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PORTABLE WIRE TROLLEY

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ABSTRACT

Electricians and technicians are the person who installs, maintains, operates, or repairs electrical equipments in construction area, renovation area, inside or at the underground of the building. General, an electrician and technician's work is physically demanding such as climbing ladders and lifting tools or supplies from those days till now electricians and technicians were facing many problems while they working especially the problems were with wires. The reason of the problem is because they do not have a proper device or machine for the wire system. The purpose of this study is to design a portable wire trolley with auto wire puller system and pursuits all the aspects that an electricians and technicians needs. A part of its function, our project contained some safety features as per occupational safety and health act. The materials that we used were T5 LED light as an extra light source, roller with stopper and electricity insulator cover for safety purpose, hand driller technique for auto pull the wire. Our project will decrease the risk of electricians and technicians works and will provide safety for them too.

ABSTRAK

Jurutera dan juruteknik adalah orang yang memasang, menyenggara, mengendali, atau membaiki peralatan elektrik di kawasan pembinaan, kawasan pengubahsuaian, di dalam atau di bawah tanah bangunan. Jeneral, kerja juruelektrik dan juruteknik menuntut secara fizikal seperti memanjat tangga dan mengangkat peralatan atau bekalan dari hari-hari sehingga tenaga elektrik dan juruteknik menghadapi banyak masalah ketika mereka bekerja terutama masalahnya dengan kabel. Sebab masalahnya adalah kerana mereka tidak mempunyai peranti atau mesin yang sesuai untuk sistem wayar. Tujuan kajian ini adalah untuk merekabentuk troli wayar yang mudah alih dengan sistem penarik kawat automatik dan mengusahakan semua aspek yang diperlukan oleh juruelektrik dan juruteknik. Sebahagian daripada fungsinya, projek kami mengandungi beberapa ciri keselamatan seperti mana tindakan keselamatan dan kesihatan pekerjaan. Bahan-bahan yang kami gunakan adalah lampu LED T5 sebagai sumber cahaya tambahan, roda dengan penyumbat dan perlindungan penebat elektrik untuk tujuan keselamatan, teknik gerudi tangan untuk tarik wayar secara automatik. Projek kami akan mengurangkan risiko pekerja elektrik dan juruteknik dan akan memberikan keselamatan kepada mereka juga.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Electricians and technicians are the person who installs, maintain, operates, or repairs electrical equipment in construction area, inside or at the underground of building. Electricians and technicians are facing many problems while doing their work and which are very dangerous too.

The common problems that faced by electricians and technicians is about the light source which not enough for them to do their work in certain places like corners, underground and while doing their works at overnight more.

Then, based on the research we do, we get to know that it takes too much of time to roll back the wire bundle that they used (15-30 min) due to a lot of wire bundles. Commonly, electricians and technicians will use three types of wire bundle that is phase conductor (line), neutral conductor and protective conductor (earth). the number of the wire bundles that used is depends on the dimension of area.

Thus, electricians are facing problems to bring their things all in one time for example the wire bundles while working in sufficient heights. It can be stated as not convenience to move the wire bundles from one time.

This types of common problems can lead to serious risks like electrical burns and fatal electrical shock. This is the reason why we are doing “Portable Wire Trolley”.

1.2 PROBLEM STATEMENT

After conducting an observation, there are some problems faced by electrician and technicians that we had found. The main problem is wires after used had not keep neatly in a short time. As mention before, electricians and technicians need to roll back the wires by manual. They will take 15 to 30 minutes to roll back the wire neatly after using it. If they did not keep the wire neatly, the sites will be messy. This also will affect their working at the next time because sometimes the wires will tie together.

The next problem is sometimes the workplace had no enough light source especially electrician and technician work at night time and without any daylight. Examples for the light source is not enough at certain places such as corners, underground level of building This will cause their work be harder and decrease the work of efficiency.

In addition, we had found the problems was electricians or technicians will not convenience to move large quantity of wires bundles from a place to another place. Below has a picture is about the quantity of the wires to be use on site.

1.3 OBJECTIVES

This is 3 objectives of the project:

1. To designs with the torchlight that can give extra light source to electrician and technicians when the workplace is not enough light sources. Especially underground, corners or at night time.
2. To identify with the cable pulling device to roll back the wires neatly within a short time.
3. To identify the movable trolley with stopper for safety purposes. The stopper is use to stabilise the trolley. Then electricians and technicians also no need to carry the wire bundle because the trolley can help them carry the wire bundle from one place to another place. to move all the wire bundles in one place to another place and stopper wheels to stable the trolley.

1.4 SCOPE OF PROJECT

The creation of Portable Wire Trolley for technician or electrician to save their time, energy and provide a safety equipment to them during their working. Besides that, we had considered some scope that suitable for our project.

The scope of project is for renovation area:

1. Electric room The Sphere mall, Kuala Lumpur
2. Block B, ground floor, Utropolis, Glenmarie, Shah Alam
3. Shop Lot TTDI Jaya, Seksyen U2, Shah Alam
4. Electric room NU Sentral, Kuala Lumpur

During renovation time, they need to install wires to connect the electric supply and 2.5mm² wire is usually and major quantity use to connect the electric supply to socket outlet.

Furthermore, the scope of project is use for the ground floor of building This is because Portable Wire Trolley has a heavy weight and it need to move to upper level by using lift.

1.5 MATERIAL, APPARATUS AND COSTING

NO.	MATERIALS	PRICE PER UNIT	QUANTITY	OVERALL PRICE
1.	Aluminium plate	RM55.00	2	RM110.00
2.	Hand drill	RM60.00	1	RM60.00
3.	Wire bundle	RM45.00	1	RM45.00
4.	LED 6W T5 DC12V-80V Lamp	RM23.00	1	RM23.00
5.	GPP 1272 (12V,7.2AH) Battery	RM55.00	1	RM55.00
6.	Wheel without stopper	RM9.30	2	RM18.60
7.	Wheel with stopper	RM16.50	2	RM33.00
Total				RM344.60

Table 1.5 Material, Apparatus and Costing

1.6 SUMMARY OF CHAPTER

In my conclusion, after conducting an observation the problem that faced by electricians and technicians during their working times, our idea “Portable Wire Trolley” will make the work of electricians and technicians to be more convenience. The problems we mentioned before are sometimes the working place like construction area is not enough light sources and difficult to keep the wires neatly after used. So if the light sources not enough, this will make them difficult to focus on working. As we know, electricians and technicians is a high risk work. If they careless during working, an incident, accident or near miss will happen.

So, we design with the torchlight that can give extra light source to electrician and technicians. This is because torchlight is easy to carry and also can light up the place in 360°

Furthermore, wires are the most often things that used by electricians and technicians during working. They need to carry more than one wires bundle from one place to another place, this seen like very strenuous. Sometimes it will cause the worker be injured. Moreover, the wires should not be keep neatly after used. This will make the sites to be messy and the messy wires will decrease the efficiency of work of electricians and technicians. Examples, worker will stumble by the messy wires.

Thusly, our innovation has identified with the cable pulling device to roll back the wires neatly within a short time within 2-3 minutes. It's operation concept will be like the hand drill system.

Lastly, 'Portable Wire Trolley' is a multipurpose trolley. It can provide extra light sources, can move large quantity of wires bundle and can keep the wires bundle neatly. Our original intentions are decrease the risk of work of electricians and technicians and provide safety to them.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In carry out a project, literature review is the most important part to proceed a research proposal and result section. A well-structured literature review is characterised by a logical flow of ideas like current and relevant with consistent, appropriate referencing style such as proper use of terminologies and an unbiased and comprehensive view of the previous research on the topic.

This report that we need to study about the types of materials, size and colour and method of installation, level of product safety, structural strength, project size and the others. This all is to ensure that can follow the specifications and can safety applied and no any problems would happen during completion the project.

Furthermore, the study was conducted to obtain information for project implementation in a timely manner. The systematic planning is use to produce complete and prefect project.

2.2 HISTORY

At the last century, wires were widely to use to connect the electricity. During working, workers had always manual roll back the wires after used. Because of this strenuous action, some inventor had invented a product call 'Wire Reel'. For the first version of it, it had roll on a reel and the wires will keep when rotate the reel.

