. The concept for this table was derived from a seat flip up table with a storage compartment. When users are seated on the floor, they just open the hand stand and utilise it as needed. If the gamers need to use the hand stand when standing, they may simply attach the shaft to the slot on the back of the hand stand that already exists. Figure 4.24 shows an illustration of the mechanism. Some of the reasons for the unavailability of this design are because individuals have varying body dimensions. There are just two options for the adjustment, sit or stand. This will make it difficult for the user who does not have a hand stand that is the proper size. When users or gamers use the device while standing, the balance will become problematic.



Figure 4.24 Second idea of adjustable hand stand

The third and last design for the hand stand, which is the final idea, will be assembled from simple parts. In order to build a full hand stand, there will be eight pieces in total. This hand stand was created particularly for gamers who played games on their phones while sitting at a table. Figure 4.25 explained about the design. This hand stand may be adjusted to the user's comfort level by adjusting the height of the stand. This hand stand will be locked at the heights that the gamers choose to use it at. The hook will secure the handphone's balance, resulting in an improvement in overall stability. The basis of this design is the most important component. The base was constructed of a solid material to ensure that the product's stability could not be questioned.



Figure 4.25 Third idea generation

## 4.5 3D Modelling in CATIA V5

The third idea generation has been selected as the improvement of the current hand stand handphone. All the figure will be displayed in diametric and isometric view. The exact dimension for the components can be referred to Appendix B.

#### 4.5.1 Base

Figure 4.26 shows the base of the hand stand. The base is the main component of this new ergonomic hand-stand handphone. The base is the component to ensure the stability of this new ergonomic product. The material used by these components is mild steel.



Figure 4.26 Isometric view of the base

## 4.5.2 Bottom Stick

Figure 4.27 shows the bottom stick of the component. The bottom stick will attach with the base on the bottom and attach with the top stick for the top. The material chosen for the bottom stick are stainless steel.



## 4.5.3 Stick Lock

Figure 4.28 shows that the stick lock which designed to grip the adjustable of the heights of the hand stand. The material chosen was plastic because it will help in reducing weight of this new ergonomic product.



# 4.5.4 Top Stick

Figure 4.29 shows the top stick of the component which designed to increase the height of the hand stand. The top stick will attach with the hook connector. The material chosen for the top stick are stainless steel.



## 4.5.5 Hook Connector

Figure 4.30 is a hook connector that can be assembled. When connecting the hand stand, the hook connector will be attached to the top stick at the bottom, while at the top, the hook connector will be attached with a hook. The material chosen for hook connector was plastic.



4.5.6 Hook

Figure 4.31 is a hook that control angle of this product. It is attached to the phone holder with a hook connection at the bottom and to the hook connector with a phone holder at the top. Grip lock components are placed between the hook and the phone holder, allowing the hook and the phone holder to be locked together so that they adhere to one another.



UNIVERSITI – Figure 4.31 Isometric figure of a hook

# 4.5.7 Grip Lock

Figure 4.32 is a grip lock components that are placed between the hook and the phone holder. The function of the grip lock is to lock the hook and the phone holder to one another.



## 4.5.8 Adjustable Phone Holder

In Figure 4.33, you can see an adjustable phone holder that connects using a hook and grip lock system. The phone holder's primary function is to hold the phone when users or gamers are using their phones to play games. The plastic used in the construction of the adjustable phone holder. The material was selected for its ability to ensure the user's safety. This will protect consumers from receiving an electric shock while they are using their phones while they are charging.



Figure 4.33 Isometric view of an adjustable phone holder

# 4.5.9 Assembly of new ergonomics hand stand handphone

Figure 4.34 shows the assembly of the component. All eight parts in total have been assembled together to make it a single product.



Figure 4.35 shows the real photo of the product which is new ergonomics hand stand handphone.



#### 4.6 RULA Analysis by using CATIA software

RULA analysis is used to figure out how much exposure each individual worker has to ergonomics risk factors that can cause upper extremity MSD. CATIA V5 software has been used to finish the analysis process. RULA analysis has been used. For this part of the analysis, the hand stand handphone is drawn with the help of CATIA and is based on the height of the current hand stand handphone. Manikins (human bodies in CATIA V5) were made. The manikin's body size was set to the percentile that came from a database of gamers' anthropometry (refer to Table 4.1). CATIA was used to draw the general shape of the chair with the lowest height. Finally, the RULA analysis will be applied on the manikin that which is set in sitting posture.

Before beginning the RULA analysis of sitting position, it is necessary to assemble the current hand stand handphone, the manikin (human body in CATIA V5), and the chair together. Then, utilizing the computer table, the manikin (human body in CATIA V5) will be set up in a sitting position for testing. The posture that is configured in CATIA will correspond to the way that gamers often position while playing games on a table with a handstand and a handphone. This will be followed by the establishment of the RULA analysis for the state of the playing handphone posture. The results of the RULA analysis will be shown in the figure below. The same procedures that were employed in the analytical method will be applied in the redesign of the ergonomics computer table as well.

Before doing the RULA analysis for the current computer table and the redesign ergonomics computer table, the body dimensions of the manikin (human body in CATIA V5) need to be modified by referring the percentile of gamer's database.

RULA analysis is used to evaluate required body posture, force, and repetition. Based on the evaluations, each body region of scores are entered for the upper arm, lower arm, wrist, neck, trunk and legs. Figure 4.41 and Figure 4.42 show the complete RULA analysis of gamers who used the current hand stand table with sitting posture in CATIA V5 software. In RULA analysis, there are 4 levels show the score that represents the level of MSD risk as outlined below:

a. Level 1 - (RULA score of 1-2) indicates negligible risk, no action required.

b. Level 2 - (RULA score of 3-4) indicates low risk, change may be needed.

c. Level 3 - (RULA score of 5-6) indicates medium risk, further investigation, change soon.

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d. Level 4 - (RULA score of 7+) indicates very high risk, implement change now.

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4.6.1 Sitting posture while using hand stand handphone on a table

Figure 4.36 shows the isometric view of the manikin sit on the chair while using hand stand handphone on a table in CATIA V5 software.



Figure 4.36 Sitting posture while using hand stand handphone on a table in isometric view

Figure 4.37, Figure 4.38, Figure 4.39 and Figure 4.40 show the top view, front view, side view and rear view of the manikin sit on the chair while using the current the current hand stand handphone in CATIA V5 software.



Figure 4.37 Top view



Figure 4.38 Front view





Figure 4.39 Side view

Figure 4.40 Rear view

This manikin is set as sitting posture and facing with hand stand. The results in Figure 4.41 indicate result for left hand. For left hand posture result, the final score of the manikin is 5 which indicated in orange. The problems occurred at wrist, wrist and arm, muscle, neck, trunk and leg. So, the final score for this side indicates medium risk posture needs to do further investigation and some parts need to change.

For the result of right hand side part is shown in Figure 4.42. The final score of manikins using the hand stand handphone is 5 (orange color as indicator). The problems occurred at forearm, wrist and arm, muscle, neck, trunk and leg. So, the final score for this side indicates medium risk, further investigation is needed, and the posture of the problem parts need to be improved.

RULA Analysis (Manikin current hand stand)	×
Side: 🕢 Left 🔿 Right	
Parameters Details	
Posture + Upper Arm: 1	
Static O Intermittent O Repeated	
Repeat Frequency + Wrist: 2	
O < 4 Times/min.	
Posture A: 2	
Arm supported/Person leaning Muscle: 1	
Arms are working across midline Force/Load: 2	
Check balance Wrist and Arm: 5	
Load: 2kg 🛨 Trunk: 1 🗖	
Score Leg: 1	
Final Score: 5 Score: 5 Score: 6 Score: 6 Score: 6 Score: 7 Score:	
Investigate further and change soon Neck, Trunk and Leg: 4	
WALATSIA 4	Close
State of the second sec	
***AININ	
RULA Analysis (Manikin current hand stand)	× let
Side: O Left S Right	-
Parameters	KA
Static O Intermittent O Repeated Forearm: 2	
Repeat Frequency + Wrist: 2	
O < 4 Times/min. ♥ > 4 Times/min. 📕 Wrist Twist: 1 💻	
Posture A: 2	
Arm supported/Person leaning Muscle: 1	
Arms are working across midline Force/Load: 2	
U Check balance Wrist and Arm: 5	
+ Neck: 1	
+ Trunk: 1	
Score Leg: 1	
Final Score: 5 Posture B: 1	
Investigate further and aban as a see	
Investigate further and change soon Neck, Trunk and Leg: 4	
Investigate further and change soon Neck, Trunk and Leg: 4	

Figure 4.42 The RULA analysis for right hand side

4.6.2 Siting posture using the new ergonomics hand stand handphone

Next, we input a redesign adjustable ergonomics hand stand to run an analysis to test on ergonomics. The analysis process will follow the same as the current hand stand. Figure 4.43 shows the isometric view of the manikin sitting on the chair while using the new ergonomics hand stand handphone in CATIA V5 software.



Figure 4.43 Isometric view of the manikin sitting on the chair while using the



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Figure 4.44, Figure 4.45, Figure 4.46 and Figure 4.47 show the top view, front view, side view and rear view of the manikin sit on the chair while using the current the current hand stand handphone in CATIA V5 software.



Figure 4.46 Side view

Figure 4.47 Rear view
Figure 4.48 and Figure 4.49 show the complete RULA analysis of student with the same sitting position as current hand stand handphone. For the result of left hand side part, the final score of the manikin using the new ergonomics hand stand handphone is 3 (indicated as yellow). After the improvement on the hand stand and also the posture of manikin, the problems for forearm, neck, trunk and leg have been solved which the yellow colour indicator have changed to green color indicator. While wrist and arm color indicator changed from orange to yellow

For the result of right hand side part, the final score of manikin using the new ergonomics hand stand is 3 (indicated as yellow). The improvement of the hand stand and the posture of manikin have minimized the problems for forearm, neck, trunk and leg which the yellow color indicator has changed to green colour indicator while the wrist and arm has changed from orange colour indicator.

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RULA Analysis (Manikin new ergonomic)	×
Side: 🖬 Left 🔿 Right	
	Details
Posture	
Static O Intermittent O Repeated	E E E E E E E E E E E E E E E E E E E
Repeat Frequency	Write 2
O < 4 Times/min, 🕑 > 4 Times/min,	+ Wrist Z
Arm supported/Person leaning	Posture A: 3
Arms are working across midline	Muscle: 1
Check balance	Force/Load: 0
	Wrist and Arm: 4
Load: 2kg	+ Neck: 1
	+ Trunk: 1
Score	Leg: 1 💻
	Posture B: 1
Investigate further	Neck, Trunk and Leg: 2
	Close
کل ملیسیا ملاك	اونىۋىرىسىتى تىكنىچ
RULA Analysis (Manikin new ergonomic)	
Side: O Left SRight	KAL MALAT SIA MELAKA
Parameters	Details
Static O Intermittent O Repeated	+ Upper Arm: 2
Repeat Frequency	+ Wrist 2
O < 4 Times/min.  ● > 4 Times/min.	+ Wrist Twist: 1
	Posture A: 3
Arm supported/Person leaning	Muscle: 1
Check balance	Force/Load: 0
	Wrist and Arm: 4
Load: 2kg	+ INECK: 1
Score	Leg: 1
Final Score: 3	Posture B: 1
Investigate further	Neck, Trunk and Leg: 2

Figure 4.49 The RULA analysis for right hand side

4.7 Current Hand Stand Handphone and New Ergonomics Hand Stand Handphone Test on Respondent

In this section, a respondent have been selected for doing this test to prove that the improvement between the current hand stand and the new ergonomics hand stand. The respondent are the frequent users who use the current hand stand while playing games. Besides that, the respondent also one of the respondents who took part in answering the questionnaire.

### 4.7.1 Respondent A using the current hand stand handphone

Figure 4.50 shows the sitting posture of the respondent while using the current hand stand. The figure below clearly shows that the respondent could be easily get injuries and disorders at many body parts while playing games with the current hand stand due to:

- a) The device is too far from the respondent eyesight that can cause neck injuries.
- b) The current device can't reach the eye level of the respondent.
- c) The wrong position of arm that might due to hands pain.
- d) The posture of body that needs to go further to reach the device that might get back pain.



Figure 4.50 Respondent A using the current hand stand handphone

4.7.2 Respondent using the new ergonomics hand stand handphone

Figure 4.51 shows the sitting posture of the respondent while using the new ergonomics hand stand handphone. The figure below clearly shows:

- a) The device can be adjust followed the users comfortability.
- b) The screen of the phone can reach the eye level of the users.
- c) The correct position of wrist, arm and shoulder.
- d) The posture of respondent's body getting comfortable.



Figure 4.51 Respondent using the new ergonomics hand stand handphone

## 4.8 Comparison of hand stand

For this section, there will be a comparison between current hand stand and the new ergonomics hand stand. Table 4.2 below shows the different between both hand stand.

