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Design and Develop Model for Cable Pulling Machine using 0.37kW Motor

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Abstract: A cable pulling machine is a machine that helps in the installation of cable into an oil and gas platform's electrical system. There are numerous types of cable pulling machines available on the market, but none of them are appropriate for installing cable on an oil and gas platform. Because there was no suitable machine available, the cable installation was done by hand. There is no problem with small size cable, but when larger size cable is involved, too much manpower is wasted to install the cable. This project is being completed to assist the company in improving the cable installation process. To complete this project, three phases were created: conceptual design, embodiment design, and detailed design. On the other hand, engineering analysis must be developed alongside component simulation, and this requires formula calculation and SolidWorks features. The results of component analysis and simulation are crucial for assessing the performance and quality of the final product. The studies showed that this machine can pull cables at the necessary 34.5 rpm speed and 10.4 kgm torque for cable installation. This design is expected to be a practical help for workers installing cable for the electrical system of the oil and gas platform.

Keywords: Cable Pulling Machine, Oil and Gas Platform, Solidworks

1. Introduction

Every offshore platform needs a comprehensive and integrated power, instrumentation, control, and communication system capable of performing under the most difficult operating circumstances while protecting both human safety and the environment. Offshore cable is intended for use on offshore facilities for electrical power and instrumentation. The offshore cable acts as a medium for delivering electricity and instruments. Because the marine offshore risk is high, the offshore cable must be both resilient and strong. This enables them to resist the harsh conditions in which offshore cables must operate. Furthermore, an offshore cable should be resistant to fire and flame. They are also mud resistant and halogen-free, allowing them to resist drilling oils and hydrocarbons. Offshore cable is designed to

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function efficiently at severe temperatures and to be resistant to humidity, oil, acid, and saltwater corrosion.

There are many types of cable that have been used in different system for every offshore platform which are:

1) Power System
2) Lighting System
3) Fire & Gas System
4) Telecommunication System

1.1 Power System

Almost every item or equipment that uses electricity makes use of power cables. All the way up to generators and massive industrial machinery. The length of the cables may differ, but the electrical current will function at the same high capacity regardless of the distance it must go. Power is obtained from the mains through a standard power cable, and the electricity travels through the wire to its destination. This can be done through a power source or straight into the machine or equipment. When using a power cable, it is critical to protect the wires. Each of these cables comes with a high-quality, thick outer wrapping. The wires will stay intact and undamaged in this manner, ensuring both safety and lifespan. In this project, all the cable power was using the type of cores cable. While the air and triad types of cables were uses for instruments.

1.2 Lighting System

The use of LED lighting as an alternative to traditional lighting in facilities will result in significant cost savings and an increase in overall facility safety. The reason for this is that electrical incidents in oil and gas facilities are more likely to occur because of maintenance activities that are not performed correctly or at all, and less likely as a result of incorrect or poorly designed facilities. This is especially important for explosion-proof equipment, where, according to inspections performed in most facilities, the assembly of this equipment following maintenance activities is frequently incomplete [2].

1.3 Fire and Gas System

The fire and gas system are utilised to minimise further risk by implementing emergency procedures using a high-integrity safety and control solution. It is also critical to immediately recover from unexpected events to restart full productivity. A typical fire and gas safety system includes detection, logic control, alarm and prevention functions, and so on. The logic solver is the entire fire and gas detection and control system's core control unit. The controller receives alarm and status signals, as well as analogue signals, from field monitoring equipment used for fire and gas detection. The controller oversees initiating alerts and minimizing hazards.

1.4 Telecommunication System

Communication and telecommunications cables are used for a broad range of functions, including the transfer of audio, data, and signals through diverse mediums such as fiber optic cables, coaxial conductors, copper conductors, and twisted pair. Telecom cables enable two-way communication over great distances by transporting data from one location to another. Although the telephone was the first technology that made this accessible, it is now possible to do it through computer and television.

2. Materials and Methods

Every project need design planning. A specific and systematic approach is required for the design process. Furthermore, design planning helps as a guideline for designers to guarantee that the project runs successfully. For this project, the design of cable pulling machine must follow the design process which is conceptual design, configuration design, parametric design, and detailed design.