After this, 'Wire Reel' had been upgrade to "Wire Roller". The wires still roll a reel but besides a reel had a paddle. The paddle function is pull the paddle will cause the reel rotate and at the same time to keep the wires.

Until now, we had a creation about auto roll back the wires when after used. This invention is related to apparatuses and methods for spooling wires.

2.3 PREVIEW RESEARCH

2.3.1 Safety

An article by four authors, Jianzhong Lin, Tianhong Yan, Xinsheng Xu and Zhengyi Jiang in 2014 said that construction refers to a number of industrial processes with increased risk. Every year on the construction objects there are many accidents. Big amount of accidents had some reason, including the organizational and related to the lack of knowledge in the field of safety. So this article discusses the relevance and options for education in the field of security in the construction. Would be particularly useful experience of foreign construction companies and training centres in construction safety area.

Problems of occupational safety in construction area are very serious, as evidenced by the high level of accidents. Occupational safety and health in construction is a system of interrelated legal, socio-economic, technical, hygienic and organizational measures. Its purpose is to protect the health of construction workers from accidents and occupational disease, as well as provide the most favourable conditions for increasing productivity and quality of work performed.

Experience the world's largest companies shows that the top managers is considered the labour protection as one of the top priorities. Thus, among the many indicator of the enterprise, safety and health of their workers, they put on the second place, immediately after the qualification and competence of personnel. In the European Union today raised the issue of safety culture, which is the one of the key elements of enterprise management.

However, managers of construction organisations are laying the expenditure budget insufficient training costs and providing personal protective. It is therefore particularly important to give employees the necessary knowledge in the field of construction safety before the beginning of professional occupation.

The basis for high performance and safety, the prevention of possible hazards is right organisation of construction site and construction and installation work. Therefore,

safety issues into account when drafting the organisation works, which are carried out with strict observance of the requirements of the building regulations.

The main cause of injuries in construction is workplace of worker is not constantly, moving all the time. Because of this, they always need to take time to recognise a new place and identify where is not safety. Second cause is on the object at the same time is a lot of different building processes in different places and at different heights. Last cause is on the object at the same time running a lot of different building organisation not subordinated to each others and not harmonized among themselves.

2.3.2 Reasons of Injuries

Based on my research, an author, Hester J.Lipscomb at 2010 said that contact injuries accounted for 54% of all construction emergency departments treated injuries. Hospitalizations were most common for injuries from contact with discharged nails from pneumatic nail guns, with hand held power saws, and fixed saws. Some injuries were proportionally more serious and sometimes involved multiple workers including trenching injuries and those resulting from collapse of buildings under construction, walls, roofs, and scaffolding.

Then, an author, Ivan W.H.Fung at 2009 said that problems on occupational health and safety are commonly occurred in the construction industry, including falling of materials or person from height, stepping on objects and injured by hand tools. Key of dealing with project safety and risk assessment in construction industry is important, thus, way on doing assessment and liability of assessment are necessary for all professionals. However, it is found that those professionals prone to heavily rely on their own experiences and knowledge on decision making on risk assessment, which lack of a systematic approach and lack of ways to check the reliability of the decisions.

2.3.3 Prevention of Injuries

A journal has about decisions made before construction can affect safety on the construction site, either positively or negatively. This was observed from past research that identified the link between design decisions and fatalities. The concept of implementing design decisions that positively affect safety falls under the general concept of prevention through design (PtD), which attempts to identify and mitigate hazards early in the design process to eliminate the risks of injury or damage during construction. Prevention through design is practiced in other countries, primarily through legislation. The objective of this paper is to present the results of a survey that was conducted to identify construction industry stakeholders' views on the concept of PtD and gauge the possibility for implementing PtD in the U.S. construction industry through either legislation or other means. Four distinct groups were surveyed: engineers, architects, contractors, and owners.

Within this study, PtD was described and introduced to survey participants as design for construction worker safety (DCWS) to differentiate PtD efforts in construction from efforts in other industries. The survey consisted of questions that asked about the industry's knowledge of PtD and the extent of PtD practice in the United States, participants' opinions on designer and owner safety knowledge and perceptions, and obstacles and enablers for designer participation in construction safety. The responses from the various groups were compared to identify the groups that are more receptive to the idea of designer participation in construction worker safety. The results showed that architects were the least receptive to the idea, whereas the other groups were more likely to be supportive, with some hesitations. Architects and engineers identified the existence of economic, legal, and contractual obstacles for designers to practice DCWS, whereas contractors only identified economic obstacles. No enablers were identified by any group. The research contributes additional information that can be used by construction industry practitioners and organizations desiring to expand and optimize PtD implementation in the United States. The research results can be used by project teams to plan for PtD education and training efforts on projects and by construction industry organizations to develop PtD diffusion strategies.

2.3.4 Wire Spool

An invention article by an author, Bigbee Jr. in 2015 said that to distribute electricity throughout a building, insulated electrical wires or cables are installed between a power source and a power distribution box and routed to electrical boxes to supply electricity to a device. Often, these electrical wires or cables are routed through multiple conduits throughout the building spanning great distances. As such, installing electrical wires presents both logistical and mechanical challenges. Wires are typically installed in a building by pulling the wire via pulling cables through the buildings infrastructure. The wire is spooled off of a reel assembly during the wire pulling process.

Wire is typically transported from a wire manufacturing site to the building construction site on the reel assembly. These reel assemblies can have diameters of up to 48 inches or more, and are capable of carrying thousands of pounds of wire. At the construction site, construction workers are faced with the challenge of spooling the large bulk of wire from the reel assembly during a wire pull. The reel assembly is usually lifted off of the ground and set upon a pair of jack stands, which allows the reel to freely spin during a wire pull. During a wire pull, one end of the wire is attached to a pulling cable.

There has an invention an apparatus for spooling wire. In a preferred embodiment, the apparatus is a reel assembly comprising an inner flange assembly and an outer flange assembly. The inner flange assembly is Supported by the outer flange assembly and capable of freely rotating relative to the outer flange assembly. In another embodiment, a method is disclosed for spooling wire from a reel. The reel assembly comprises an inner flange assembly and an outer flange assembly. Wire is wrapped around the inner flange assembly for spooling. The inner flange assembly is Supported by the outer flange assembly and capable of freely rotating relative to the outer flange assembly. Wire is spooled from the reel assembly while the assembly rests directly on the ground or some other Surface.

2.3.5 Swivel Castor Braking System

An article by Andre Fallshaw in 2012 state that for many years swivel castors with braking systems have been constructed such that the brake pedal is attached to the swivelling fork or frame element of the castor. When these castors are mounted to the bottom of a piece of equipment or furniture, such as an equipment trolley, the brake pedal rotates with the castor and in particular positions the brake pedal is orientated such that access is restricted by the trolley. If four swivel castors are attached to the base of the equipment trolley at its corners, and the trolley is pushed from one side, all four castors swivel to align themselves with the direction of travel. This will position two of the brake pedals underneath the trolley, making them difficult to access to activate the respective brakes. It is therefore an object of the present invention to provide an improved castor assembly, in which this disadvantage of present castor assemblies is addressed.

A swivel castor assembly, includes a body having at least one rotatable wheel engage able with a floor or ground surface below the body, a brake actuatable to brake or prevent rotation of the wheel, and an element for mounting the body such that it is able to swivel about a generally upright axis. A head is adapted to be mounted to prevent or restrict its rotation about the upright axis. A brake activator is mounted to the head for movement between a braking position in which it activates the brake, a neutral position in which the brake is inactive and the body is not prevented from swivelling about the upright axis, and a direction-lock position in which the body may be swivelled to one of plural selectable orientations with respect to the head at each of which the body is locked against swivelling but the brake is inactive.

2.4 TYPES OF WIRES

A wire is a single, usually cylindrical, flexible strand or rod of metal. Wires are used to bear mechanical loads or electricity and telecommunications signal. Wire is commonly formed by drawing the metal through a hole in a die or draw plate. Wire gauges come in various standard sizes, as expressed in terms of a gauge number.

2.4.1 Alarm Wire



Figure 2.4.1 Alarm cable

Source: Sapphire. Choosing The Alarm Cable. Sapphire Alarms, 1983. <http://www.diy-alarms.co.uk>. 09 June 2013.