No	Comparison	Current Hand Stand	Ergonomics Hand Stand
1.	Adjustability		$\checkmark$
2.	Durability		$\checkmark$
3.	Comfortability		$\checkmark$
4.	Space	× −	
5.	Ergonomics		$\checkmark$
6.	Material		
7.	Aesthetic	ىيتى تېكىنىكل	اونيۇس
8.	Easy to use SITIT	EKNIKAL NALAYSIA	MELAKA
9.	Safety		
10.	Productivity		
11.	Performance		
12.	Cost		

Table 4.2 Comparison of hand stand

### 4.9 Costing

For the sake of this pricing section, a comparison between the present hand stand and the new ergonomics hand stand will be made. The current cost of a hand stand was determined via the use of Shopee, but the cost of a new ergonomics hand stand was estimated since the components were purchased and constructed by the creator. The costs for the present hand stand and the new ergonomics hand stand handphone are shown in Tables 4.3 and 4.4 below, respectively. It is more expensive to manufacture the new ergonomics hand stand than it is to manufacture the current hand stand because the current hand stand only uses aluminium for their device, whereas the new ergonomics hand stand has many components and incorporates other materials for safety purposes, resulting in a higher cost.

Table 4.3 Cost of Current Hand Stand Handphone

No	Component	Quantity	Material	Cost
1.	Hand Stand Handphone	1	Aluminium	RM 15.25

Table 4.4 C	ost of New Ergo	nomic Hand Sta	nd Handphone
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No.	Component	Quantity	Material	Cost
1.	Adjustable Grip	1	Plastic	RM 9.70
2.	Base	1	Mild Steel	RM17.00
3.	Bottom Stick	1	Aluminium	RM3.55
4.	Hook Connector	1	Plastic	RM4.30
5.	Hook	1	Plastic	RM3.30
6.	Top Stick	1	Aluminium	RM 3.70
7.	Phone Grip Lock	1	Plastic	RM1.30
8.	Stick Lock	1	Plastic	RM2.70
9.	Silicone	1	Rubber	RM1.90
	RM 47.45			

### **CHAPTER 5**

#### CONCLUSION AND RECOMMENDATION

### 5.1 Introduction

The general overview of the project will be brought to a close in this chapter. The recommendations and suggestions for improvement will be summarized for the sake of the future project. The findings and results from the ergonomics design study of the present hand stand that has been sold in the market were included in the summary of the findings and results. The upgrading of the existing hand stand has been addressed in order to prevent injuries and ailments related with the usage of soft tissues, such as muscles or tendons, uncomfortable posture, and repetitive jobs, among other things. Carpal tunnel syndrome, tendinitis, and various sprains and strains are among the most prevalent types of injuries.

### 5.2 Conclusion

A new ergonomics hand stand is designed and developed. This project is definitely related with the application of ergonomics aspects in designing the new ergonomics hand stand so that it is the process of designing the activity to fit the player, rather than forcing the player's body to fit the activity. In order to reduce physical stress on the body and remove potentially crippling job-related musculoskeletal illnesses, it may be necessary to adjust duties, the work environment, and equipment to match the special demands of gamers (MSDs).

It has been determined that injuries and disorders of the human body posture have occurred as a result of the present hand stand research and analysis that has been carried out. Before identifying the issue, it is necessary to gather all of the anthropometric data from the players involved. Although all of the anthropometric data was evaluated, the anthropometric database among gamers was determined. The present hand stand's dimensions have been measured and drawn with the help of the CATIA V5 modelling programmer. Using the CATIA V5 software, a new manikin has been created, and the measurements of the human body have been keyed in using an anthropometric database that has been created by collecting data from a group of individuals. The manikin was implanted with the present hand stand in order to achieve a more ergonomic working position.

Finally, after identifying the issue with the present hand stand, a new ergonomics hand stand idea is devised and produced into a product for the market. The new ergonomics hand stand is designed to not only suit everyone for excellent working posture, but also to eliminate injuries and diseases associated with poor working position. All of the goals have been met and all the objectives have been achieved.

### 5.3 Recommendation

Following the completion of this study, several suggestions for the future of this project have been suggested. To enhance working posture (both sitting and standing posture), to improve the design of the product, which is a novel ergonomics hand stand, and to include an ergonomics design feature into our daily lives, it is recommended that more research be conducted. In accordance with the findings of the completed RULA study (see Section 4.6), modifications have been made to the present hand stand in order to accommodate the new ergonomics hand stand. In order to achieve a suitable working posture, the posture of several body components has been corrected. However, when it comes to the muscle component, it is the only part that has still recognized the issue, which is shown by the colour red, and it is this part that requires additional investigation (Refer to figure 4.39, figure 4.40, figure 4.46, figure 4.47). Furthermore, it is necessary to do further research on the muscle component and to make improvements to the hand stand design in order for the hand stand to be suitable for every user. Apart from that, research may be carried out to determine the state of the muscular system in preparation for future studies.

For individuals who utilize the new ergonomics hand stand, the eye level with the phone screen is also a concern for them while using the device. Because of the differences in height between users, there is a difference in eye level when looking at the phone screen. The top of the screen is at or slightly below the level of the observer's eyes. Whenever you're looking towards the centre of the screen, your eyes should be slightly downward. Consequently, by developing the new ergonomics hand stand, additional study into the ergonomics of the view should be conducted in the near future.

The last advice is that the study should be concentrated on the feet. Whenever a person sits for an extended period of time without touching the ground, there is always the issue of their feet being lame. Users must increase the height of their chair in order to maintain proper sitting posture because the chair is too high for them to rest their feet flat on the floor or because the height of the table on which the hand stand is placed is too high for them to rest their feet flat on this topic that may be conducted. Instead of a footrest, a small stool or a stack of strong books might be used as a substitute if none is available.

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# APPENDICES

# APPENDIX A























# **APPENDIX B**

(Questionnaire)



# Section A: Design and Development of Ergonomic Hand Stand for Prolong Playing Game for Smartphone Users

Questionnaire to identify the issues that gamers may have when playing games on or off a controller. The results will be examined, and a remedy will be offered to enhance the gaming controller's present danger factor.

 -					
22	0		6.13	TE	2 m
4. Y	-	ч	N. 11	1.1	20

1. 1. Age \*

Mark only one oval.



3. 3. Do you feel comfortable while using smartphone? \*

Mark only one oval.



4. 4. Do you have game on your smartphone?\*

Mark only one oval.



5. 5. Are you a gamer? \*

Mark only one oval.

WALAYS/A

Yes No

6. Do you prefer playing games u	sing handphone?		
Mark only one oval.		er	<b>M</b>
کل ملیسیا ملاق	ٽيڪنيد	ى سىيتى i	اونيق
	<ul> <li>6. Do you prefer playing games u</li> <li>Mark only one oval.</li> <li>Yes</li> <li>Ng Jun oly one oval.</li> </ul>	6. Do you prefer playing games using handphone? Mark only one oval Ves Ng Ng N	<ul> <li>6. Do you prefer playing games using handphone?</li> <li>Mark only one oval</li> <li>Yes</li> <li>Ng Ng N</li></ul>

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7. 7. How often you play games? \*

Mark only one oval.

- Once a week or less
- Once every few days
- 0-2 hours daily
- 3-5 hours daily
- More than 5 hours daily

8. 9. What type of gamer would you say you are?\*

Mark only one oval.

- Casual; you play games more to have fun than to be the best
- Competitive; you play games more to practice your skills and improve
- Pro; you play games to win competitions and show off your skills
- 10. Have you feel uncomfortable or hand injuries while using smartphone for a long period? \*

Mark only one oval.	
Ves MALAYSIA	
No No	UTeM
10. 11. If yes, please tick the injured h	and part that you experienced before. *
Checkell that apply	اونيۈمرسىتى تيكنيە
Thinger number TEKNIK	AL MALAYSIA MELAKA
Thumb pain	
Elbow pain	
Arm Pain	
	The current hand stand state is defined by the player. Rating score:
	1. Not Agree
Section B: Current Hand Stand in	2. Fair
Market Place	3. Satisfying
	4. Agree
	5. Totally Agree

# 11. The current hand stand offers: \*

Check all that apply.

		1	2	3	4	5
Comfortable while playing ga	mes.					
Finger and wrist position in a condition.	good					
The design of the controller in consisting of ergonomics cor	s ncept.					
The material of controller is g and comfort.	bool					
Market controller is guiet goo	d.					
Won't get any injury while using ame controller.	ng ≮≻		P			
What a gamers need in a n	ew prod	luct of ha	indstand:	7 I \ 		
-> 1111	1		5		7.2	
A simple handstand	KNIK	ALMA	LAYSI	A MEL	AKA	
A simple handstand						-
A simple handstand Capable to use anytime Can use anywhere						-
A simple handstand Capable to use anytime Can use anywhere No limit of uses						
A simple handstand Capable to use anytime Can use anywhere No limit of uses. Can adjust the height						

# APPENDIX C

(Hand Measurement)



#### HAND MEASUREMENTS OF MEN, WOMEN AND CHILDREN



HAND DATA		MEN			WOMEN		CHILDREN						
HAND DATA	2.5%tile	50,%tile	97.5% tile	2.5% tile	50.% tile	97.5 % tile	6 yr.	8 yr.	li yr.	14 yr.			
hand length	6.8	7.5	8.2	6.2	6.9	7.5	5.1	5.6	6.3	7.0			
hand breadth	3.2	3.5	3.8	2.6	2.9	3.1	2.3	2.5	2.8	-			
3 <sup>d.</sup> finger lg.	4.0	4.5	5.0	3.6	4.0	4.4	2.9	3.2	3.5	4.0			
dorsum lg.	2.8	3.0	3.2	2.6	2.9	3.1	2.2	2.4	2.8	3.0			
thumb length	2.4	2.7	3.0	2.2	2.4	2.6	1.8	2.0	2.2	2.4			

# **APPENDIX D**

(Gantt Chart)



# 3.2.5 Gantt Chart BDP 1

No.	Project Activity	Expected /								WEE	KS						
		Actual	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Propose tittle of project	Expected															
	1 1 J	Actual															
2.	Define background, problem statement,	Expected															
	objectives and scope	Actual															
3.	Chapter 1 : Introduction	Expected															
	Ĩ	Actual															
4.	Chapter 2 : Literature review	Expected						1									
		Actual								M							
5.	Chapter 3: Research Methodology	Expected					2										
	1/1/10	Actual															
6.	Proposal report	Expected		• .	1						•						
		Actual		statution and the			20	5.	"	2	29						
7.	Revise project report and prepare	Expected					+										
	presentation (BDP 1) UNIVERSIT	Actual	IK/		MA	LA	YS	A	ME	LA	KA						
8.	Presentation (BDP 1)	Expected															
	o. Presentation (BDF 1)	Actual															

# 3.2.6 Gantt Chart BDP 2

No.	Project Activity	Expected /								WEE	KS						
		Actual	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Experiment execution	Expected															
	1	Actual															
2.	Collection data	Expected															
		Actual															
3.	3. Analysis data	Expected															
		Actual			L												
4.	Verification and validation	Expected															
		Actual								V							
5.	Chapter 4: Result and discussion	Expected	1				1										
	AINO	Actual															
6.	Chapter 5: Conclusion and recommendation	Expected		. /	1												
	يسبا ملاك	Actual	~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		-2.0	S		0	2	201						
7.	Complete report	Expected															
	UNIVERSITI	Actual	KA	LI	ΛA	_A'	YSI	AI	ΛE	LA	KA						
8.	Revise project report and prepare	Expected															
	presentation (BDP 2)	Actual															
9.	Presentation (BDP 2)	Expected															
		Actual															

# APPENDIX E

(Type of Current Handstand Handphone)







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# BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA

### TAJUK: Design and Development of Ergonomic Hand Stand for Prolong Playing Game for Smartphone Users.

SESI PENGAJIAN: 2021/22 Semester 1

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Tarikh: 18 Januari 2022

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Sekian, terima kasih.

# "BERKHIDMAT UNTUK NEGARA" "KOMPETENSI TERAS KEGEMILANGAN"

Saya yang menjalankan amanah,

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# CHAPTER 1

### INTRODUCTION

#### 1.1 Introduction Background

Technology nowadays can be access anywhere as long as we have gadget in our hands. The easier yet compact gadget nowadays is smartphone. Handphone had been used for decades. Technology for handphone back then is a basic communication for people. From calling to texting then facetiming. With the passage of time, handphone had been upgraded to a smartphone. Technology on smartphones nowadays is beyond our mind. What had been created by the technologist are something to be thankful in this super busy day. Smartphone never gave unexpected result to the user. Too much activity that someone can do with a smartphone.