2.1 Conceptual Design

This is the phase in which the design is initiated, different possible solutions are proposed, and finally the best solution among the solutions discussed is chosen to solve the problem mentioned in Chapter 1. To complete several different stages, this phase required students to be creative, problem solve, and coordinate among many functions in the business organisation.

2.2 Embodiment Design

Designers can learn more about the elements of the product that must be produced by creating a schematic diagram of the design. This can also result in the creation of a group of product modules with a design element arrangement. The design can then be configured to determine the preliminary material and manufacturing selection. The process is then continued with parametric design. Parametric design is where the greater refinement takes place to set the critical design variables to enhance the robustness of the design involves optimizing critical dimension and the setting tolerances.

2.3 Detailed Design

The detailed design stage requires the designer to finalise all detailed design elements such as product specifications, drawings, tests, BOM, and manufacturing details. Solid Work software is used to create the product's drawings and BOM.

2.4 Simulation Process

SolidWorks is a 3D CAD solution and rendering software that assists in the product development process by providing a simplified, integrated workflow for design, communication, and data management. Designers and engineers may easily span different disciplines with this software, reducing the design cycle, improving productivity, and bringing new products to market faster.

3. Results and Discussion

Each component for the design concept has been chosen and tabulated in a morphological chart for this chapter. The best design concept was determined by the decision matrix The best design concept was chosen and divided into four parts for simulation to check structural integration. The results show that the parts will fill or can withstand the parameters that were set prior to running the simulation.

3.1 Define Problem

To make a good machine, information has been gathered from my experience during my internship at the company. This is important as the information will fulfil the requirements of the machine. The priority requirement & its weighting for the design is displayed in Table 1.

Table 1: Priority Requirement and Weighting

No	Priority Requirement	Rating (%)	Weighting

1	Design	4.5	0.21
2	Cost	4.7	0.22
3	Productivity	4.0	0.19
4	Function	4.3	0.20
5	Sustainability	3.5	0.18
	Total	21.0	1.00

3.2 Product Design Specification

A product design specification (PDS) is a statement that describes how to create a design (specify the design). A product design specification (PDS) was created after gathering information from the data. This approach aims to establish the minimum design specifications that can be acquired for this project. Furthermore, PDS is intended to establish standards and requirements for implementing and maintaining the relevant infrastructure design process and product development designed to suit the suitability of the service. The specification of the product design is shown in Table 2.

Table 2: Product Design Specification

Introduction	
Title: Design and Simulate a Cable Pulling Machine Design problem: Design a cable pulling machine that are suitable to use on the oil rig.	
Requirement	
Functional performance	• The machine is compatible to pull different size of cable. • The machine will reduce energy and time for cable pulling work.
User Friendly	• Design of the machine is simple.
Economic	• Low maintenance cost. • High lifetime. • Easy to get spare part.
Geometry limitation	• The height of the machine must not exceed 100cm. • The width of the machine must be less than 100cm.
Maintenance	• Easy to maintenance. • Spare part is easy to find.
Safety	• Less risk of injury to operator. • Sharp edge should be eliminated by coating or fillet.
Appearance	• Design of the machine should be simple but functioning well.

3.3 Concept Generation

After gathering information from the literature review, three design concepts that are relevant for this study were created. After considering all the optimal conditions that meet the requirements of the cable pulling machine design, a morphological chart will be used to generate a suitable design concept. A study was conducted, and the results showed that morphological charts are useful for analyzing design meetings. Aside from being able to present the evolution of design concepts, morphological charts have proven to be effective in reducing the time required to analyse a large set of data. The advantage of

using a morphological chart is that it can reveal unexpected pairings of features, allowing the designer to create amazing design concepts.

3.4 Evaluation Concept

After done propose the alternative mechanism, the next stage is combining the alternative to form a best combination of ideas and evaluate the combination by using a weighted rating system by select a suitable combination that can fulfil design specifications (Table 3).