Security alarm cable is a type of shielded cable used to connect up security systems. The sheath provides protection against frequency interference, which could otherwise cause false alarms to occur.

Security alarm cables consist of a number of strands of wire, all contained within a protective sheath. They connect the alarm device to a power supply, making the alarm sound when the device is triggered. If a sensor is inbuilt, movement is detected by the cable and a signal is sent to sound the alarm. Security alarm cables can sometimes be embedded into the ground or into walls to detect intruders.

2.4.2 PVC Insulated Wire



Figure 2.4.2 PVC insulated cable

Source: Gaurang Gupta. Why are PVC Insulated Wires Needed by Electrical Industries. Rajasthan Electric Industries, 1959. <http://www.rajasthanelectric.com>. 20 Feb 2019.

PVC (Polyvinyl chloride) is widely used in electrical cable construction for insulation, bedding and sheathing. PVC started to replace rubber insulated and sheathed cables in general household wiring due to its ease of processing. PVC is cost-effective and also has excellent ageing properties and typically exceeds a 25 to 30 years' service life.

Cable with a PVC insulation or sheathing is flame retardant, which is an important consideration for electric cables in most applications. PVC can be made resistant to a wide range of chemicals including oils, acids and alkalis, and is tough, durable and resistant to abrasion. The addition of various additives can improve its temperature range, typically from -40 to 105°C, as well as the resistance to sunlight, reduced smoke emission and improved water resistance.

2.4.3 Synthetic Rubber Flexible Wire



Figure 2.4.3 Synthetic Rubber Flexible Cable

Source: Julia Tong. Rubber Double Insulated Welding Flexible Rubber Cable with Test Report. Zhengzhou Jinyuan Wire And Cable Co., Ltd, 2015. <https://www.vwcable.com>. 07 July 2015.

Synthetic rubber flexible cables ideal to provide power supply to portable electrical equipment and devices. The mechanical stresses involved in moving apparatus require cables to withstand a high degree of wear-and-tear. These flexible rubber cables are suitable for a wide range of applications including mobile power supplies, light and heavy duty equipment, and submersible pumps, as welding cables providing power from the machine to the tool, for audio visual equipment, and equipment on construction sites.

2.4.4 Trailer Wire



Figure 2.4.4 Trailer cable

Source: Jacketed Trailer Wire, 4-Way, 6-Way, And 7-Way, 100 Ft. Spools. Wiring Depot, 1979.
<https://www.wiringdepot.com>. 10 January 2018.

Trailer connector is a multi-pole electrical connector between a towing vehicle such as a car or truck and a trailer. It is intended primarily to supply automotive lighting on the trailer, but also provide management and supply to other consumers. It is also referred to as trailer wire, trailer cable, or trailer connecting cable. Another feature the connector offers is feedback from the trailer to the towing vehicle

2.4.5 Conclusion

Based on the research of the type of wires, PVC insulated wire had chosen as the component of Portable Wire Trolley. This is because PVC insulated wire is most often used to connect the electric supply to device and long life span such as 20 to 30 years.

2.5 COLOUR OF WIRE

Wires have many types of colour and common colours have red, black, blue and green. The picture below has showed that the usage of wires in different colours and used in Malaysia.









	Single Phase	Three Phase
Phase Conductor (Line)	 Red or  Yellow or  Blue	 Line 1 Red  Line 2 Yellow  Line 3 Blue
Neutral Conductor	 Black	
Protective Conductor (Earth)	 Green-and-Yellow	

Figure 2.5 Colour of Wire

Source: Cherroy. Wiring guide : 3 colour wire (green, blue, black), which one neutral, live and earth. Lowyet.net, 2003. <https://forum.lowyat.net>. 01 June 2001.

2.6 MATERIAL OF WIRE

Many materials are used to transmit electrical energy, but those most frequently specified for types of conductors are copper, aluminium and others. For more unusual applications, conductors are fabricated from pure nickel, pure silver, copper-covered aluminium, and a host of metals, metal alloys, and metal combinations.

These metals may be coated with rubber, polyethylene, asbestos, thermoplastic, or varnished cambric material, which are called insulators as they have very low electron mobility (few or no free electrons), all of which depend on the voltage of the circuit, the temperature, and whether the circuit is exposed to water or chemicals.

Not all conductive metals have the same level of conductivity – some obviously being better than others – and not all insulators are equally resistant to electron motion. Additionally, it's also useful to know that some materials experience changes in their electrical properties under different conditions. The following section will go over some of these differences.

2.6.1 Copper

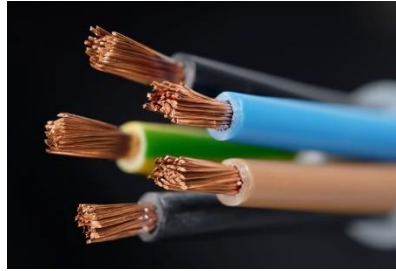


Figure 2.6.1 Copper Wire

Source: Teflon Coated Copper Wire. Huadong Cable Group, 1988. hdchightemperaturewire.com. 5 March 2010.

Copper is the electrical conductor in many categories of electrical wiring. Copper wire is used in power generation, power transmission, power distribution, telecommunications, electronics circuitry, and countless types of electrical equipment. Copper and its alloys are also used to make electrical contacts. Electrical wiring in buildings is the most important market for the copper industry. Roughly half of all copper mined is used to manufacture electrical wire and cable conductors.

Surpassed only by silver, copper is a highly conductive metal. This means electricity can pass through it with greater ease, making it ideal for use in electrical wires. Companies can use other conductive metals to create electrical wires. Unless they use silver, though, the high conductivity properties of copper allow for a greater distance of electrical current travel. Companies can create longer, better performing electrical wires using copper instead of most other conductive metals.

Copper is also relatively inexpensive when compared to other metals. Gold, for example, is an excellent conductor of electricity, but it costs several times more than copper. If companies used gold to manufacture electrical wires, they'd essentially waste money, as copper is more conductive and costs less than its gold counterpart. This alone is reason enough to make copper the de-facto standard for electrical wires.

Copper is not just conductive; it's also ductile. In other words, you can bend and flex copper to some degree without it breaking or otherwise sustaining damage. Well, electrical wires must often travel through walls, floors, ceilings and other tight spaces. As a result, they'll naturally bend and snake their way around the home or building in which they are used. The ductile properties of copper allow copper electrical wires to

bend and flex. They'll still transmit electricity, and they won't lose any power strength from shape deformity.

2.6.2 Aluminium



Figure 2.6.2 Aluminium Wire

Source: Aluminium Cables & Wires. Helukabel, 1978 <http://www.helukabel.com>. 26 July 2015.

Aluminium is used as a conductor material, its lower conductivity requires a wire size that is approximately one-third larger than that of a copper wire. In the end however, the insulating material used with the wire plays a crucial role in performance and an aluminium wire can possess the same current carrying capacity as copper wire. Furthermore, aluminium which is lighter and significantly less costly than copper. Aluminium's larger wire size would only be a disadvantage in applications requiring tight spacing, such as when installed in densely packed control boxes.

The facts for aluminium speak for themselves when it comes to the issue of weight. As a raw material, aluminium is approximately 70 percent lighter in weight than copper. This can be helpful in the efforts of numerous application fields looking to reduce the weight of all components. Naturally, when used in electrical cables, the lower weight makes them easier to install.

2.6.3 Conclusion

Based on the research of type of material of wire, wire with copper had chosen as the component Portable Wire Trolley. This is because copper is excellent conductivity and malleability even aluminium is lighter than copper.

2.7 TYPES OF WOOD FOR WIRE ROLLER

Roller is one of an important part of component in project. It is use to roll back the wire. However, roller can make by many type of materials. So different material has different strength, advantages and also disadvantages. The type of materials for roller like plywood, plastic and others. Usually the roller had make by plywood because it is durable than plastic but in the scope of plywood, it also had many types like softwood plywood, hardwood plywood and others.

2.7.1 Softwood Plywood



Figure 2.7.1 Softwood Plywood

Source: Softwood Plywood. Anderson Plywood, 1946. <https://www.andersonplywood.com>. 09 July 2018.

This is the most common plywood product, made of softwood veneer, usually fir. The layers are stacked at a right angle to each other and glued together with resinous glues. Due to its ready availability, softwood plywood is an excellent choice for homebuilding.