Nowadays game is a must for a smartphone users. As we can see, games or e-sport right now had been an international tournament. The gamers can earn a living using games and some earn more than a living. Playing games in a smartphone is much easier for the gamer to practice their skill because smartphone is easy to carry without feeling burdened. Unlike laptop that having a hard situation when the battery drop, we have powerbank to keep on the smartphone. The users can safely use the device while charging.

From my search, there's no product or device that can support the gamer to play game in a long period of time. The existing product only help the gamer to feel more excited while playing online gaming. The gamers still having the problem such as neck pain, back hurt and waist cramp. This will cause the gamer to lose focus.

Nevertheless, to gain smartphone user attention of the new and helpful product is not easy because the existing product advertisement always mislead with the original concept of the product. Unbearable body and finger position will lead to gaming injuries. Studies from Harvard Health Blog, repetitive stress injuries, or overuse injuries, are injuries that come from activities that involve repeated use of muscles and tendons, to the point that pain and inflammation develop. If these injuries are allowed to progress, numbness and weakness can come out, and permanent injury is the outcome. Overuse injuries of the hands and arms are pervasive among gamers.

One common syndrome is carpel tunnel syndrome, which many gamers evolve. Carpal tunnel syndrome, often seen in office workers, involves swelling of a nerve in the wrist, which causes pain and numbness. Gamers can also get tennis elbow, a painful inflammation of the place where the tendon inserts into the bone on the outside of the elbow.

"PlayStation thumb" or now known as "Gamer thumb" arise when the tendons that move the thumb become swollen. The medical phase for this is Quervain's tenosynovitis, and it can lead to lump and limited movement. Gamers are also at risk for trigger finger, or stenosing tenosynovitis, which is when a finger gets stuck in the bent position due to chronic inflammation.

Research from the American Academy of Orthopaedic Surgeons, carpat tunnel syndrome is a common syndrome that cause common condition of pain, numbness, swelling and inflammation in the hand, wrist and arm. The affliction crop up when one of the major nerves to the hand which is the median nerve is squeezed or compressed as it travels through wrist.

In most patients, early diagnosis and treatment are important because carpal tunnel syndrome gets worse over time. Early on, symptom can often be relieved with simple measures like wearing a wrist splint or avoiding certain activities. For some patients who the pressure on the median nerve continues, it can lead to nerve damage and worsening symptom. To forbid everlasting damage, surgery to take pressure off the median nerve may be recommended.

This project is focusing on how to design a device that will preventing the smartphone users or most importantly a gamer to focusing on the game for hours without having pain or damage. The data for this project will collecting by the people who active playing games and the improvement will be made after collecting the data.

#### 1.2 Problem Statement

Based from the observations and explaining video from eSports therapy YouTube channel and reading the journal from the American Society for Surgery of the Hand, it can be sure that an ergonomic design of an ergonomics adjustable controller hand support is salient in findings comfortable and safety while enjoying the game in a long time without having any ergonomics risk factor and injuries.

Market controller that the gamer usually use for their phone while playing games does not provide safety for the phone and comfortable for the user. This will cause ergonomics risk factors for those who play games in a long period of time such as, carpal tunnel syndrome, repetitive stress injuries, tennis elbow, Quervain's tenosynovitis and stenosing tenosynovitis.

# 1.3 Objective

The main objective of this research is to advocate a design and to generate a new ergonomics adjustable hand stand support for smartphones users especially smartphone gamers. To confirm this project success, these objectives will be rough out as follows:

- a) To study and analyze current device for hand stand support for smartphone user and gamers from the market place.
- b) To make an innovation on the device to prevent from pain or injury.
- c) To design and develop new ergonomics adjustable hand stand support for gamers that good in preventing hand and wrist pain.

#### 1.4 Scope

This project studies on the journal of finger pain and injury wrist of gamers from the worldwide collecting data. The collection data includes the current controller and the pain that the gamers faced while and after playing games in a long period of time. The following task will be done in this project which includes:

- a) Studies and searching the injury and pain faced by the gamers after playing
  - the video games in a long period of time.
- b) Analyze what cause the pain.
- c) Develop and optimize solutions of ergonomics adjustable hand stand support
  according to the injury and analyzed by using CATIA software.
- d) Enlargement of ergonomics adjustable hand stand support using CATIA

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#### 1.5 Expected Result

software.

The expected result for this project is to design and develop a new ergonomics adjustable hand stand support for smartphone users and gamers.

# CHAPTER 2

#### LITERATURE REVIEW

### 2.1 Introduction

The goal of this chapter is to compile and edit information from a variety of publications, books, and journals that pertain to this study, with a focus on ergonomics. This chapter contains a literature review based on past studies as well as theoretical readings based on ergonomic concepts, particularly in the areas of sitting, lying, and playing games postures, which may be understood via ergonomic studies and past researches. There is also information on human-body studies that are relevant to engineering design or human factor design considerations. The majority of the literature evaluations are based on media social complaining, online databased journals like Jstor, BioMed Central, Google Scholar, Mendeley, EZproxy, SCI HUB and internet search engine. In the references section, all of the data that was found will be mentioned.

# 2.2 Definition of Ergonomics

Ergonomics can be derived into few definitions. However, the fundamental definition which is used internationally is derived from the Centre for Occupational and Environmental Health. University of Manchester. Economic and Political Weekly (COEH, 2020). Table 2.1 shows the numerous meanings of ergonomics.

No.	Author/Resources	Year	Definition
1	Dohrmann Consulting. (Dohrmann Consulting, 2014)	2014	Ergonomics is the process of designing or arranging workplaces, products and systems so that they fit the people who use them. Ergonomics applies to the design of anything that involves people workspaces, sports and leisure, health and safety.
2	International Ergonomics Association (International Ergonomics Association, 2015)	2015	Ergonomics is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human well-being and overall system performance.
3	Centre for Occupational and Environmental Health. (COEH, 2020) UNIVERSITI	2020 TEK	Ergonomics is the study of how humans interact with manmade objects. The goal of ergonomics is to create an environment that is well-suited to a user's physical needs. Ergonomics it is commonly applied to the NIKAL MALAY SIA MELAKA workplace environment.

### Table 2.1 Definition of ergonomics

With all of the criteria, we can conclude that ergonomics is concerned with the fulfilment of the workplace, ensuring that the environment is well-organized and safe. A well-balanced between end-task user and demands may be implemented with effective work system design and ergonomics. This can help workers enhance their performance, their safety, and their emotional and physical well-being. Users experience discomfort, agony, and inefficiency

as a result of the abandonment of ergonomics principles. The goal of workplace design is to accommodate as many people as possible to understanding the ergonomics concept of posture and mobility, which is critical for providing a safe, healthy, and comfortable working environment.

#### 2.3 History of Ergonomics

Ergonomics was developed as a result of the design and operational difficulties that have arisen as a result of technology improvement over the previous decade. Its evolution has been constrained by the same historical processes that gave rise to other principles like occupational medicine and industrial engineering. (R.S Bridger, 2003).

According to Christensen (1987), the need of a "good fit" between people and tools was likely recognised early in the evolution of the species. For example, in a clear illustration of creating things to make chores simpler to do, pebble tools are chosen for manufactured scoops from antelope bones. Following World War II, the focus of concern shifted to encompass both worker safety and productivity. Research began in a number of areas, including:

- i. Manual labour takes a lot of muscle power.
- ii. When raising, there is a compressive stress on the low back discs.
- iii. Cardiovascular response when performing heavy labour.
- iv. Maximum load that may be carried, pushed, or dragged as perceived.

The name Ergonomics was gained from the Greek words. *Ergon* referred to work while *Nomos* referred to natural law. Prof. Wojciech Jastrzebowski coined the term "ergonomics" in 1857 in Poland. "Based upon the facts gleaned from the Science of Nature," he said in a philosophical narration. At a conference of the British Admiralty in 1949, Prof. Hugh Murell advocated the formal use of the phrase Ergonomics, which was adopted in 1950. (Pandve, 2017)

#### 2.4 Ergonomics Principle

Over the years, a few basic principles have emerged from the ergonomics sector. The majority of the ideas are well-explained, and the new applicable core philosophies should not be overlooked. These guidelines should be followed to ensure that the intended task is appropriate for the worker. The essential principles involve performances, comfortable, productivity, safety and health (Soubi et al., 2013)

#### 2.4.1 Performance

Human performance is the highly regarded outcome of the efforts of those who operate within a system (Spector, 2015). Performance is about human skill, attitude and temperament that shows at their workplace. Employee performance is determined by a variety of financial and non-financial factors, with workplace comfort and amenities being particularly crucial for manufacturing personnel (Ravindran, 2019). The ergonomics of the workforce, according to (Smith, 1997), is critical for greater labour performance in the workplace. When tools and equipment were constructed to minimise awkward postures, wrist aches, more standing positions, etc. with adequate lighting and ventilation set up, (Narayan et al. 1993) reported a reduction in accidents and employee unhappiness in a medical device assembly factory.

#### 2.4.2 Comfortable

Comfortable zone is everyone favourites and it comes more excited when it comes to works. Go through a tough day sometimes will be ease if we have a comfortable works environment. Comfort has always been a primary concern and idea in nursing, and it is especially significant in defining the character of nursing knowledge, discipline, and profession. (Oxford University Press, 2016). Kolcaba's research is based on the well-known comfort theory, which defines comfort as "the immediate state of being strengthened by having the needs for relief, ease, and transcendence addressed in the four contexts of holistic human experience: physical, psychospiritual, sociocultural, and environmental"(Keionen et al., 2003). To allow for appropriate rates of human performance and to limit any negative impacts on the user during the user-product interaction, discomfort should be avoided (Ahmed-Kristensen & Stavrakos, 2012).

#### 2.4.3 Productivity

Productivity is the output that is produced more than the input in term of industry. Other definition of productivity is a measure of a person's ability to complete a task. Productivity is essentially about making good decisions (on a regular basis) with our energy, concentration, and time in order to maximise our potential and produce positive outcomes (*Apakah Maksud Produktiviti\_ Dan Bagaimana Hidup Secara Produktif\_*, n.d.).

According to P. Krugman (Krugman, 1994), the amount of output divided by the volume of inputs is frequently referred to as productivity. In other words, it assesses how effectively a country's production inputs, such as labour and capital, are employed to generate a particular amount of output. Productivity is a crucial source of economic development and competitiveness, and it is used as the basis for many international comparisons and assessments of country performance. Productivity and performance always walk together in order to achieve a great output.

#### 2.4.4 Safety and Health

Safety and health of the worker is one of a major reason for an organisation to achieve their goal keep improving their performance. A healthy body and mind will lead to a quick respond on something that come unexpectedly. When you having an energetic body and free mind, you will decide something with a wise mind. Other than that, you will stay focus on your works and always get rid of yourself from a danger situation. If you having a lethargic body and chaotic mind, you will lose focus and that will put you in a danger situation.

#### 2.5 Musculoskeletal Disorder (MSD)

Work-related musculoskeletal disorders (WMSD) associated with repetitive and demanding working circumstances remain one of the most serious issues in developed countries. Musculoskeletal disorders are disorders that affect the upper limb extremities, the lower back area, and the lower limbs that are caused or worsened by employment. WMSD is identified by deficiencies in physical structures such as muscles, joints, tendons, ligaments, nerves, bones, and the regional blood circulation system, which are largely induced or worsened by work or the work environment (CDC, 2020). MSDs are musculoskeletal system and connective tissue illnesses and illnesses that occur as a result of a physical reaction (e.g., bending, climbing, erawling, reaching, twisting), overexertion, or repetitive motion, according to the Bureau of Labor Statistics of the Department of Labor. Disorders induced by slips, trips, falls, or other similar accidents are not included in MSDs. Examples of MSDs include Sprains, strains, tears, back pain, carpal tunnel syndrome, hernia (Health and Safety Executive, 2020) MSD, repetitive strain injuries (RSI), repetitive motion injuries (RMI), and cumulative trauma disorders (CTDs) are some of the terms used to describe soft tissue injuries (L. & McCauley, 2012)

Apart from physically demanding employment, the ageing of the workforce also contributes to the growth of WMSD, because the tendency for developing a WMSD is linked to the disparity between work demands and the worker's physical work capability, which diminishes with age (Okunribido & Wynn 2010). Work-related musculoskeletal disorders (WMSD) are situations in which the work environment and job performance play a substantial role in the development of the condition, and/or the ailment is made worse or lasts longer as a result of the work environment (Barrimi et al., 2013)

It is not new to recognise that one's job might have a negative impact on one's health. Musculoskeletal diseases have been diagnosed in the medical sector for many years. It is also possible to locate references to a range of injuries connected to the performance of certain tasks in historical medical records. Raynauld's phenomenon, commonly known as dead finger or jackhammer illness, was discovered to be caused by a lack of blood flow and linked to repeated actions in the eighteenth century.