Table 3: Weighted rating of THREE (3) different combination

No	Parts	Relative weight	Combination					
			Combination 1		Combination 2		Combination 3	
			Rate	Weighted rating	Rate	Weighted rating	Rate	Weighted rating
1	Type of motor	0.186	5	0.072	3	0.043	5	0.072
2	Type of connection	0.143	3	0.043	3	0.043	4	0.057
3	Shape of structure	0.171	3	0.043	4	0.057	5	0.071
4	Wheel design	0.171	4	0.057	5	0.071	3	0.043
5	Drum material	0.157	3	0.043	3	0.043	5	0.071
6	Gripper	0.171	4	0.057	3	0.043	5	0.071
	Total			0.315		0.300		0.385

3.5 Configuration Design

At this point, the form and general dimensions of the components are determined by the configuration processes. To complete the configuration layout, two different stages are required, which are modelling and simulation. Figure 1 shows the full assembly of the cable pulling machine.

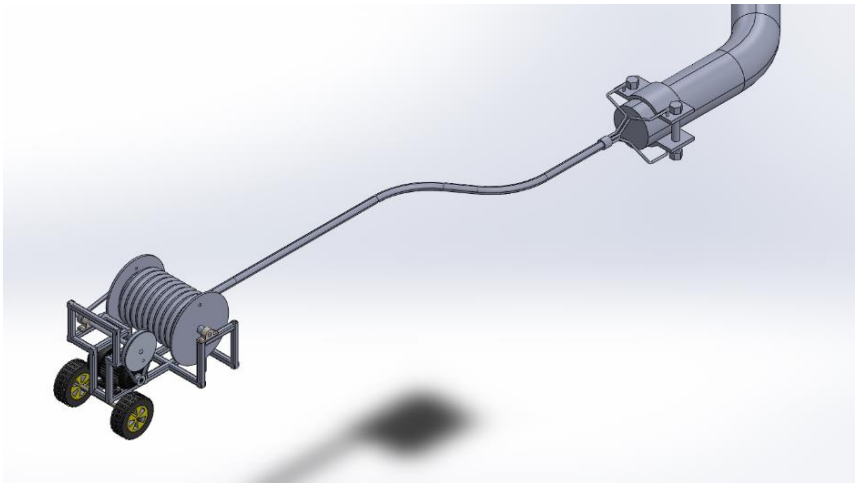

Figure 1: Full assembly of cable pulling machine

In the theoretical calculation part, the required torque and speed is calculated to choose the type of motor to use. From that expected speed (Table 4) and torque are then calculated.

Table 4: Expected torque and speed

Expected speed	34.5 rpm
Expected torque	10.4 kgm

The calculation was done by using an add-on SolidWork Motion to get the expected speed of the machine (Figure 2).