2.7.2 Hardwood Plywood



Figure 2.7.2 Hardwood Plywood

Source: Hardwood Plywood. Anderson Plywood, 1946. <https://www.andersonplywood.com>. 09 July 2018.

Most commonly used for cabinet and furniture making, where a smooth, attractive surface is required for finishing. Hardwood plywood is manufactured the same as softwood plywood, except the exterior layers (face and reverse) are made of hardwood.

2.7.3 Conclusion

Based on the research of the type of wood of wire roller, softwood plywood had chosen as the component of Portable Wire Trolley. This is because softwood plywood is lighter than hardwood plywood so that easy to carry.

2.8 TYPES OF LIGHT

A flashlight or torchlight is a portable hand-held electric light. The source of the light is usually an incandescent light bulb (lamp) or light-emitting diode (LED). A typical flashlight consists of the light source mounted in a reflector, a transparent cover (sometimes combined with a lens) to protect the light source and reflector, a battery, and a switch. These are supported and protected by a case.

2.8.1 Incandescent



Figure 2.8.1 Incandescent

Source: Severin Borenstein. Trash those incandescent bulbs today. Energy Institute, 1996.
<https://energyathaas.wordpress.com>. 03 Oct 2016.

Incandescent flashlights use incandescent light bulbs which consists of a glass bulb and a tungsten filament. The bulbs are under vacuum or filled with argon, krypton or xenon. Some high-power incandescent flashlights use a halogen lamp where the bulb contains a halogen gas such as iodine or bromine to improve the life and efficacy of the bulb. In all but disposable or novelty flashlights, the bulb is user-replaceable; the bulb life may be only a few hours.

The light output of an incandescent lamp in a flashlight varies widely depending on the type of lamp. A miniature keychain lamp produces one or two lumens. A two D-cell flashlight using a common pre focus-style miniature lamp will produce on the order of 15 to 20 lumens of light and a beam of about 200 candlepower. One popular make of rechargeable focusing flashlight uses a halogen lamp and produces 218 lumens. By comparison, a 60-watt household incandescent lamp will produce about 900 lumens. The luminous efficacy or lumens produced per watt of input of flashlight bulbs varies over the approximate range of 8 to 22 lumens/watt, depending on the size of the bulb and the fill gas, with halogen-filled 12 volt lamps having the highest efficiency.

2.8.2 Light-Emitting Diodes (LED)



Figure 2.8.2 Light-emitting Diodes (LED)

Source: Severin Borenstein. Trash those incandescent bulbs today. Energy Institute, 1996.
<https://energyathaas.wordpress.com>. 03 Oct 2016.

LEDs can be significantly more efficient than incandescent lamps, with white LEDs producing on the order of 100 lumens for every watt, compared to 8-10 lumens per watt of small incandescent bulbs. An LED flashlight will have a longer battery life than an incandescent flashlight with comparable output. LEDs are also less fragile than glass lamps. LED lamps have different spectra of light compared to incandescent sources, and are made in several ranges of colour temperature and colour rendering index. Since the LED has a long life compared to the usual life of a flashlight, very often it is permanently installed.

LEDs maintain nearly constant colour temperature regardless of input voltage or current, while the colour temperature of an incandescent bulb rapidly declines as the battery discharges, becoming redder and less visible. Regulated LED flashlights may also have user-selectable levels of output appropriate to a task. For example, low light for reading a map and high output for checking a road sign. This would be difficult to do with a single incandescent bulb since efficacy of the lamp drops rapidly at low output.

2.8.2 Conclusion

Based on the research of the type of light, LED light was more suitable used as the component of Portable Wire Trolley. This is because LED light is more efficient than incandescent lamps that has larger lumens per every watt compare to incandescent light. Second, LED light can maintain the colour temperature regardless of input voltage or current to avoid less visible.

2.9 TYPES OF WHEEL

Wheel is a circular block of a hard and durable material at whose central has been bored a circular hole through which is placed an axle bearing about which the wheel rotates when a moment is applied by gravity or torque to the wheel about its axis, thereby making together one of the six simple machines. Wheel usually is an inconspicuous component but it acts an important role to make our project's product to be move and easy carry the things. If without this, the whole project cannot success. However, wheel has wheel with stopper or wheel only.

2.9.1 Swivel Wheel with Brake Castor



Figure2.9.1 Polyurethane Caster with Brake

Source: Polyurethane Swivel Caster With Total Lock Brake. Caster Connection, 1987.
<https://casterconnection.com>. 08 April 2013.

This is a wheel with a stopper call polyurethane caster with brake. The design of brake is use to protect the safety of the people by stop movement the object. This stopper with wheel can be constructed for superior performance with heavy loads. It designed to be resistant to cutting and abrasive wear and use on any flat surface, commercial or residential.

2.9.2 Swivel Wheel Without Brake Castor



Figure 2.9.2 Polyurethane Caster

Source: Polyurethane Swivel Caster Without Total Lock Brake. Caster Connection, 1987.
<https://casterconnection.com>. 08 April 2013.

This wheel is very commonly we can saw at supermarket trolley. This wheel is without the brake but its function is same with polyurethane caster with brake. The wheel be constructed for superior performance with heavy loads. It designed to be resistant to cutting and abrasive wear and use on any flat surface, commercial or residential.

2.9.3 Conclusion

Based on the research of the type of wheel, swivel wheel with brake castor had installed as rear wheel that can step on the brake castor when need to stable the trolley; while swivel wheel without brake castor had installed as front wheel.

2.10 TYPES OF MATERIAL FOR BASEMENT

Basement is the most important part of component in project because it acts as the structure of the whole project. However, basement can make by many type of materials. So different material has different strength, advantages and also disadvantages. The type of materials for roller like wood, plastic, aluminium and others.

2.10.1 Wood

Wood is a renewable material and the production and processing of wood uses much less energy. Wood has high bearing capacity. Example, 1 kg of wood bears more load than 1 kg concrete or steel. Furthermore, wooden materials are resistant to earthquakes and different climate conditions. Its wooden structure is the most durable structure when compared to other flat structures. In addition, when wooden structures are disassembled, they can be reinstalled with lesser loss. It is easy to repair wood and change its plan.

2.10.2 Plastic

Plastic is material consisting of any of a wide range of synthetic or semi-synthetic organic compounds that are malleable and so can be moulded into solid objects. Plastic is not bio-degradable so that it was harmful environment. Besides that, plastic have a short useful life compared to metals and have a low melting point, so they can't be used where heat levels are high. This also means they cannot be used as protective barrier for furnaces.

2.10.3 Aluminium

Aluminium is corrosion resistant and virtually maintenance free. It has unbeatable strength to weight ratio when compared to other metals, and weighs in at roughly 1/3 as much as iron, steel, copper, or brass. Electrical conductivity of aluminium plate has depended on the thickness of it. Furthermore, aluminium is non-toxic and non-combustible. Some end uses for all grades of aluminium include transportation, food packaging, furniture, electrical applications, building, construction, machinery and equipment.

2.10.4 Conclusion

Based on the research of the type of material for basement, aluminium is more suitable as the part of component of Portable Wire Trolley compare to wood and plastic. This is because aluminium is non-toxic, corrosive resistant and can support a heavy weight.

2.11 TECHNIQUE OF AUTOMATIC PULLING WIRE SPOOL

In the creation of Portable Wire Trolley, the wire spool had been designed to automatic roll and pull the wires. The wire spool will rotate when press the switch and the wire can keep neatly in a short time. According to the creation, hand driller technique and vacuum cleaner technique have been research for the project.

2.11.1 Hand Driller Technique

Hand driller technique was use to the auto wire puller by inserting the wire bundle into the spindle which turns the tool which can be advanced in the workpiece either automatically. This technique is lest in cost compare to wire puller device and other material. It easy to operate when wire was stuck in spindle and the cost of maintenance is low. Furthermore, hand driller technique is easy to handle and extra energy source is not required. However, wire bundle have stuck easily due to the spindle cannot withstand more weight so that the spindle has high chance to break easily.