Physical risk factors connected with employment, such as awkward postures, high repetition, excessive force, static labour, cold, or vibration, are widely established to have a substantial link with the occurrence of WMSD. WMSD has a multifactorial aetiology, according to WHO, which implies that these illnesses develop as a result of a worker's exposure to a variety of work-related risk factors (World Health Organization, 2015). Other risk variables, such as characteristics inherent to the worker and variables unrelated to work, contribute to its development in addition to job-related risk factors. Any source or event that has the potential to cause damage or lead to the development of a disease is considered a risk factor. The variety and complexity of the elements that contribute to the emergence of various illnesses explains the difficulty in determining the optimum ergonomic intervention to be implemented in a specific workplace and controlling them.

Employers face substantial expenditures due to absenteeism, lost productivity, and higher health care, disability, and worker's compensation expenditures due to musculoskeletal problems. The severity of MSD instances is higher than the normal nonfatal injury or illness. MSDs took an average of 8 days off work in 2001, compared to 6 days for all nonfatal injury and sickness cases (e.g., hearing loss, occupational skin diseases such as dermatitis, eczema, or rash) (Health and Safety Executive, 2020). According to the most recent estimates from the Labour Force Survey (LFS), there were 480,000 instances of work-related musculoskeletal diseases in 2019/20, a prevalence rate of 1,420 per 100,000 employees. There were 212,000 instances involving the upper limbs or neck, 176,000 instances involving the back, and 93,000 instances involving the lower limbs.

MSD is truly a serious illness that happen to the workers. The most prevalent symptom linked to WMSDs is pain. In certain circumstances, the afflicted area may experience joint stiffness, muscular tightness, redness, and swollen. Some employees may also report "pins and needles" feelings, numbness, skin colour changes, and reduced hand perspiration. WMSDs can range in severity from minor to severe:

- Early stage: Aching and fatigue of the afflicted limb occur throughout the work shift, but go away at night and on days off. There will be no decline in work performance.
- ii. Intermediate stage: Aching and exhaustion begin early in the work shift and last throughout the night. Repetitive job capability is reduced.
- iii. Critical stage: Aching, weariness, and weakness remain even while the patient is at rest. Inability to sleep and carry out simple tasks.

These stages do not occur in the same order for everyone. In fact, determining when one stage finishes and the next begins can be tricky. The initial ache indicates that the muscles and tendons need to rest and recuperate. If not, an injury can become chronic and, in some cases, irreparable. People should respond to symptoms as soon as they become aware of them (Canadian Centre for Occupational Health and Safety, 2018).

Disorders **Occupational risk factors** Symptoms Tendonitis/tenosynovitis Pain, weakness, swelling, burning Repetitive wrist motions Repetitive shoulder motions sensation or dull ache over Sustained hyper extension of arms affected area Prolonged load on shoulders Epicondylitis (elbow Repeated or forceful rotation of the Same symptoms as tendonitis tendonitis) forearm and bending of the wrist at the same time Carpal tunnel syndrome Repetitive wrist motions Pain, numbness, tingling, burning sensations, wasting of muscles at base of thumb, dry palm Repetitive hand twisting and DeQuervain's disease Pain at the base of thumb forceful gripping LINIVE MΔ AYSIA MEL ΔΚΔ Thoracic outlet syndrome Prolonged shoulder flexion Pain, numbness, swelling of the Extending arms above shoulder hands height Carrying loads on the shoulder Tension neck syndrome Prolonged restricted posture Pain

Table 2.2 Outlines occupational risk factors and symptoms(Canadian Centre for Occupational Health and Safety, 2018)

Workers suffer from strained or exacerbated muscles, tendons, ligaments, nerves, discs, or blood vessels as a result of MSDs on a daily basis. The illness has substantial human costs that can last for years, if not all of a person's life. Due to MSD of nerves, tendons, and muscle, several heavy industries' job performance has suffered.

A key premise of occupational health and safety is that hazards should be addressed at the source. The repetition of labour is the primary source of hazard in the case of WMSDs. Other aspects of the job, such as the applied force, fixed body postures, and the rate of labour, also play a role. To safeguard workers against WMSDs, the primary focus should be on preventing repetitive labour patterns through job design, which may include automation, job rotation, job expansion and enrichment, or cooperation. Prevention techniques incorporating workplace structure, tool and equipment design, and work behaviours should be explored whenever eliminating repeated work patterns is not practicable or practicable.

Worker, management, and representative participation in workplace preventative and control measures, as well as improvements in occupational health and safety, are all crucial.

### 2.6 Design, Materials Selection and Marketing of Successful Products

There are various aspects that contribute to a product's marketability and success. This section will go through complete tools for product design that are integrated with product development. For a product developer to create a design manual, materials selection, design analysis, and marketing are critical tools. Since the previous few decades, numerous approaches for material design and selection have emerged. However, due to the physical entity material, certain procedures are limited in their ability to create a new product. Aesthetic, fashion, cultural characteristics, market trends, recycling, and the target demographic are all included in the new Integrated Product Materials Selection (IPMS) model.

In order to produce the product, the selection of an acceptable material and decisions are both dependent throughout the design phase. Whether it leads to commercial success or failure, the decision will have an impact on the look, form, cost, and marketing. When the design grows more intricate, the selection of acceptable materials and production will become more distinct. As a result, before making any final selections, design engineers must be wellversed on qualities, attributes, and materials.

Based on my expertise with game controllers, there are a variety of materials used in the production of a gaming controller. The most frequent materials utilised to make a gaming controller include polymers, rubber, and plastics. Manufacturing can make a game controller out of only one material, such as plastic, or it may make a gaming controller out of two or more. More ergonomics in design is the finest technique to develop the new enhanced design.

#### 2.7 THE DESIGN PROCESS

The process of designing is used to come up with solutions to challenges. The term "design" refers to a wide range of activities, most of which are associated with aesthetic expression. However, it is better viewed as a mental process combining planning with the idea of achieving a goal. We design everything from the look of a room to the vacation that we hope we will soon take. More importantly, design refers to the process of coming up with solutions to problems.

With the idea that designing is not a linear process; that is, you do not think and act in distinct, sequential phases when you design and produce anything. Designing is more like transitioning between a thinking-questioning-evaluating phase and an acting-doing phase during the creative process. These seven modes are known as the active and reflective stages of design, and you alternate between them all the time.

Because you'll be switching back and forth between the active and reflective stages, you'll probably need to move about a little while designing. For example, if you come to the stage of selecting a solution and realise you need additional background information, you'll need to go back to stage inquiry and study. Alternatively, if you are creating the selected solution and discover a fatal fault that prevents you from competing with it, you must return to the phase where you looked at "creation of other solutions" and choose another solution. There's no reason why you shouldn't do it. The design loop should help you stay on track by providing a structure for your design and problem-solving activities.

#### 2.8 DEFINITION OF GAME CONTROLLER

Definition of game controller according to Wikipedia, often known as a gaming controller or just a controller, is an input device used with video games or entertainment systems to provide input to the game, usually to control an item or character. A controller consist of directional pads, multiple buttons, analog sticks and motion detection. Game controllers have been designed and improved over the years to be as user friendly as possible. Some controllers, such as steering wheels for driving games or dance pads for dancing games, are designed specifically for one sort of game.

# 2.8.1 History of Game Controller (NIKAL MALAYSIA MELAKA

Joysticks, pads and wheels have all had a huge influence on the way games play. This section takes a look at the history of gaming controllers from their inception to the present day. Also explored will be some national examples such as designs that stand out in particular, either because they have grown familiar through time or because they are of exceptional design significance, will be considered.

In video games, controller failures are frequently blamed on the player's inability to achieve what they desired. Countless controllers have been martyrs as a

result of player frustration, as they have been shattered or hurled. The next generation of video game controllers will accompany the next generation of consoles. The joystick was shortly to follow with the introduction of switch-based buttons. A generic joystick has a straightforward design. A joystick only needs four separate switches to work, each of which corresponds to a distinct direction (Lu, 2003).

When the joystick is pushed in a specific direction, a small metal disc makes contact with the circuit board, turning the switch on and creating an electrical signal that signals the joystick has been moved. To regulate firing, an extra switch can be provided (Lu, 2003). The so-called digital joysticks were based on this architecture, in which the switches were either on or off.



Figure 2.1 A simple circuit diagram for a basic joystick (Engdal, Digital joystick connector pinouts)

After Spacewar, button-based controllers remained popular; but, another video game was rapidly gaining popularity. Pong was the name of the game. Pong may be traced back to Higinbotham's 1958 book "Tennis for Two" (Rosenthal, Fun With an Oscilloscope). Magnavox also released a version with the Odyssey, but it wasn't until Al Alcorn and Atari collaborated on a version that Pong truly took off, as it was Atari who popularised home video games. A dot on the screen bounces back and forth between two paddles in Pong, a simple arcade game.

Potentiometers, which were little knobs that moved the paddle up and down on the screen when rotated, have been used to control the paddles on Pong from the game's inception. The de facto paddle controller was included in the first few Atari home systems sold to play Pong due to the game's tremendous popularity (AtariAge, Atari 2600 History). The paddle controller was unique in that it included two potentiometers on two parts of one large controller board, allowing two players to play with one controller (Cassidy, Warlords).



Figure 2.2 The paddle controller. g. (Atari Home Pong)

Fairchild Camera and Instrument debuted the Channel F in 1976, right in the middle of the Pong craze. It was called the Video Entertainment System (VES) and cost around \$170 at the time (Hunter, Player 3: Home Systems). The VES controller sensed the pressure of Pong and had a twistable top that enabled the player to move the controller top to the left or right while offering other buttons to control direction such

as up, down, left, and right. All of this was housed in a controller that looked like a dynamite detonator (Dyer and Webb, Fairchild Channel F Faq). This detonator-like controller, which included a central shaft and spinning features and was influential in the design of the Atari 2600 joystick a year later, was a sufficient departure from paddle controllers of the time.



Stephen D. Bristow is credited with inventing the first joystick, which UNVERSITITEKNIKAL MALAY SIA MELAKA comprised of a central shaft and a crucial point. There were numerous different joystick designs by 1978, when Bristow secured the Atari joystick patent. This was partly owing to the ease with which a primitive joystick may be constructed, as discussed above. The Atari joystick was unique in that it included a pivoting centre shaft that made the connections for the five directions (up, down, left, and right) as well as a fire button. (Journey to the Joystick, Yung and Hsu) The departure from the paddle controller maintained the trend initiated by the VES controller in terms of design. When it came to incorporating rotational features in controller design, the pivotal rotation was akin to the twistable top. With the Atari 2600 Video Computer System (VCS) in 1977, Atari introduced the Atari joystick as well as the de facto paddle controller for Pong, paving the way for the first joystick on a video game system.



Figure 2.4 The original joystick patent awarded to Stephen D. Bristow

### of Atari. (U.S.Patent Office)

The invention of the directional pad, which followed the joystick, was a necessary step backwards in controller progression. A basic history of Nintendo is required to comprehend the creation of the directional pad. Fusajiro Yamauchi founded Nintendo Koppai in Meiji 22 (1889) to create and distribute handcrafted hanafuda cards. Nintendo officially became NCL – Nintendo Firm, Ltd. – in 1959, following a successful licence arrangement with Disney to create playing cards, and the company attempted to expand into new companies. Gunpei Yokoi was one of the employees employed during this time of growth. Yokoi was employed to maintain the assembly-line equipment that produced the playing and hanafuda cards, but was later transferred to the engineering department to create something for Nintendo to sell for Christmas. With more engineers hired to his department, Yokoi produced Nintendo's first toy, the

Ultra Hand, which is a groping extension of the hand. This project cemented Yokoi's position as he continued to create Nintendo's Ultra series of toys.

In his leisure time, Yokoi continued to make toys, working with circuits and oscilloscopes. Nintendo attempted to enter this new market in the 1970s, with the shrinking of electronics and the rising popularity of video game consoles. Nintendo had previously entered the market in 1977 with the Color TV Game 6, which featured six different Pong-style tennis games. It was followed by Color TV Game 15, but Nintendo's president, Hiroshi Yamauchi, wanted to move in a different path and pressed Yokoi and his engineers to come up with new ways to make video games. Yokoi was inspired by the shrinking of electronic calculators and wanted to capitalise on it (Game Over, 1993). In 1980, Nintendo came out with a game called Game & Watch (History of Nintendo).

Figure 2.5 Game & Watch. (Cuciz, Total Control - A History of Game Controllers)

Originally, Game & Watch comprised of a digital clock, alarm, and a game operated by two left-right switches. The game quickly got more difficult, requiring four directions. Because a joystick-like control on the little gaming unit was not practicable, it was determined that each direction would be controlled by a switch. However, this design made the game uncomfortable because it had the same problem as the original Spacewar in that it wasn't apparent which switch controlled which direction. Yokoi devised a "cross-shaped, thumb-operated, micro-switched lever capable of moving in four directions and addressing up to eight" (Cuciz, Total Control – A History of Game Controllers) to tackle this issue. The directional pad, sometimes known as the D-pad, was born as a result.