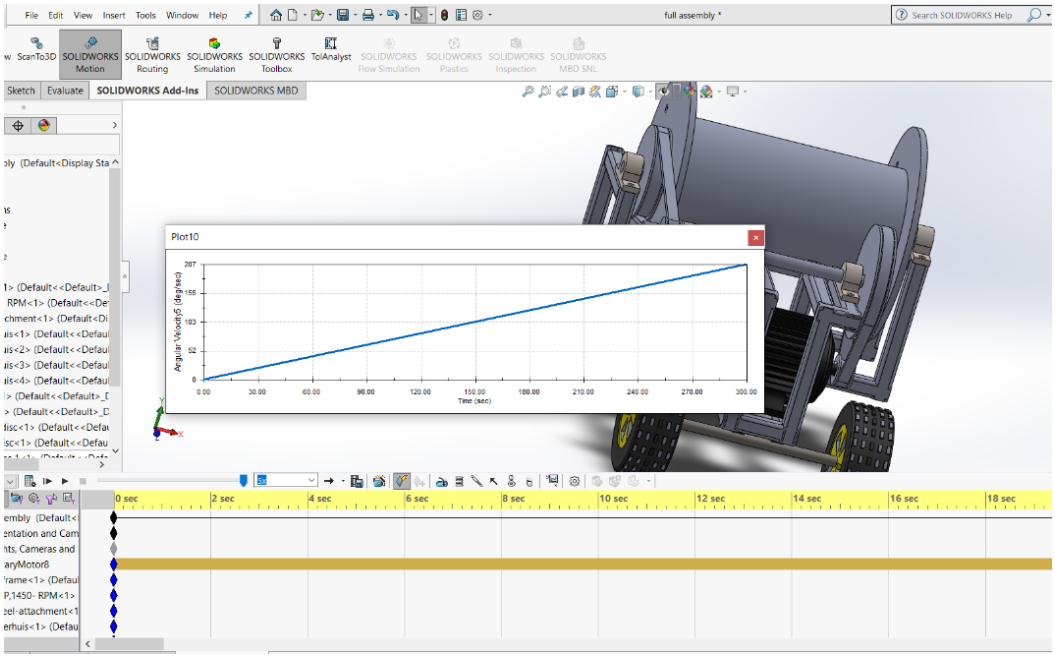

Figure 2: Graph of the drum angular velocity acquired

Based on the graph generated we get that the drum reach 207 degree/s after 5 min.

207 degree/s = 34.5 rpm.

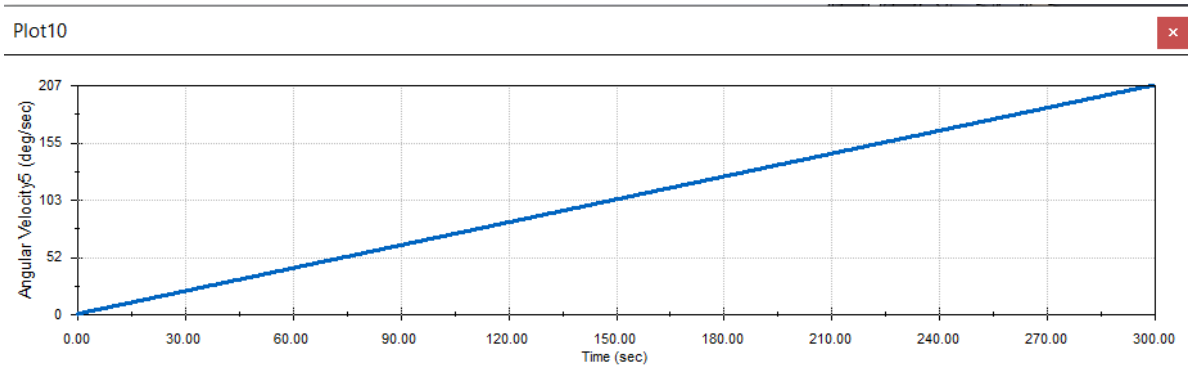

Figure 3: Graph of the drum angular velocity

This shows that it is a success that the simulated result is equal to the theoretical result.

Table 5 depicts the component elements in their whole and with exact dimensions, shape, and size. This is to determine whether the product can suit the needs of the consumer.

Table 5: Product specification of cable pulling machine

Envelope Dimension	955mm (L) × 740mm (W) ×792mm (H)
Frame	Mild steel
Machine Weight	85 kg
Power	0.37 kW

3.6 Cost Evaluation

The cost of production and the cost of growth are the two major components of cost evaluation. The cost of production includes direct material costs as well as overhead costs. Cost evaluation is only one component of a larger cost-benefit analysis, which aims to assess how resources are used efficiently. Recognizing the costs associated with any operation being assessed is one phase in monitoring the use of resources in a project or company. Overall cost and Total cost are shown in Table 6 and Table 7 respectively.

Table 6: Overall cost

No	Items	Cost (RM)
1	Direct Material Cost	3650
2	Overhead Cost	400
3	Direct Labour Cost	450
4	Development Cost	100
	Total	4600

Table 7: Total cost

No	Item	Cost (RM)
1	Overall Cost	4600
2	Selling price make up 20% of the overall cost	920
	Total	5520

4. Conclusion

In conclusion, the design process helps a lot to develop the design of this cable pulling machine systematically. Overall, the objective of this project is achieved which is to identify the criteria of existed design of cable puling machine, produce improvised design of cable pulling machine and to do simulation study on how good the designed machine in term of process. It is advised to explore and choose a new, better material for the manufacturing process of this cable pulling machine. The cable pulling machine's overall weight will be reduced in addition to its strength and durability being improved. It is highly advised to use improved materials with high strength and low weight.

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