2.11.2 Vacuum Cleaner Technique

Vacuum cleaner technique is by using a retractable cord or it is known as rewind mechanism to automatically pull the wire inside easily. This technique is easy to handle and the wire will be easily pulled inside within a short time. This technique can withstand more weight compare to hand drill technique. Button will be provided to pull the wire by pressing the button, therefore man power is not required. However, the retractable cord is expensive and maintain cost is high. Second, the system of the automatic wire puller is very complicated. Third, the electric cord has a high chance to get stuck and refuse to budge, making for a potential tripping hazard.

2.11.3 Conclusion

Based on the research of the technique of automatic pulling wire spool, hand driller technique is more suitable used in the project compare to vacuum cleaner technique. This is because hand driller is more economic because its maintain cost is very low. Furthermore, the hand driller technique is easy to handle and repair.

2.12 SUMMARY OF CHAPTER

In conclusion, after finish all the literature review, all the information we get to increase our knowledge in producing our project which is Portable Wire Trolley. In short, the literature review has been made to show the type of material for our project. Based on the type of material's specification, we had choose the most suitable material for our project.

Moreover, this proposal had been make planing for my project to ensure can follow the specifications and can safety applied and no any problems would happen during completion the project.

In addition, we had knew that safety always is the most important things we need to remember.

CHAPTER 3

METHODOLOGICAL

3.1 INTRODUCTION

The study methodology is a process, a set of tools for conducting research and information gain, as well as an art for performing a work. Project methodology can also be defined as a series of systematic activities to solve a problem by developing a program or project. A methodology will utilize a tactic used to perform specific activities. There are several types of development methodologies that can be used in developing a project and each approach selected should be appropriate to the project.

Design is as an important role in our life because design influences almost everything we do. This chapter presents a design process framework that can be used to solve various situations in the design process. After we have identified key issues based on research from the background of project and identified the objectives that we need to achieve, at the same time, we have outlined the scope of the project.

The main purpose of this is to ensure that the implementation of this project does not fall out from our scope of project. So we need to implement some working methods to ensure that our projects are supported in detail and recommended.

Therefore, we decided to implement this project to ensure this was achieved where we chose the method of study carried out through interviews, questionnaires and testing against our scope of project. From the methods we implement, we get a lot of information about the project creation process in detail, so we can improve the information and enhance our product design and meet the requirement of users.

3.2 RESEARCH DESIGN

According to Burns & Grove in 2001 state the research design is a blueprint for conducting the study that maximizes control over factors that could interfere with the validity of the findings. According to Polit & Hungler in 1995 state the research design guides the researcher in planning and implementing the study in a way that is most likely to achieve the intended goal. Research design is the overall plan for obtaining answers to the research questions or for testing the hypothesis and that it is the structural framework within which the study is implemented.

In this study, the survey research is used to gather the information by using questionnaire. Uys & Basson in 1991 state that survey research is an empirical and logical investigation that involves the systematic and impartial collection of data from a sample of cases, as well as the statistical analysis of the findings.

For the purpose of this study, we identified the working condition of electricians and technicians, describe the problems that faced by the electrician and technician and determine strategies to solve the problems.

Furthermore, we were used the descriptive correlational survey. The respondents were included technicians, electricians and engineer. Because of the respondents in between a larger range, so it made difficult to conduct face interviews and a questionnaire was ideal as the respondents used their own time and pace to complete the questionnaire. According to Uys & Basson in 1991 states that the questionnaire is less expensive, time consuming, and have an advantage of involving a large number of subjects while Babbie in 1992 supports the choice of questionnaire stating that the central element in survey research is the standardized questionnaire.

3.3 FLOW CHART PLAN OF PRODUCT

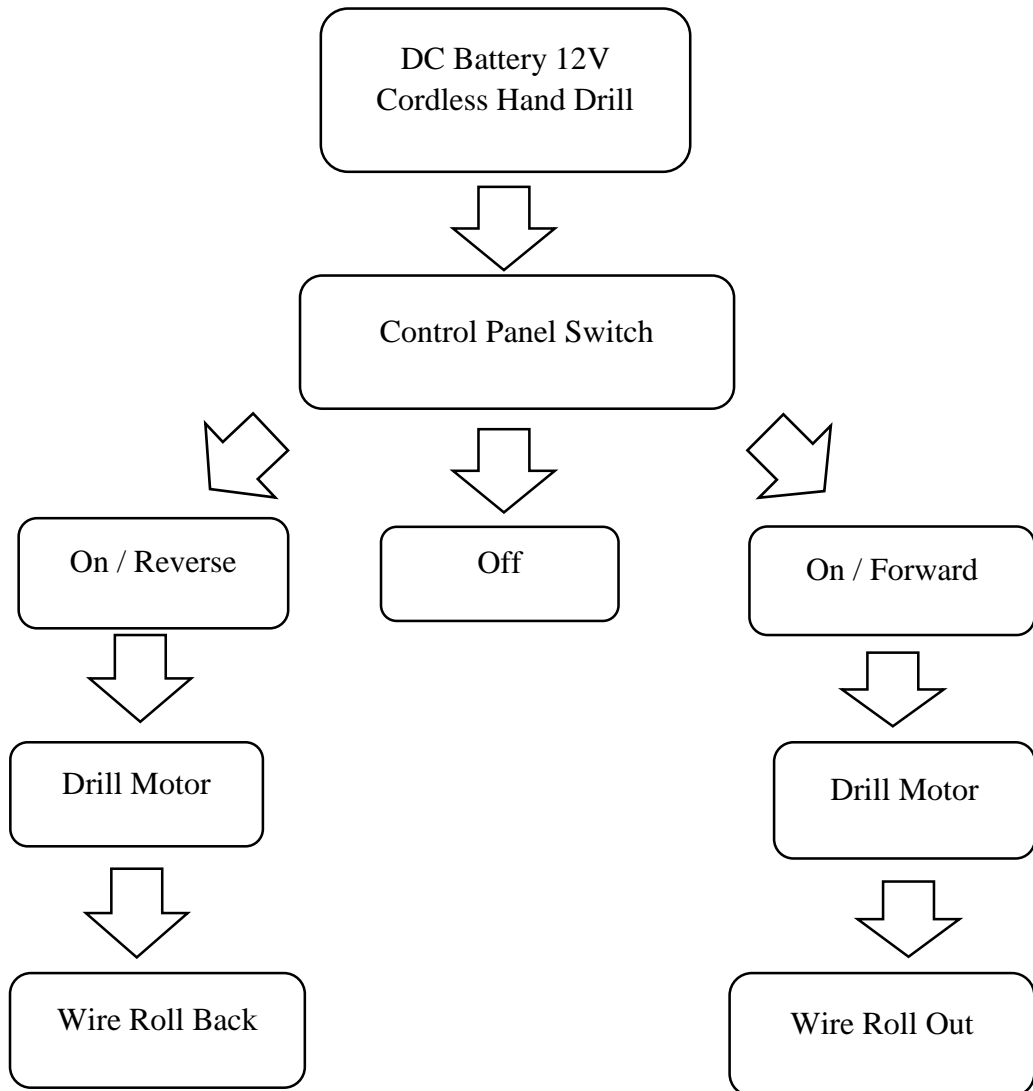


Figure 3.3 Flow Chart Plan of Product

3.4 DATA COLLECTION METHOD

Data collection is the process of gathering information and command from all the relevant sources to find answer to the research problem. Data collection method for our group had done by used primary data sources and secondary data sources.

Primary data source is data collected by the researcher themselves. This kind of data is new, original research information. Primary sources enable the researcher to get as close as possible to what actually happened and is hands-on. A primary source reflects the individual viewpoint of a participant or observer.

The collection data tool that had been chosen in this study is questionnaire. The used of questionnaire in this study does not meddle with the daily routine at the respondent's since it took them only several minutes to answer the questionnaire.

Secondary data source is secondary data is a type of data that has already been published in books, newspapers, magazines, journals, online portals and others. According to this method, we have use internet to search a lot of useful information for our project. We browse the internet is because it can save time, energy, cost and also is the easy way to get information about our project.

3.5 RESEARCH INSTRUMENTS

Research instrument is any tool or method used to obtain and collect study data. In some studies, this instrument may be a questionnaire, list of interview questions or checklists. In our studies, this instrument may refer to equipment used to obtain and collect study data. So, we refer to questionnaire. Questionnaire is form by three section that are respectively section A, section B and section C. Section A is about background of respondent, section B is about technical questions while section C is about the command of our project.