With the release of Nintendo's Famicom, also known as the Nintendo Entertainment System (NES) in the United States, the direction pad was finally incorporated into a video game system. Following Game & Watch, Nintendo expanded into coin-operated arcade games, such as Donkey Kong. Yamauchi was motivated by the emergence of home computer systems and the prospect of a computer system disguised as a toy – a so-called Trojan Horse that might enter the home market – while developing coin-op games. While most computers on the market at the time were between \$200 and \$350, Yamauchi sought a system that was cheaper than \$75 and had more features than the competition. All of the frills, including the keyboard, modem, and disc drive, were removed to save money on what is essentially a computer. Because the keyboard was removed, the player needed to find another means to connect with the computer. The Nintendo controller, which has two buttons on the right controller and a directional pad, was created to solve this problem. The directional pad was firmly established in the history of video game systems with the advent of the NES controller (Game Over, 1993).



#### Figure 2.6 Nintendo NES controller featuring the directional pad.

The directional pad and joystick controller components have been integrated into one controller since the debut of Sony's PlayStation dual shock controller. The directional pad and the joystick differed in their control possibilities and trade-offs in various scenarios, although sharing the same history. The early joysticks, for example, were more prone to damage than the directional pad, although having a broader range of motion. The PlayStation's dual shock controller had a directional pad, two joysticks, and a slew of buttons (14 buttons to be exact, including the directional pad). The twin shock controller's joysticks were analogue, unlike the original Atari digital joystick. Analog joysticks descended from digital joysticks and differed in that two potentiometers – similar to those found on the original Pong controllers – were attached to the joystick to measure how far the joystick had moved in both the horizontal and vertical directions, allowing the switches to be toggled on and off based on how far the joystick was moved. Furthermore, these joysticks featured force feedback, which meant that each joystick had two motors controlled by a CPU that could make the stick move in a certain direction when needed (Tyson, How PlayStation Works).



Figure 2.7 Sony PlayStation Dual Shock Controller

(Tyson, "How PlayStation Works)

Most current controllers are based on this concept, and include two joysticks, a directional pad, and a variety of additional buttons. The placement of various features varies depending on the design and user testing, resulting in a unique controller design for each platform. The directional pad and joystick have their own distinct locations in today's controllers due to the various types and levels of control they provide, as well as the tradeoffs they provide. The necessity for controllers and the design of controllers gradually evolved from the simple beginnings of Spacewar, giving rise to the directional pad and the joystick, which combined create the controllers we have today. Despite the fact that technological issues contributed to the growth of each of the controller aspects, today's controllers do not suffer the same issues. Instead, there is more leeway, allowing for more creative design. Knowing how these aspects have developed allows developers to create new controllers that benefit from improved design.

Until now, the design of the game controller has been nearly identical to that of the dual shock controller. However, some aspects, such as the rubber or plastic analogue and the position of the buttons, may alter.

#### 2.9 Anthropometry

This obsession is referred to as anthropometry in technical terms. It is the assessment of the physical characteristics of the body, and these characteristics may be used as variables in epidemiology, psychology, and anthropological investigations. The ability to accurately characterise our current health, as well as make predictions about outcomes as diverse as our physical attractiveness, ability to reproduce, and long-term survival, should be enabled by precise and unambiguous measurements of the body's physical dimensions and underlying composition (Matejovičová et al., 2014)

Anthropometry is the science of measuring the human body in terms of bone, muscle, and adipose (fat) tissue measurements. Individuals with high subcutaneous adipose tissue levels have been linked to an increased risk of hypertension, adult-onset diabetes mellitus, cardiovascular disease, gallstones, arthritis, and other diseases, as well as cancer (岩澤, 1988) (Iwazawa, 1988).

Furthermore, within applied anthropometry, a differentiation is created based on the procedures utilised to collect the raw data. The first segment focuses on traditional anthropometric data gathered with traditional procedures and devices such as anthropometer, personal scale, spreading caliper, pelvimeter, sliding caliper, soft metric tape and caliper. Traditional anthropometric devices offer one-dimensional measurements of the body or its portions, such as forearm length. They can also deliver measures along a plane of a two-dimensional bodily characteristic, such as the diameter of the skull. The second portion is devoted to the use of various three-dimensional methods for the creation of surface

representations of body shapes. They can also offer surface area and volume measurements, which are difficult to get with typical equipment (Matejovičová et al., 2014).

Anthropometric design guarantees that the user, the equipment, and the environment are all in perfect alignment. Anthropometry is used in ergonomics to improve the fit and function of items during both design and assessment. The fundamental procedure begins with determining the relevant body dimensions. The measuring of abilities associated to job performance, such as reaching, manoeuvring, and mobility, as well as other characteristics of space and equipment, is known as functional anthropometry.

According to Ergonomic risks in sitting and standing workplaces written by I.Grabovac, there are the suggested ergonomics guidelines for sitting work:

- All sitting work should be planned to preserve vertical spine alignment and reduce shoulder stress.
- 2) Provide items that are little below the level of your elbows.
- 3) Heavy hand tools should be avoided.
- The height and tilt of the chair, as well as the height and angle of the backrest, must all be adjustable.
- 5) The height of the computer table, must be adjustable. ALAYSIA MELAKA

For computer gamers who plays video games using computer and game controller, those suggested ergonomics is applicable for them. Tests of dynamic postural control, such as the star excursion balancing test, have been found to be influenced by anthropometric measures, age, sex, and activity level (SEBT). The HSEBT (hand reach star excursion balance test) assesses many components of dynamic postural control. The HSEBT (hand reach star excursion balance test) has been shown to be a viable and reliable instrument for assessing dynamic postural control (Eriksrud et al., 2019). When contrasted to the wellknown star excursion balance test (SEBT), the hand reaches conducted on each foot capture various components of dynamic postural control (Eriksrud et al., 2019). Thus, adjustable table and chair will help to prevent musculoskeletal disorders.

#### 2.10 Traditional Anthropometry

The dimensions are employed for numerous design tasks in applied anthropometry. The sort of dimension that should be chosen is highly dependent on the design challenge at hand. One-dimensional data are useful when building a regular gateway or an emergency door for a bus, for example. Complex designs, such as spare car parts frequently need the simultaneous use of many one-dimensional measurements. The two-dimensional head circumferences are useful for making a soft and flexible scarf for the head. A three-dimensional depiction that takes into consideration curvatures and curves would be more suited for constructing a hard-shell helmet for the same head.

When it comes to the posture of working postures, one-dimensional measures are typically the best option because they can be immediately tied to the workspace in issue. The crucial dimension in determining the level of a work surface for a simple standing assembly position, for example, is elbow (or waist) height. Additional measurements would include forward arm reach and maybe abdominal depth if the greatest depth of the work surface is essential (because hitting the work surface with the abdomen can effectively reduce forward arm reach). On the other hand, design for more complex working positions, such as assembly operations in a small enclosed space (as when building ship components, for example) or repair operations that require leaning into the work space (as in automobile engine repair, for example), often necessitates the use of multiple dimensions and is best accomplished with digital human models. Anthropometry and posture are inextricably related. When data is gathered, the subject's posture has a direct impact on anthropometric statistics. The inverse is also true: an individual's anthropometric proportions have a direct impact on his or her posture. For example, when seated in the same chair, a guy who is 180 cm tall and a girl who is 150 cm tall have quite distinct postures. The long man's hand will rest on the desk, allowing him to recline in his chair. The short woman's feet must not touch the ground, and she must not lean on the chair or she will be unable to reach the table. Gamer's spaces should ideally be sufficiently adaptable so that the gamer can adopt a posture that reduces the risk of injury and weariness, however this aim has yet to be realised.

Despite the obvious relationship, however, anthropometry does not always define a precise seated posture in each space. The relevance isn't huge, but it's worth paying attention to. There doesn't seems to be a single anthropometric element that explains the differences in body-balancing motions when standing (Eriksrud et al., 2019). Furthermore, even among people with identical anthropometry, there is a lot of variation in posture. Fatigue, the unique workload, and the individual work environment all contribute to this heterogeneity.

# 2.11 Rapid Upper Limb Assessment (RULA)

Rapid Upper Limb Assessment (RULA) is a strategy for assessing the risk of workrelated upper limb ailments based on postural targeting. A RULA examination provides a rapid and systematic evaluation of a worker's postural hazards. The analysis can be done before and after an intervention to show that it was successful in reducing the risk of damage (*Rapid Upper Limb Assessment (RULA) - A Step by Step Guide*, n.d.).

RULA was developed to evaluate individual worker exposure to ergonomic risk factors linked to upper extremity MSD. The biomechanical and postural load needs of occupational tasks/demands on the neck, trunk, and upper extremities are taken into account by the RULA ergonomic assessment instrument.

According to Mark Middlesworth, (*A Step-by-Step Guide to the RULA Assessment Tool*, n.d.) RULA was created to be simple to operate without requiring an extensive degree in ergonomics or costly equipment. The evaluator will provide a score to each of the following body parts using the RULA worksheet: upper arm, lower arm, wrist, neck, trunk, and legs. Following the collection and scoring of data for each location, tables on the form are utilised to assemble the risk factor variables, resulting in a single score that indicates the amount of MSD risk as outlined below:



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RULA is a method for analysing risk factors to the upper extremities of the manikin, or human in the actual physical environment in DELIMIA V5. The RULA analysis measures the following risk factors:

- 1) Body posture
- 2) Number of movements
- 3) Force
- 4) Repetition task

#### 5) Time worked without a break

After measuring these risk factors, a final score is provided in the form of a number

between 1 and 7 indicating the following:

- RULA score of 1 or 2 implies that if a position is not maintained or repeated for an extended length of time, it is okay.
- RULA score of 3 or 4 suggests that more research is needed and that modifications may be necessary.
- RULA score of 5 or 6 signals that further study and modifications are imminently necessary.
- RULA score of 7 plus suggests that quick inquiry and modifications are necessary.

#### 2.12 Summary of Literature Review

Ergonomics was developed as a result of the design and operational difficulties that have arisen as a result of technology improvement over the previous decade. The goal of ergonomics is to create an environment that is well-suited to a user's physical needs. Ergonomics it is commonly applied to the workplace environment. With all of the criteria, we can conclude that ergonomics is concerned with the fulfilment of the workplace, ensuring that the environment is well-organized and safe. A well-balanced between end-task user and demands may be implemented with effective work system design and ergonomics. For computer gamers who plays video games using computer and game controller, those suggested ergonomics is applicable for them. Work-related musculoskeletal disorders (WMSD) are situations in which the work environment and job performance play a substantial role in the development of the condition, and/or the ailment is made worse or lasts longer as a result of the work environment. RULA was developed to evaluate individual worker exposure to ergonomic risk factors linked to upper extremity MSD. RULA is a strategy for assessing the risk of work-related upper limb ailments based on postural targeting. On the other hand, design for more complex working positions.



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# CHAPTER 3

### METHODOLOGY

#### 3.1 Introduction

The main of this chapter are about explaining the methodology for this project from the starting until the product are ready to be used. Presently, the most commonly smartphone users posture (Figure 3.1) and, the most commonly smartphone gamers posture (Figure 3.2). This project is focus to improve the design of the current hand support stand by minimize the pain or injury while playing games.

The methodologist that will be used in this project are:

- 1. Research study
- 2. Collecting data
- 3. Analyzing the data
- 4. Design a new product

5. Develop new product TEKNIKAL MALAYSIA MELAKA

Before using CATIA software to analyze the hand posture issue, a statistical study will be conducted to identify the user population and serve as a catalyst for creating a new ergonomics design for this project.



Figure 3.1 Most commonly smartphone user's posture



Figure 3.2 Most commonly smartphone gamer's posture

### 3.2 Research Methodology

Figure 3.3 depicts the analysis approach used for this project from the beginning to the end. The flow chart simplifies the steps that will be taken to complete this project, starting with the first step and continuing with what will be done with the next step until the final step. The flow chart also includes the project's most critical move.


#### 3.2.1 Identify Problem

Identifying the problem entails determining the source, the consequences, and the best solutions that can be devised to resolve the problem. Before deciding on a solutions, the relation data must be obtained in order to identify the problem. After identified the cause and effect, try to come up with the best solution for resolving the problems.

#### 3.2.2 Background Research

Background study focused on learning more about the challenges in general. Aside from it, background research focused on prior studies was carried out. Journals, books, the internet, and newspapers are all helpful reasons to find for research. While saving time and money, this technique focuses more on identifying the most effective solution to the problem. In this situation, there will be so many unquestionable question you need to find the answer.

Data accumulation of repetitive stress injury was search to complete the task about people having pain while using their phone without applying the correct posture in a long time of time. How long the time taken for user to start having the pain and what the cause of those pain.

#### UNIVERSITITEKNIKAL MALAYSIA MELAKA Statistical analysis of repetitive stress injury data was gain to analyze which part

of body effect the pain and which type of work and posture effect the most. Data collection on current game device used by gamers will help on the time period. The gamers usually play games on their phone more than one hour. This method is to observe the first changing posture in one hour period of time.

# 3.2.3 Conceptual Design and Development for Ergonomics Adjustable Hand Stand Support

Following the data collection, the following stage is to determine the ergonomics adjustable hand stand's conceptual design and turn it into a product. Before the improvement can be made, this process will require a few stages. The dimensions of the present hand support device will be used to create a more ergonomically adjustable hand stand support.

# 3.2.4 Analyse Data Using RULA in CATIA

INA

The RULA technique will be used to assess the risk of work-related upper-limb illnesses via data collecting and postural targeting. As a result, the ergonomically adjustable hand stand support that will be developed will be more beneficial to the user than the existing hand stand support.

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# 3.2.5 Gantt Chart BDP 1

No.	Project Activity	Expected /	Expected / WEEKS														
		Actual	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1:
Ť	Propose tittle of project	Expected											C				
1.	Propose nulle of project	Actual										<u>.</u>					
2	Define background problem statement	Expected	alt	TE	KNIA												8
2.	objectives and scope	Actual	8			T E											<i>0</i> ,
3	Chapter 1 : Introduction	Expected				N.											e.
1703		Actual															
4	Chapter 2 · Literature review	Expected															
т.		Actual			VNY	13							2			ū	÷
5	Chapter 3: Research Methodology	Expected		1												;	
2.		Actual	6														
6	Proposal report	Expected															
v.		Actual			F												
7	Revise project report and prenare	Expected															2
	presentation (BDP 1)	Actual	6														
0	Procentation (RDP 1)	Presentation (BDP 1)	/												-		
0.		Actual						2					9	k			
10		G	-	<												12 12	di.
	K	5.															
	-																

# 3.2.6 Gantt Chart BDP 2

No.	Project Activity	Expected /								WEE	KS						
		Actual	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
î	Experiment execution	Expected															
1.	Experiment execution	Actual															
2.	Collection data	Expected	1710	TEA	WIR,	6											
		Actual				4											
3.	Analysis data	Expected				ALA											
	- III	Actual				IS A		0									
4.	Verification and validation	Expected				4											
		Actual		N	NAJ	2											
5.	Chapter 4: Result and discussion	Expected															
	KA	Actual	-							0 / / /				9		_	
6.	Chapter 5: Conclusion and recommendation	Expected															
	MA NA	Actual															
7.	Complete report	Expected															
100	X .	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$															
0	Pavice project report and prepare	Expected															
0.	presentation (BDP 2)	Actual															
9.	Presentation (BDP 2)	Expected	-														
	K I	Actual		-													×

## 3.3 Proposed Methodology

The main purpose of proposed methodology is to clearly explain detailed of how to accomplish this project's objectives. The attention of this project is to develop of a new ergonomics adjustable hand stand support that capable to comfort the users and reduce the amount of pain that the user gain for using phone in a long time of period. As the reference to produce a better ergonomics products, current console used by the gamers that can be observed from online gaming were adopt. Gathering data, analyzing process, rewriting the analyzing process, and then developing a new ergonomics gaming controller are some of the strategies that will be used in this project.

#### 3.3.1 Experimental Setup

The role of gathering data is to identify the population of gamer who use a gaming controller that is connected to a smartphone, as well as to obtain information, that will be used to develop guidelines for redesigning a hand stand support that is acceptable and pleasant for gamers. The data were gain by spreading the questionnaire about typical gamer's problems while playing games. The numbers of samples to make through are 100 people.

# UNIVERSITITEKNIKAL MALAYSIA MELAKA The statistical study begins with data collection and is followed by an RULA

examination of the gaming controller's ergonomics condition. After receiving the result, or RULA analysis, the fault will be identified, and the RULA analysis of the gaming controller will be revised. Before the proportion of the gaming population can be determined in statistical analysis, the normal distribution must evolve. The percentage will be combined with the dimensions of the gaming controller to determine the hand issue. The results of the RULA analysis will then be used to finish the analysis

procedure. The revising process is done by changing the dimension of the game controller.

The last method of this project is the development of new ergonomics hand stand support. In this procedure, a questionnaire for the player in FTKMP will be provided. The goal of this survey is to get input from gamers on the new product that will be developed as part of this project. The house of quality is established based on the feedback in order to link it to the engineering description. Finally, the ergonomics hand stand support design may be created.

To get the accurate dimension and the weight of the controller is not a big deal because the controller is standard item in market. To choose the suitable controller is quite difficult because in this Covid pandemic era, those things will be selling online. To get the best result, three different controller will be measured with different feature.

#### 3.3.1.1 Equipment

There's are only three types of material that are be using in the process to complete this project. The materials are the equipment of measurement, the parts of project and CATIA V5 software. For equipment of measurement, there will be use is digital Vernier caliper and measuring tape while parts of project is game controller. Those of this measurement equipment are used to measure dimension of the hand place on the game controller and the size suitable for gamer to hold the game controller. Figure 3.4 shows the measuring equipment use in this project to measure parts of the game controller. CATIA V5 software is needed to analyze the gamer population with the current game controller dimension.



Figure 3.4 Measuring equipment

# 3.3.1.2 Parameter

The purpose of the measuring equipment that will be used in this project is to measure the body dimension of the game controller and the gamer finger. The measurement that need to use this measuring equipment is about 12 parts of hand gesture dimension on the game controller. Digital venier caliper is used to measure the buttons on the game controller while measuring tape is to measure the whole dimension of the game controller.

The ergonomics prospect with study for the game controller is described by the CATIA software. This software is being used to address an issue of ergonomics. The software that will be utilized to produce anthropometry data and assess for ergonomics prospects is shown in Figure 3.5.



#### 3.4 Limitation of Proposed Methodology

In this project, numerous processes will be carried out. Take the weight of the gaming

controller first, then measure the length and width of the controller. All of the present controller's dimensions should be recorded, and then this information should be converted into a perfect drawing. Next, for the measurement operations, gather anthropometric data from gamers who spend an hour or more each day playing games. Following the collection of those data, both will be entered into CATIA software for analysis.

The dimensions of the current game controller, such as height, breadth, thickness, and other elements of the specifications that are included in this current game controller design, are generally taken for measurement. After that, all of these dimensions will be converted and

drawn in Solidworks before being converted into CATIA software. In order to define the ergonomics idea of the hand stand support, the drawing must be used in conjunction with anthropometric data throughout the analysis phase.

There will be ten gamers who will be measure their body measurements using a game controller. The technique of measurement is detailed in table 3.1, and each sample will have 25 hand and finger dimension measurements performed in this process. Three anthropometric measures for body dimensions will be obtained, with the average for each sample being calculated before the standard deviation is calculated. The dimensions are distributed in a normal distribution, and statistical analysis was used to determine the population of players.

No	Variable	Method of Measurement
1.	Body weight	Subject stands on weighing scale.
2.	Stature Seaning	Vertical distance from the floor to the highest point of the head (vertex). Subject stands erect with feet together with heels, buttocks, shoulders, back of head touching a vertical surface.
3.	Eye Height IVERSITI	Vertical distance from the floor to the outer corner of the eye. Subject stands as above.
4.	Shoulder Height	Vertical distance from the floor to the acromion. Subject stands as above.
5.	Elbow Height	Vertical distance from the floor to the lowest bony point of the bent elbow. Upper arm hangs freely and elbow is flexed 90 degrees.

Table 3,1 ISO list of anthropometric variables (ISO/DIS 7250)

6.	Fist (grip axis) height	Vertical distance from the floor to the grip axis of the
	4	fist, with the arms hanging freely.
7.	Vertical Grip Reach,	Vertical distance from the standing surface to the center
	standing	of a cylindrical rod firmly held in the palm of the right
		hand, with the right arm and wrist extended upward.
8.	Shoulder (biacromial)	Distance along a straight line from acromion to
	breadth	acromion.
9.	Elbow-to-elbow breadth	Maximum horizontal distance between the lateral
		surfaces of the elbow region.
10.	Sitting height (erect)	Vertical distance from a horizontal sitting surface to the
	NALAISIA	highest point of the head (vertex). Subject sits against a
		vertical surface thighs fully supported and lower legs
		hanging freely.
11.	Eye height, sitting	Vertical distance from a horizontal sitting surface to the
	Alun	outer corner of the eye. As for standing but in the seated
	لىسىا ملاك	ونوم ست تڪ، posture above
12.	Shoulder height, sitting	Vertical distance from a horizontal sitting surface to the
	UNIVERSITI	Tacromion KAL MALAYSIA MELAKA
13.	Elbow height, sitting	Vertical distance from a horizontal sitting surface to the
		lowest bony point of the elbow bent at a right angle
		with the forearm horizontal. As for standing but in the
		sitting position above.
14.	Elbow Grip Length	Horizontal distance from back of the upper arm (at the
		elbow) to grip axis, with elbow bent at right angles.

15.	Grip reach; forward reach	Horizontal distance from a vertical surface to the grip								
		axis of the hand while the subject leans both shoulder								
		blades against the vertical surface.								
16.	Hand Length	Perpendicular distance from a line drawn between the								
		styloid processes to the tip of the middle finger.								
17.	Hand breadth at metacarpals	Projected distance between radial and ulnar								
		metacarpals at the level of the metacarpal heads from								
		the second to the fifth metacarpal.								
18.	Hand Thickness	Thickness of the hand at the level of middle portion								
	1 AVer	(circumference passing over the metacarpal joints)								
19.	Thumb breadth	Breadth of the thumb on the right hand measured when								
	Kulle	is extended								
20	Index Finger breadth,	Maximum distance between medial and lateral surfaces								
	proximal	of the second finger in the region of the joint between								
	AINO	middle and proximal phalanges. Distance from tip of								
	لىسىا ملاك	2 <sup>nd</sup> finger to the proximal skin furrow between digits.								
21.	Head Length	Distance along a straight line between the glabella and								
	UNIVERSITI	the rearmost point of the skull. YSIA MELAKA								
22.	Head Breadth	Maximum breadth of head above the ears, measured								
		perpendicular to the midsagittal plane.								
23.	Head Height	Measure the linear distance from the bottom of chin to								
		the highest point (vertex) on the top of the head								
24.	Head circumference	Maximum, approximately horizontal, circumference of								
		head measured above the glabella and crossing the								
		rearmost point of the skull.								

25.	Wrist circumference	The circumference of the wrist between styloid process
		and the hand, with the hand outstretched.

Source: Journal of Human Ergology (Karmegam et al., 2011)

After collecting all of the existing game controller measurements and anthropometric data, the analyzing procedure may begin using the CATIA software. By utilizing this software, the present game controller's measurements will be converted and drawn, and the drawing will be used in conjunction with the anthropometric data. The virtual human is built at random using anthropometry, and the ergonomics of the present gaming controller will be tested. Following the collection and scoring of data for each location, tables on the form are utilized to assemble the risk factor variables, resulting in a single score that indicates the amount of MSD risk. After measuring these risk factors, a final score is provided within the kind of variety between 1 and 7. Table 3.2 shows the RULA grand score and the decision about the posture.

RULA Grand ScoreRisk LevelDecision about Posture1-2LowAcceptable working posture.3-4IntermediateFurther investigation is needed and change<br/>may be required.5-6HighPrompt investigation and changes are<br/>required soon.

Table 3.2 RULA grand score and decision about posture

7+	Very High	Immediate investigation and changes are
		required.

Source: Hayati Kadir Sahar (CUergo\_RULA, n.d.)

Finally, the design and development of a new ergonomics hand stand support is the project's last step. The conceptual design is based on the gamer's needs throughout this procedure. The concept of a new hand stand support is crucial for all users to find comfort when playing games for long periods of time without risking injuries due to ergonomics. The new hand stand support design will next undergo the same stages as the present hand support to guarantee that it is ergonomically sound.



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# **CHAPTER 4**

# **RESULTS AND CONCLUSION**

## 4.1 Introduction

In this chapter, the procedures for completing this project have been finalised, and their findings have been addressed in relation to their conclusions. Statistical analysis, conceptual design, new product design, and RULA analysis are some of the strategies that were employed to finish this project successfully. The discussion was held in response to the findings of the analysis, which was ongoing at the time.

4.2 Statistical Analysis of Human Anthropometric Data

The anthropometric data of gamers has been searched and analysed in order to determine their percentile ranking. Based on that percentile, the existing phone holder will be subjected to design study in order to define the ergonomics aspect of the product. The percentiles of the gamers are shown in Tables 4.1 in this section.