In this research, the scaling technique that have chosen are Nominal Scale for all section in questionnaire. A Nominal Scale is a measurement scale, in which numbers serve as “tags” or “labels” only, to identify or classify an object. A nominal scale measurement normally deals only with non-numeric (quantitative) variables or where numbers have no value.

Second, lux meter and timer had been a research instrument for the project. Timer was used to measure the time of wire auto roll back while lux meter was used to measure the illumination of light.

3.6 SAMPLING TECHNIQUE

This section describes in brief the sampling technique to be used in the study to be conducted. Sampling allows for inferences to be made on a population without having to involve each individual in the population. If a sample is used for data collection, it is important for researchers to make sure the selected respondents actually represent the population.

After collect the data through questionnaire and sampling done, data analysis was investigated by using a google form.

Among the common sampling techniques used are simple random sampling, systematic sampling, stratified sampling, cluster sampling, quota sampling, purposive


sampling, sampling convenience sampling and snowball sampling. From the example of sampling above, our group were used stratified sampling method for our investigated.






3.7 DATA ANALYSIS METHOD

Data analysis method describes the methodology that will be used to compile, process and analyse the collected data to answer the objectives of the study. In addition, data analysis can also provide other information that can give an insight into the issues studied.

In addition, items in which the subject provided two responses when only one response was requested and items in which the subject has marked a response between two options and items that ask the subject to write in some information such as role/position, gender and years of experience.

3.8 COMPONENTS

No	Components	Image	Description
1.	Softwood plywood		Softwood plywood has a lighter weight and less expensive. Due to this reasons, softwood plywood can save the cost and also easy to carry. Furthermore, it is lasts for over a decade and weather resistant when treated. Based on the reasons above, this is why we choose softwood plywood.

2.	PVC insulated cable		<p>PVC insulated cable is most common wire be use at anywhere. It has made by copper and coated by PVC. It has better general appearance, less liable to damage storms or lighting, low maintenance cost, less chances of faults and small voltage drops.</p>
3.	Swivel wheel with brake castor		<p>This swivel wheel design with brake for safety purpose. The brake is use to stabilise the trolley and avoid trolley to move.</p>
4.	Swivel wheel without brake castor		<p>This swivel wheel without brake castor are use as front wheel of trolley. It made the trolley to be smooth movement.</p>
5.	LED Light		<p>The LED light use in project is call T5 LED light. It was 80V and 6W. T5 LED light is white in colour.</p>
6.	Aluminium plate		<p>Aluminium plate is use as the basement of trolley.</p>

3.9 PROJECT SPECIFICATIONS

This product has created base on the demand of people. The product specifications are:

Type	Specifications
Product Size	870mm x 590mm x900mm
Weight	15kg
Material Use	Basement: Aluminium plate
	Handle: Stainless Steel
	Wood
Colour	Black
Cost	RM344.60
Durability	Can bear 500kg
Life Span	Long

Table 3.9 Project Specification

3.10 PROCESS

1. Purchase suitable material for our project.



Figure 3.10.1 Material of Project

2. Weld the structure of the project by using MIG.



Figure 3.10.2 Structure of Project

3. Screw the aluminium plate on the structure of project.



Figure 3.10.3 Aluminium plate had been screw

4. Install the wire spool.



Figure 3.10.4 Install Wire Spool

5. Install the hand drill that connect the spindle.



Figure 3.10.5 Install Hand Drill

6. Sharpen the aluminium plate.



Figure 3.10.6 Sharpen Aluminium Plate

7. Heat the heat shrinkable sleeves on the handle of LED light.



Figure 3.10.7 Heat the Heat Shrinkable Sleeves

8. Install all the component together.



Figure 3.10.8 Install all the component together

3.11 PROCESS OF TESTING



Figure 3.11.1 Engineer had answer the questionnaire



Figure 3.11.2 Electrician and technician answer the questionnaire



Figure 3.11.3 Explain the function of product



Figure 3.11.4 End of Testing

3.12 SUMMARY OF CHAPTER

As conclusion for this chapter, the methodology of the study is use in conjunction with the objective of the project title. By this technique, our group members were able to prefer suitable components that we should use on our product so that our product less the burden of electricians and technicians.

Moreover, we gather some useful information about our research. For example, we were also able to identify the problem that faced by electricians and technicians.

A methodology offers the theoretical underpinning for understanding which method, set of methods, or best practices can be applied to a specific case. For example, to calculate a specific result.

CHAPTER 4

ANALYSIS OF PROJECT

4.1 INTRODUCTION

Analysis of project is carry out after the project finished. The project will be analysed through questionnaires and experiment. Experiment we did were about the illumination of T5 LED light in renovation area and the time to roll back the wire. The data generated in renovation area were analysed in more detail to summarize the objectives of the study.

4.2 TIME OF ROTATE SPEED OF HAND DRILL

The testing for time of rotate speed of hand drill had test by using timer.

Length of wire (m)	Roll back time (s)							
	Min			Average min time	Max			Average max time
	1	2	3		1	2	3	
5	10	7	9	8.67	1.88	2	1.73	1.87
10	10	12	20	14	3	2.56	3.48	3.01

Table 4.2 Time of Rotate Speed of Hand Drill

4.3 ILLUMINATION OF T5 LED LIGHT

The testing for illumination of T5 LED light had did at renovation area. We had compare the illumination of T5 LED light and the illumination of light at there. We were used lux meter to measure the illumination of light.



Figure 4.3 Lux Meter

Table 4.3.1 below has showed the data about illumination of light in workplace and T5 LED light. We had does the testing at The Sphere mall’s electric room which the electrician had did the renovation of work.

Distance (m)	Angle (°c)	Illumiation of light in workplace (lux)	Illumination of T5 LED Light (lux)
1	180	315	121
2		160	39
3		-	18
4		-	10
5		-	7
1	90	200	78
2		77	23
3		-	11
4		-	7
5		-	5
1	45	243	100
2		121	34
3		-	17
4		-	8
5		-	7

Table 4.3.1 Illumination of Light at Electric Room The Sphere Mall Bangsar South, Kuala Lumpur



Figure 4.3.1.1 Testing at Electric Room The Sphere Mall Bangsar South, Kuala Lumpur



Figure 4.3.1.2 Testing at Electric Room The Sphere Mall Bangsar South, Kuala Lumpur

Table 4.3.2 below has showed the had showed the data analysis renovation at Block B, ground floor Utropolis, Shah Alam.

Distance (m)	Angle (°c)	Illumination of light in workplace (lux)	Illumination of T5 LED Light (lux)
1	180	209	117
2		103	38
3		56	25
4		-	20
5		-	15
1	90	44	69
2		24	38
3		8	22
4		4	15
5		3	7
1	45	46	103
2		24	47
3		-	20
4		-	13
5		-	8

Table 4.3.2 Illumination of Light at Block B, ground floor Utropolis, Glenmarie, Shah Alam



Figure 4.3.2.1 Testing at Block B, ground floor Utropolis, Glenmarie, Shah Alam



Figure 4.3.2.1 Testing at Block B, ground floor Utropolis, Glenmarie, Shah Alam

Table 4.3.3 below had showed the data analysis renovation at Shop Lot TTDI Jaya, Seksyen U2, Shah Alam. The place we do testing haven't connected the main electric supply due to they do the renovation work.

Distance (m)	Angle (°c)	Illumination of T5 LED Light (lux)
1	180	124
2		53
3		17
4		12
5		10
1	90	90
2		24
3		17
4		10
5		5
1	45	92
2		24
3		15
4		13
5		9

Table 4.3.3 Illumination of Light at Shop Lot TTDI Jaya, Seksyen U2, Shah Alam



Figure 4.3.3.1 Testing at Shop Lot TTDI Jaya, Seksyen U2, Shah Alam



Figure 4.3.3.2 Testing at Shop Lot TTDI Jaya, Seksyen U2, Shah Alam



Figure 4.3.3.3 Testing at Shop Lot TTDI Jaya, Seksyen U2, Shah Alam

Table 4.3.4 below had showed the data analysis renovation at electric room NU Sentral, Kuala Lumpur.