No.	Body Part	М	SD	Percentile					
				5 <sup>th</sup>	50 <sup>th</sup>	95 <sup>th</sup>			
1.	Forward Functional Reach								
	a. Includes body depth at shoulder	64.96	10.82	47.161	64.960	82.759			
	b. Acromial process to functional pinch	56.58	4.678	48.885	56.580	64.275			
	c. Abdominal extension to functional pinch	51.59	2.867	46.874	51.590	56.306			
2.	Abdominal Extension Depth	19.76	4.511	12.339	19.760	56.306			
3.	Waist Height	100.10	4.025	93.479	100.10	106.721			
4.	Tibial Height	48.65	3.700	42.564	48.650	54.737			
5.	Knuckle Height	73.00	9.365	57.595	73.00	88.405 0 0 0			
6.	Elbow Height UNIVERSITI TEK	105.40 NIKAI	5.007 MAL	97.163 AYSIA	105.40	-113.637 AKA			
7.	Shoulder Height	139.20	5.481	130.18	139.20	148.216			
8.	Eye Height	156.40	10.14	139.72	156.40	173.08			
9.	Stature	170.30	5.602	161.09	170.30	179.515			
10.	Functional Overhead Reach	203.00	9.559	187.28	203.00	218.725			

# Table 4.1 Percentile for gamers

11.	Thigh Clearance Height	13.10	2.031	9.759	13.100	16.441
12.	Elbow Rest Height	17.62	2.314	13.813	17.620	21.427
13.	Midshoulder Height	59.62	10.77	41.093	59.620	77.337
14.	Sitting Height Normal	83.97	14.26	60.512	83.597	107.428
15.	Knee Height	52.23	5.992	42.373	52.230	62.087
16.	Popliteal Height	45.38	3.893	38.976	45.380	51.784
17.	Elbow to fit length	36.91	3.175	31.687	36.910	42.133
18.	Upper Arm Length	36.36	3.245	31.022	36.360	41.698
19.	Shoulder Breadth	44.39	3.364	38.856	44.390	49.924
20.	Buttocks to Popliteal Length	45.02	3.085	39.945	45.020	50.095

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Anthropometric data was collected for 20 different areas of the human body to determine its dimensions. For the purpose of ergonomics study, these human body sections will be imported into the CATIA programming. A statistical analysis was performed on the data collected in order to determine the percentile. The percentiles that were chosen were the 5th percentile, the 50th percentile, and the 95th percentile, respectively. The normal distribution for each body dimension will be obtained by processing all of the data that has been gathered in the statistical analysis procedure, which will take many hours. The normal distribution may be used to calculate the mean and standard deviation, which can be obtained from the percentile of body dimensions for gamers.

Based on the anthropometric data acquired, a new idea of ergonomics hand stand will be designed with the use of the data collected and utilized as guidance. In most cases, various persons will have distinct physical sizes and dimensions than one another. As a result, the percentiles that were selected are based on the way in which the persons utilized their handphones while doing a handstand. The notion of using an ergonomics hand stand is for all gamers of any size, as long as they can utilize the handstand correctly and in excellent shape without experiencing any difficulties. As a result, it is critical to carefully choose the percentiles that will be utilized to verify that they are suitable for the product. In this case, the acceptable /ERSITI TEKNIKAL MAL AYSIA MEL percentile to utilize will be the average of the database, which corresponds to 50th percentile for this project. The reason why I picked the 50th percentile as the primary database for this project is because persons who utilized the handstand had varying anthropometric characteristics, despite the fact that they would all use the same handstand to play games. Because of this, the 50th percentile of the anthropometric database was selected to guarantee that gamers can use the ergonomics hand stand comfortably, regardless of their body size or gender.

## 4.3 Results of Questionnaire

In order to finish this research, a questionnaire was chosen as one of the techniques of collection. Essentially, the goal of the questionnaire is to determine the level of student worry about certain requirements. In this project, a group of people from Facebook are invited to participate in a questionnaire session in order to get some information about them as well as about any problems that may arise during the use of the present hand stand, which is being developed. Gamer needs will be taken into consideration while developing an improved hand stand based on the findings of this questionnaire, allowing them to use the gadget more comfortably.

More than 50 people were asked to respond to the surveys in order to get feedback. Section A and Section B of this questionnaire are the two components that make up the whole questionnaire. Section A of this questionnaire asks for basic information about plople as well as an ergonomics study of how they using their smartphones. Section B, on the other hand, is more concerned with the state of gamers' condition when they utilize the existing hand stand while playing games. The final findings of the questionnaire, which was filled out by gamers, are displayed in the table and graph below, respectively. (Refer to the questionnaire - Appendix

D).

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#### (A) Gamers Basic Information and Ergonomics Analysis While Playing Games

Figure 4.1 depicts the age information collected from 63 people via the use of a questionnaire. According to the statistics, the majority of the candidates are between the ages of 18 and 25, followed by the next age group, which is between 26 and 30 years old. 31 and older had just 2 percent of the data, while 18 to 25 year olds held 57 percent of the data (36 gamers) and 41 percent of the data (26 players), which were held by those between 26 and 30 years old, respectively.



Figure 4.1 The information about the players' ages

Figure 4.2 depicts the information pertaining to the applicants' gender identities. The bulk of the population is owned by women, who are represented by 44 candidates, with the remaining candidates being male.



The comfortability of using smartphone was recorded in the data below (Figure 4.3). Most of the candidates was comfortable when using smartphones. Only 6 candidates were not comfortable when using smartphones.



To be more specific, the applicants were questioned about if they had games on their phones. And the outcomes were exactly what had been predicted by the pie graph (Figure 4.4). From the data, 58 respondent have games in their phone out of 63 respondent.



In order to get the best findings, the applicants were questioned about their level of activity when participating in games. The information's was exposed in Figure 4.5. This will aid in the achievement of spectacular outcomes with the new ergonomic hand stand. Only 5 people out of a total of 63 respondents are not actively participating in gaming.



Figure 4.5 The data of the candidates actively participating in gaming

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The next piece of information pertains to the gadget that applicants use while participating in games. Some folks enjoyed playing video games on their laptops or personal computers. The proportion of people who use their smartphones to play games is larger than the proportion of those who do not.



Figure 4.7 depicts the frequency with which the applicants engaged in game-playing activities. According to the statistics, those who spent 3 to 5 hours per day playing games received the highest ranking, followed by those who spent not more than 2 hours per day playing games. It is then followed by more than 5 hours everyday, once every few days and then once a week or fewer.



Figure 4.7 Frequency of the candidates playing games

The kind of gamer is the most important thing to ask in order to get the greatest results from a decent and high-quality ergonomic handstand product. According to the results of Figure 4.8, casual players who play games for pleasure took top position among the rest of the participants. The second position went to the competitive players who wanted to develop their abilities even more than the first. As can be observed, there isn't a single professional player among the contestants who is actively seeking to win the tournament.



Figure 4.8 Data of type of gamers

The condition of the applicant is the primary reason for administering this questionnaire. An excellent ergonomic product may be created as a consequence of the findings. It is possible to gain the painful regions of the body as a consequence of the outcome. The end outcome is seen in Figure 4.8.



Figure 4.8 The result for comfortable and uncomfortable when using smartphone

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Data on applicants' pain while using a smartphone was collected, and then the following set of data was acquired to establish which body parts were the most impacted by using a smartphone. It was decided to evaluate the applicant's injured body parts, and the findings are given in the following section.



UNIVERFigure 4.9 Data of injuries body part AYSIA MELAKA

## (B) Current Hand Stand in Market Place

Following the completion of the ergonomic components, the following step is to discuss the current hand stand available on the market. To improve upon the present product, it is necessary to first identify its flaws. Then, using the superior material, test the product to see whether it is the correct approach to proceed. The information provided below pertains to the present hand stand in various states of repair that may be seen in market locations.





4.12 Data of the current hand stand that offer ergonomics concept



Figure 4.14 The results of the material for controller for current hand stand



The next following set of data was gathered in order to design a new ergonomic hand stand. Based on these findings, a new ergonomics hand stand may be introduced at the same time as a new product that meets consumer demand while also including an ergonomics idea in its entirety.



Figure 4.16 The recorded data of what gamers needs for the new product



Figure 4.18 The information from applicants who wants a new product that capable to use

anywhere



Figure 4.20 The results of the applicants who wants a new product that can adjust the heights







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#### 4.4 Conceptual Design

The design was created in accordance with ergonomics measurements that were taken from the present handstand hanphone and used to establish a superior design that was more ergonomically sound. When designing a phone handstand, it is important to consider the dimensions of the human body in order to guarantee that the consumers feel comfortable when using it. Consequently, to ensure that gamers can score while using an ergonomic product to play games, the ergonomic hand stand proportions must be appropriate for the person who will be using it and the users must be able to adjust with it in a comfortable setting. The opposite is true if the handphone hand stand proportions do not correspond to the person who is using it, with a significant risk of uncomfortable injuries occurring.

#### 4.4.1 Concept Generation

The conceptual design is identified in order to determine the ability of the gamers to be comfortable when utilising a handphone hand stand while playing games for an extended period of time efficiently. This has been accomplished via the brainstorming of the conceptual design, which has been drawn out in order to provide more optimised solutions that are acceptable and comfy for the consumers who will be using it. It was possible to carry out the ergonomics handphone hand stand creation and analysis with the aid of CATIA's RULA ergonomics software. In accordance with the criteria chosen, all conceptual designs will be examined in order to determine if ergonomics factors should be taken into account throughout the improvement design process. The idea design was created based on the responses received from gamers in a survey, as well as the handphone hand stand that is already available in the marketplace. (Refer to Appendix E).

From the questionnaire, a list of respondents' requirements can be developed, which are:

- a. A hand stand that can reduce body injuries such as shoulder, wrist, arm and fingers.
- b. The design of the hand stand can help gamers perform while playing games.
- c. Gamers or users can use the handstand comfortably according to their size.
- d. The design of the hand stand must consider about the user's shoulder, wrist arm and fingers to make sure it's in comfortable condition.

The main idea is making the hand stand with adjustable height as anthropometry for every respondent are varies. One of the ideas is shown in Figure 4.22. This conceptual hand stand hanphone will be intersect with the table using clip and has interchangeable angle with adjustable height by using screws for each level. Several things need to consider ensuring the stability of the hand stand. One of the considerations is the distance between hands as it is difficult to ensure the interval that is set can meet everyone's satisfaction. The balancing and the pressure that can be withstand by the hand stand. The depth of the hole also needs to be measured to ensure the hand stand will stay still when high force is exerted at all edges. Last but not least, material selection is also one of the important keys to consider the structural frame of the hand stand needs to be sturdy. Using heavy material as the base will solved this problem.



Figure 4.22 First idea of adjustable height hand stand.

An assembly idea was used for the second conceptual design, which allowed for the change of the hand stand height. The concept for this table was derived from a seat flip up table with a storage compartment. When users are seated on the floor, they just open the hand stand and utilise it as needed. If the gamers need to use the hand stand when standing, they may simply attach the shaft to the slot on the back of the hand stand that already exists. Figure 4.23 shows an illustration of the mechanism. Some of the reasons for the unavailability of this design are because individuals have varying body dimensions. There are just two options for the adjustment, sit or stand. This will make it difficult for the user who does not have a hand stand that is the proper size. When users or gamers use the device while standing, the balance will become problematic.





The third and last design for the hand stand, which is the final idea, will be assembled from simple parts. In order to build a full hand stand, there will be eight pieces in total. This hand stand was created particularly for gamers who played games on their phones while sitting at a table. Figure 4.24 explained about the design. This hand stand may be adjusted to the user's comfort level by adjusting the height of the stand. This hand stand will be locked at the heights that the gamers choose to use it at. The hook will secure the handphone's balance, resulting in an improvement in overall stability. The basis of this design is the most important component. The base was constructed of a solid material to ensure that the product's stability could not be questioned.

adjustable Short P 19/2 adjustable 1 height Th ALAYS UNI AKA

Figure 4.24 Third idea generation

#### 4.5 3D Modelling in CATIA V5

The third idea generation has been selected as the improvement of the current hand stand handphone. All the figure will be displayed in diametric and isometric view. The exact dimension for the components can be referred to Appendix B.

### 4.5.1 Base



Figure 4.25 Isometric view of the base

#### 4.5.2 Bottom Stick

Figure 4.26 shows the bottom stick of the component. The bottom stick will attach with the base on the bottom and attach with the top stick for the top. The material chosen for the bottom stick are stainless steel.



4.5.3 Stick Lock

Figure 4.27 shows that the stick lock which designed to grip the adjustable of the heights of the hand stand. The material chosen was plastic because it will help in reducing weight of this new ergonomic product.



4.5.4 Top Stick

Figure 4.28 shows the top stick of the component which designed to increase the height of the hand stand. The top stick will attach with the hook connector. The material chosen for the top stick are stainless steel.