Distance (m)	Angle (°c)	Illumination of light in workplace (lux)	Illumination of T5 LED Light (lux)
1	180	284	115
2		163	40
3		85	21
4		-	17
5		-	12
1	90	107	95
2		55	72
3		37	23
4		-	11
5		-	5
1	45	170	112
2		72	40
3		-	27
4		-	19
5		-	7

Table 4.3.4 Illumination of Light at Electric Room NU Sentral, Kuala Lumpur



Figure 4.3.4.1 Testing at Electric Room NU Sentral, Kuala Lumpur



Figure 4.3.4.2 Wiring Work Do by electricians

1.4 ANALYSIS FROM QUESTIONNAIRE SURVEY

The result from the questionnaire survey had showed in a pie chart form. Pie chart had showed the percentages for every questions that was done by respondents.

From the figure 4.4.1, pneumatic wheel is the highest percentages compare to the others. This is because the pneumatic wheel is the highest cushioning and shock absorbing wheel.

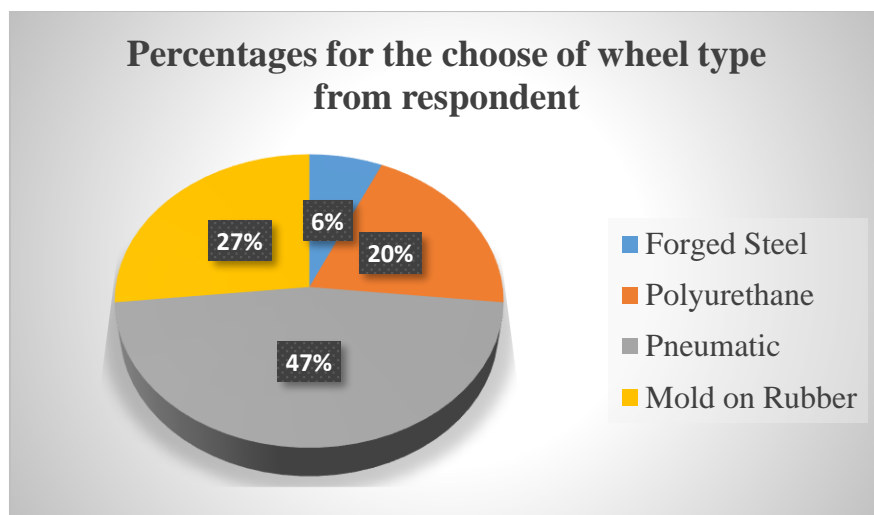


Figure 4.4.1 Percentages for the choose of wheel type from respondent

From the figure 4.4.2, decomposed granite soil was the most often soil at construction area that told by engineers, electricians and technicians.

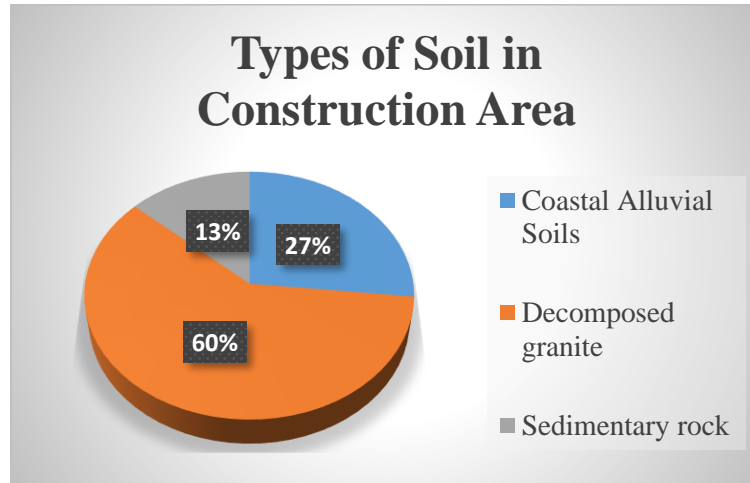


Figure 4.4.2 Types of Soil in Construction Area

From the figure 4.4.3, there had 53% respondent supported aluminium as main material because it can bear heavy weight.

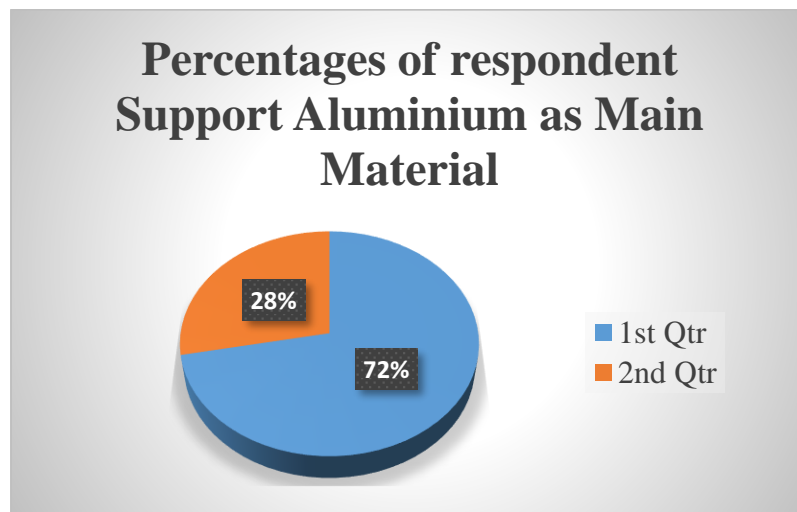


Figure 4.4.3 Percentages of respondent Support Aluminium as Main Material

From figure 4.4.4, there had 56% of respondents had approved 2.5cm PVC insulated wire was used in construction and renovation area.

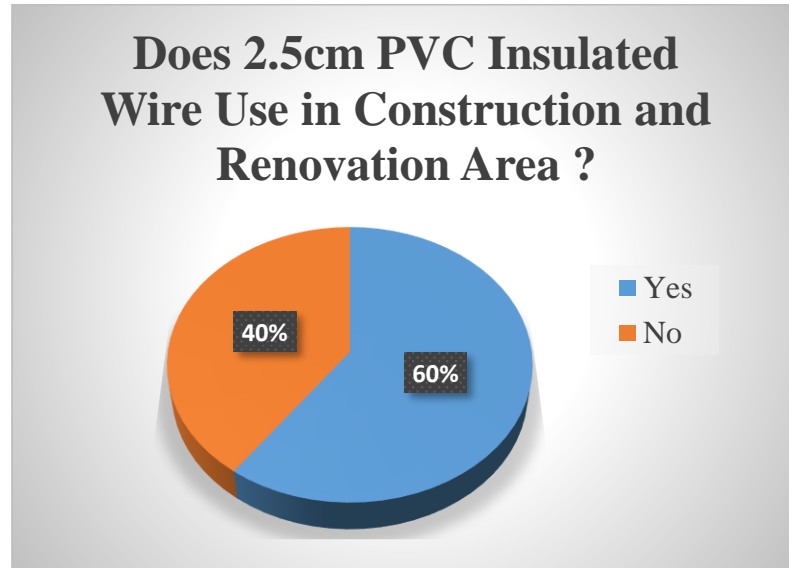


Figure 4.4.4 Percentages of 2.5cm PVC Insulated Wire Use in Construction and Renovation Area

From figure 4.4.5, there had 60% of respondent were not satisfied the weight of Portable Wire Trolley.

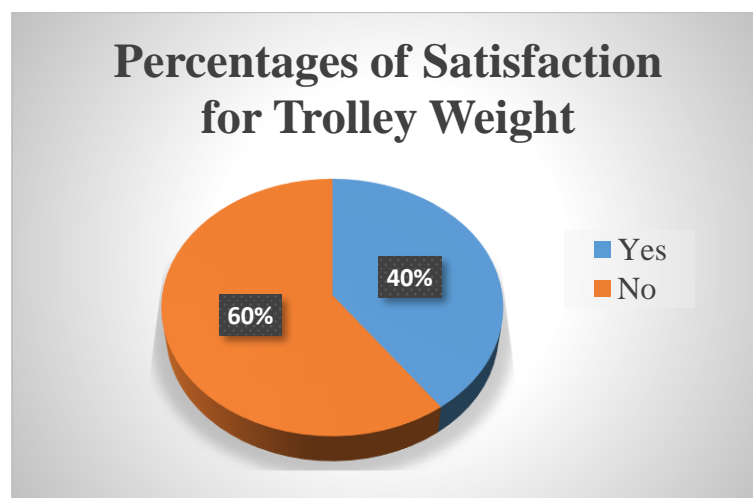


Figure 4.4.5 Percentage of Satisfaction for Trolley Weight

From figure 4.4.6, there had 53% of respondent had agreed Portable Wire Trolley can replace the wire easily after the wire had finish used.