### 4.5.5 Hook Connector

Figure 4.29 is a hook connector that can be assembled. When connecting the hand stand, the hook connector will be attached to the top stick at the bottom, while at the top, the hook connector will be attached with a hook. The material chosen for hook connector was plastic.



4.5.6 Hook

Figure 4.30 is a hook that control angle of this product. It is attached to the phone holder with a hook connection at the bottom and to the hook connector with a phone holder at the top. Grip lock components are placed between the hook and the phone holder, allowing the hook and the phone holder to be locked together so that they adhere to one another.



4.5.7 Grip Lock

Figure 4.31 is a grip lock components that are placed between the hook and the phone holder. The function of the grip lock is to lock the hook and the phone holder to one another.



#### 4.5.8 Adjustable Phone Holder

In Figure 4.32, you can see an adjustable phone holder that connects using a hook and grip lock system. The phone holder's primary function is to hold the phone when users or gamers are using their phones to play games. The plastic used in the construction of the adjustable phone holder. The material was selected for its ability to ensure the user's safety. This will protect consumers from receiving an electric shock while they are using their phones while they are charging.



4.5.9 Assembly of new ergonomics hand stand handphone

Figure 4.33 shows the assembly of the component. All eight parts in total have been assembled together to make it a single product.



Figure 4.34 shows the real photo of the product which is new ergonomics hand stand handphone.



### 4.6 RULA Analysis by using CATIA software

RULA analysis is used to figure out how much exposure each individual worker has to ergonomics risk factors that can cause upper extremity MSD. CATIA V5 software has been used to finish the analysis process. RULA analysis has been used. For this part of the analysis, the hand stand handphone is drawn with the help of CATIA and is based on the height of the current hand stand handphone. Manikins (human bodies in CATIA V5) were made. The manikin's body size was set to the percentile that came from a database of gamers' anthropometry (refer to Table 4.1). CATIA was used to draw the general shape of the chair with the lowest height. Finally, the RULA analysis will be applied on the manikin that which is set in sitting posture.

Before beginning the RULA analysis of sitting position, it is necessary to assemble the current hand stand handphone, the manikin (human body in CATIA V5), and the chair together. Then, utilizing the computer table, the manikin (human body in CATIA V5) will be set up in a sitting position for testing. The posture that is configured in CATIA will correspond to the way that gamers often position while playing games on a table with a handstand and a handphone. This will be followed by the establishment of the RULA analysis for the state of the playing handphone posture. The results of the RULA analysis will be shown in the figure below. The same procedures that were employed in the analytical method will be applied in the redesign of the ergonomics computer table as well.

Before doing the RULA analysis for the current computer table and the redesign ergonomics computer table, the body dimensions of the manikin (human body in CATIA V5) need to be modified by referring the percentile of gamer's database.

RULA analysis is used to evaluate required body posture, force, and repetition. Based on the evaluations, each body region of scores are entered for the upper arm, lower arm, wrist, neck, trunk and legs. Figure 4.38 and Figure 4.39 show the complete RULA analysis of gamers who used the current hand stand table with sitting posture in CATIA V5 software. In RULA analysis, there are 4 levels show the score that represents the level of MSD risk as outlined below:

a. Level 1 - (RULA score of 1-2) indicates negligible risk, no action required.

b. Level 2 - (RULA score of 3-4) indicates low risk, change may be needed.

c. Level 3 - (RULA score of 5-6) indicates medium risk, further investigation, change soon.

d. Level 4 - (RULA score of 7+) indicates very high risk, implement change now.



4.6.1 Sitting posture while using hand stand handphone on a table

Figure 4.34 shows the isometric view of the manikin sit on the chair while using hand stand handphone on a table in CATIA V5 software.







Figure 4.37 Side view

Figure 4.38 Rear view

This manikin is set as sitting posture and facing with hand stand. The results in Figure 4.39 indicate result for left hand. For left hand posture result, the final score of the manikin is 5 which indicated in orange. The problems occurred at wrist, wrist and arm, muscle, neck, trunk and leg. So, the final score for this side indicates medium risk posture needs to do further investigation and some parts need to change.

For the result of right hand side part is shown in Figure 4.40. The final score of manikins using the hand stand handphone is 5 (orange color as indicator). The problems occurred at forearm, wrist and arm, muscle, neck, trunk and leg. So, the final score for this side indicates medium risk, further investigation is needed, and the posture of the problem parts need to be improved.



Figure 4.40 The RULA analysis for right hand side

4.6.2 Siting posture using the new ergonomics hand stand handphone

Next, we input a redesign adjustable ergonomics hand stand to run an analysis to test on ergonomics. The analysis process will follow the same as the current hand stand. Figure 4.41 shows the isometric view of the manikin sitting on the chair while using the new ergonomics hand stand handphone in CATIA V5 software.



Figure 4.42, Figure 4.43, Figure 4.44 and Figure 4.45 show the top view, front view, side view and rear view of the manikin sit on the chair while using the current the current hand stand handphone in CATIA V5 software.



Figure 4.44 Side view

Figure 4.45 Rear view

Figure 4.46 and Figure 4.47 show the complete RULA analysis of student with the same sitting position as current hand stand handphone. For the result of left hand side part, the final score of the manikin using the new ergonomics computer table is 3 (indicated as yellow). After the improvement on the hand stand and also the posture of manikin, the problems for forearm, neck, trunk and leg have been solved which the yellow colour indicator have changed to green color indicator. While wrist and arm color indicator changed from orange to yellow

For the result of right hand side part, the final score of manikin using the new ergonomics hand stand is 3 (indicated as yellow). The improvement of the hand stand and the posture of manikin have minimized the problems for forearm, neck, trunk and leg which the yellow color indicator has changed to green colour indicator while the wrist and arm has changed from orange colour indicator to yellow colour indicator.





Figure 4.47 The RULA analysis for right hand side

### 4.7 Current Computer Table and New Ergonomics Computer Table Test on Respondent

In this section, a respondent have been selected for doing this test to prove that the improvement between the current hand stand and the new ergonomics hand stand. The respondent are the frequent users who use the current hand stand while playing games. Besides that, this respondent are also one of the respondents who took part in answering the questionnaire.

#### 4.7.1 Respondent A using the current computer table

Figure 4.48 shows the sitting posture of the respondent while using the current hand stand. The figure below clearly shows that the respondent could be easily get injuries and disorders at many body parts while playing games with the current hand stand due to:

- a) The device is too far from the respondent eyesight that might cause neck injuries.
- b) The current device can't reach the eye level of the respondent.
- c) The wrong position of arm that might due to hands pain.
- d) The posture of body that needs to go further to reach the device that might get UNVERSITIEKNIKAL MALAYSIA MELAKA back pain.

4.7.3 Respondent using the new ergonomics hand stand handphone

Figure 4.49 shows the sitting posture of the respondent while using the new ergonomics hand stand handphone. The figure below clearly shows:

- a) The device can be adjust followed the users comfortability.
- b) The screen of the phone can reach the eye level of the users.
- c) The correct position of wrist, arm and shoulder.
- d) The posture of respondent's body getting comfortable.



### 4.8 Comparison of hand stand

For this section, there will be a comparison between current hand stand and the new ergonomics hand stand. Table 4.2 below shows the different between both hand stand.

No	Comparison	Current Hand Stand	Ergonomics Hand Stand
1.	Adjustability		٨
2.	Durability		ν
3.	Comfortability		1
4.	Space	$\checkmark$	
5.	Ergonomics		√
6.	Material	$\checkmark$	
7.	Aesthetic		
8.	Easy to use	KA V	
9.	Safety		
10.	Productivity		
11.	Performance		1
12.	Cost	s, Spie	ىتۇم سىتى ئىچ

#### 4.9 Costing

For the sake of this pricing section, a comparison between the present hand stand and the new ergonomics table will be made. The current cost of a hand stand was determined via the use of Shopee, but the cost of a new ergonomics computer table was estimated since the components were purchased and constructed by the creator. The costs for the present hand stand and the new ergonomics hand stand handphone are shown in Tables 4.3 and 4.4 below, respectively. It is more expensive to manufacture the new ergonomics hand stand than it is to manufacture the current hand stand because the current hand stand only uses aluminium for their device, whereas the new ergonomics hand stand has many components and incorporates other materials for safety purposes, resulting in a higher cost. EYSIA .

	1 able 4.5 Cos	Current P	tand Stand Hand	ipnone
No	Component	Quantity	Material	Cost
1.	Hand Stand Handphone	1	Aluminium	RM 15.25

NP

Table 4.4 Cost of New Ergonomic Hand Stand Handphone

	4 Malund	» 15:	Gü är	
No.	Component	Quantity	Material 5	Cost,
	Adjustable Grip	1	Plastic **	RM 9.70
	UNBase RSITE	TEKNIKAL	Mild Steel	RM17.00
	Bottom Stick	1	Aluminium	RM3.55
2	Hook Connector	1	Plastic	RM4.30
	Hook	1	Plastic	RM3.30
	Top Stick	1	Aluminium	RM 3.70
	Phone Grip Lock	1	Plastic	RM1.30
	Stick Lock	1	Plastic	RM2.70
	Silicone	1	Rubber	RM1.90
	Te	otal		RM 47.45

#### **CHAPTER 5**

#### CONCLUSION AND RECOMMENDATION

#### 5.1 Introduction

The general overview of the project will be brought to a close in this chapter. The recommendations and suggestions for improvement will be summarized for the sake of the future project. The findings and results from the ergonomics design study of the present hand stand that has been sold in the market were included in the summary of the findings and results. The upgrading of the existing hand stand has been addressed in order to prevent injuries and ailments related with the usage of soft tissues, such as muscles or tendons, uncomfortable posture, and repetitive jobs, among other things. Carpal tunnel syndrome, tendinitis, and various sprains and strains are among the most prevalent types of injuries.

5.2 Conclusion

A new ergonomics hand stand is designed and developed. This project is definitely related with the application of ergonomics aspects in designing the new ergonomics hand stand so that it is the process of designing the activity to fit the player, rather than forcing the player's body to fit the activity. In order to reduce physical stress on the body and remove potentially crippling job-related musculoskeletal illnesses, it may be necessary to adjust duties, the work environment, and equipment to match the special demands of gamers (MSDs).

It has been determined that injuries and disorders of the human body posture have occurred as a result of the present hand stand research and analysis that has been carried out. Before identifying the issue, it is necessary to gather all of the anthropometric data from the players involved. Although all of the anthropometric data was evaluated, the anthropometric database among gamers was determined. The present hand stand's dimensions have been measured and drawn with the help of the CATIA V5 modelling programmer. Using the CATIA V5 software, a new manikin has been created, and the measurements of the human body have been keyed in using an anthropometric database that has been created by collecting data from a group of individuals. The manikin was implanted with the present hand stand in order to identify the cause of the posture issue and to make improvements to the current hand stand in order to achieve a more ergonomic working position.

Finally, after identifying the issue with the present hand stand, a new ergonomics hand stand idea is devised and produced into a product for the market. The new ergonomics hand stand is designed to not only suit everyone for excellent working posture, but also to eliminate injuries and diseases associated with poor working position. All of the goals have been met and all the objectives have been achieved.

### 5.3 Recommendation

Following the completion of this study, several suggestions for the future of this project have been suggested. To enhance working posture (both sitting and standing posture), to improve the design of the product, which is a novel ergonomics hand stand, and to include an ergonomics design feature into our daily lives, it is recommended that more research be conducted.

In accordance with the findings of the completed RULA study (see Section 4.6), modifications have been made to the present hand stand in order to accommodate the new ergonomics hand stand. In order to achieve a suitable working posture, the posture of several body components has been corrected. However, when it comes to the muscle component, it is the only part that

has still recognized the issue, which is shown by the colour red, and it is this part that requires additional investigation (Refer to figure 4.39, figure 4.40, figure 4.46, figure 4.47). Furthermore, it is necessary to do further research on the muscle component and to make improvements to the hand stand design in order for the hand stand to be suitable for every user. Apart from that, research may be carried out to determine the state of the muscular system in preparation for future studies.

For individuals who utilize the new ergonomics hand stand, the eye level with the phone screen is also a concern for them while using the device. Because of the differences in height between users, there is a difference in eye level when looking at the phone screen. The top of the screen is at or slightly below the level of the observer's eyes. Whenever you're looking towards the centre of the screen, your eyes should be slightly downward. Consequently, by developing the new ergonomics hand stand, additional study into the ergonomics of the view should be conducted in the near future.

The last advice is that the study should be concentrated on the feet. Whenever a person sits for an extended period of time without touching the ground, there is always the issue of their feet being lame. Users must increase the height of their chair in order to maintain proper sitting posture because the chair is too high for them to rest their feet flat on the floor or because the height of the table on which the hand stand is placed is too high for them to rest their feet flat on the floor. A footrest should thus be considered in any future research on this topic that may be conducted. Instead of a footrest, a small stool or a stack of strong books might be used as a substitute if none is available.



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