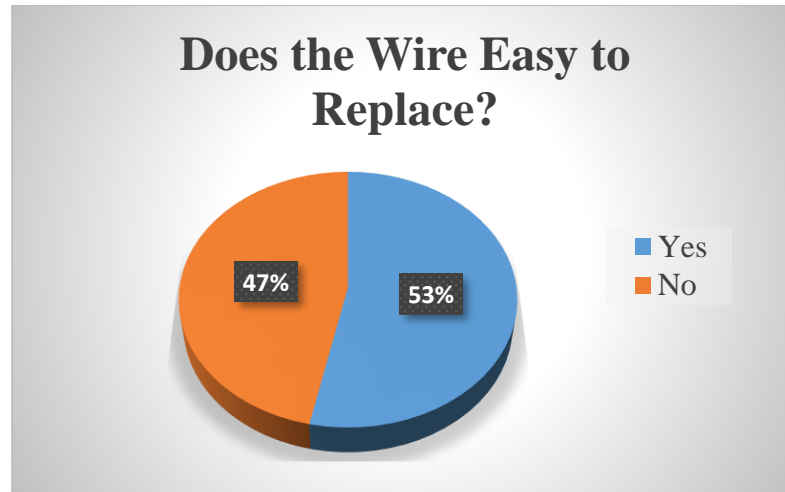


Figure 4.4.6 Percentages of Satisfaction for Wire Easy to Replace

1.4 SUMMARY OF CHAPTER

As conclusion for this chapter, analysis the data for the project had very useful because through this, we can know what is the strength and weakness of our project. So that, we can refer the suggestion and amend the weakness of project.

CHAPTER 5

DISCUSSION AND CONCLUSION

5.1 INTRODUCTION

In this chapter have given an opportunity to discuss and recommend to our product. The recommend can be an advice to improve our product. In this chapter will show the conclusion for our final project that has been done in two semesters.

5.2 DISCUSSION

The project carried out is to improve the equipment for electricians and technicians while they were working. Before that, they need to take time to roll back the wire by manual. Sometimes, their use torchlight to light up the lightless workplace. This will cause their work be inconvenient. Besides that, electricians and technicians need to carry many wire bundle from one place to another place so that this will consume their energy.

However, our project, Portable Wire Trolley, had solve the existing problems that faced by electricians and technicians. We had created the trolley which carry the large quantity of wire bundles. Then, above the trolley, there had two wire spools and hand drill to automatic rolled back the wires. Lastly, we had created a portable LED light which had high lumen that can hang on the handle.

5.3 RECOMMENDATION

The suggestion ideas design from testing:

1. Can consider to further big size of cable like 4m² and 6m², since these two cable frequently use at renovated area.
2. Rubber / PVC handle for easier pushing and electric shock when expose to electric hazard.
3. Any new cable rows into secondary roller will be difficult to use for wiring inside-conduit pipes.

5.4 CONCLUSION

From this study, we had succeeded to create a new device which name as Portable Wire Trolley. Our purposes to create this device were decrease the burden of work for electricians and technicians.

During the time of create product, we had faced a lot of problems. First, we had change many design plan for our project before the title had been fix. From this problem, we had learnt how to be patient and inclusive when faced a hard work. We had always discussed with our supervisor and follow the suggestion from supervisor before we make the decision. Second, the type of materials and the cost for material are the largest problem to us. Before we use aluminium plate as the main material in our product, we had purchased and used wood as the main material for our product. But unfortunately, wood was not suitable used as the material for our product. So that, we had purchased for aluminium plate and this action had increase our budget for project. From this failure, we must think twice before doing any decision.

As a whole, this final project is very important to us as it discover and exposes more challenging work to us and requires do a lot of hard work to succeed. By having this final project in polytechnic, we recognize that it has taught us to be more ethical and professional in everything we do.

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APPENDIX A
GANTT CHART

APPENDIX B
QUESTIONNAIRE

SURVEY QUESTIONNAIRE

I am a building service engineering student with a sincere wish to invite Tan Sri / Dato / Prof / Dr / Sir / Madam to participate in this study by answering the questions given. This questionnaire aims to identify the problems faced by technicians at the time of work. So we get a deeper understanding and to solve the problem effectively. All the information that Tan Sri / Dato / Prof / Dr / Sir / Mrs / Mrs will be kept confidential and only for academic purposes only. Thousands of gratitude and sincerely appreciation for the cooperation and willingness of Tan Sri / Dato / Prof / Dr / Sir / Madam to spend time participating and conducting this study. The questionnaire will take about 10-20 minutes to answer.

Part 1 : Biodata

1. Position : Engineer () Technician ()

2. Experience : _____

3. Professional :

Mechanical () Electrical () Civil () Technical ()

Part 2 : Satisfaction on our product

The following items describe statements about the satisfaction of the respondents on our product. Indicate your agreement or disagreement with the following statements by **giving comment** or **circle** your response.

1. We had survey about 4 types of wheel. Which one will be suitable and safe to be use?

a.



Forged steel
-Has greatest load capacity & rollability.

b.



Polyurethane
-Has higher capacity material than rubber & will not damage to the floor

c.



Pneumatic
-Highest cushioning, shock absorbing wheel.
-Capacities of pneumatics are limited due to the soft cushioning characteristics of the wheel.

d.



Mold On Rubber
-Providing a cushioned and quiet ride for the product being transported.
-Made by neoprene and high load compounds are also available.

2. Which soil can be frequently found at construction area?



Comment :

3. Aluminium is a good conductor of electricity. We had use aluminium as our trolley surface. Would it will be safe to use? Why?

- a. Yes b. No

Comment :

4. There are many size of wires and the wires cannot be use at all place. As a result of our research we were using 3core 2.5mm PVC sheathed copper wire. Our scope of project were **construction area** and **renovation area**. Therefore, 3 core 25mm wire would be not suitable to be use at both area?

- a. Yes b. No

Comment :

5. The weight of trolley is 15kg, is it easy to handle and move?

- a. Yes b. No

Comment :

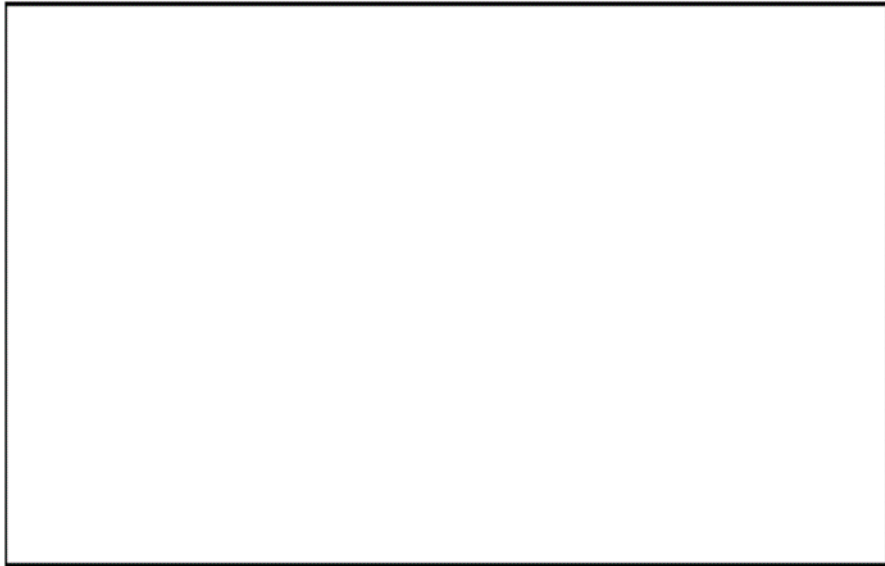
6. Does the wire easy to replace after finish?

- a. Yes b. No

Comment :

Part 3 :

Comment & Feedback

A large, empty rectangular box with a thin black border, intended for providing comments and feedback. It occupies the central portion of the page below the text labels.

APPENDIX C
TESTING LETTER