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ORIGINAL ARTICLE

INVESTIGATING EFFICIENCY OF MATERIALS MANAGEMENT AT ORIGINAL EQUIPMENT MANUFACTURER (OEM)

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ABSTRACT – Original Equipment Manufacturer (OEM) businesses always facing a challenge in managing the material effectively and efficiently. The aim of this paper is to identify, analyse and improve the efficiency of materials management at the original equipment manufacturer (OEM) company. There are two materials management problems: stock-out and overstock, occur frequently in the OEM company. Data collection is through the observation and interviews with the top manager and other staff involved in materials management operations. Secondary data is retrieved from the related information on materials management. The collected data were categorised using IDEF0 and the development of the inventory control system used MS Excel Macro. The outcome of this research is a computerised material management system that is beneficial and essential for material management efficiency.

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INTRODUCTION

Materials management is a method for planning and controlling all efforts to guarantee that the correct quality and quantity of materials and equipment are specified in a timely way, are purchased at a fair cost, and are available at the point of use when needed [1]. Materials management involves planning, executing, and regulating field and office activities. The materials management system aims to ensure that the quality and quantity of materials are identified, purchased, delivered, and managed onsite in a timely and cost-effective manner. Materials management is an essential strategy for planning of materials operations and overall material pricing [2]. Companies that engage in efficient material management are more likely to perform better than those that do not and realise significant savings in total costs of production [3]. An effective materials management can cause cost reduction, savings, and overall productivity. Inaccurate materials information, such as faulty bills of materials, inaccurate cycle counts, shipping mistakes, and receiving errors, may also damage the whole project life cycle and raise project costs. Dealing with subcontractors outside of the materials management process influences the whole project supply chain, since data errors are more likely [4].

This research conducted at Company A, a leading manufacturer and assembler of plastic parts and components for the automotive, electrical and electronics and telecommunication industries [5]. The company name will not be mentioned because of confidentiality and anonymity. However, the company will be identified as Company A. This company performs not only production and physical distribution functions but also design engineering functions in the processes of meeting their customer's needs. Company A produces plastic that has a variety of type of products and produces a customised product; design reception, and design requirement from their customer. OEM, or original equipment manufacturer, is a term that is generally found in two industries: automotive and information technology. OEM was originally linked with a firm that produced a product that was resold or rebranded by another company. However, OEM has changed over time, and it now refers to a variety of things [6,7]. For example, OEM might refer to a company that makes the actual components that another company uses to assemble a complete system. In other cases, the firm rebrands and sells the products of another company to end users [8]. The OEM is a company that manufactures subsystems or parts that are utilised by other companies to assemble the final product. Company A is an OEM in Malaysia.

The variety of product may lead to the overstock product in the inventory if the company failed to control their inventory and material management of the product. The high variety of products also may cause the component faces a lack of material management efficiency in term of excessive materials. Increasing variety of products makes inventory management more complex, reduce operational effectiveness (e.g., the unit fill rate, as measured by the percentage of units filled to total units requested), and affects [9]. Storage of material can raise the cost of manufacturing, raising the project's ultimate cost. If the storage facility does not have enough space to hold all the materials, it may force [10]. This research aims to identify, analyse and improve the Efficiency of Materials Management at Original Equipment Manufacturer (OEM) company. The research project's goals are as follows: (1) To evaluate the system characteristics of materials management at Original Equipment Manufacturer (OEM); (2) To create a generic system model incorporating all the key characteristics of materials management at Original Equipment Manufacturer (OEM); and (3) To propose efficient materials management at Original Equipment Manufacturer (OEM).

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LITERATURE REVIEW

Materials management is an integrative strategy for optimizing material operations and total material cost [7]. Materials management encompasses all the aspects of the materials i.e., material costs, material supply and material utilization. Materials management is concerned with material planning and materials control activities [11]. It is an important aspect of the factory and industrial system that includes a complete variety of duties such as material handling, material procurement, assembly line management, storage, and material transport. Material management and control are made up of several small parts that come together to make the organization more efficient and financially viable [12]. Material management consist of a series of processes that need to be integrated, coordinated, and synchronized well to ensure that material is available at their point of use when needed. The material management process begins from need generated from site followed by this information conveyed to store department and material is ordered in the store, the indent is generated. Usually, vender selection is to be carried out for the least value and best items. Materials are received at store departments and inspection is carried out [13].

Material handling is the flow of elements that allows for their movement and placement. The fact that materials are expensive and include important decisions highlights the need for effective management. Proper storage protection is sometimes overlooked, due to poor material quality or degradation of the material. As a result, it is also indicated that material storage loading and unloading should not be handled in the rain. It is also recommended that the storage area be closed, clean, and dry, with sufficient air circulation, and that specific product be stacked on pallets at no more than a particular safe height to prevent dampness, and so on [14]. Material handling equipment selection is very important because it may improve the production process, raise worker utilization, productivity, and system flexibility. Material handling equipment selection plays a critical role in the design of a material handling system in order to improve the production process, offer optimal personnel utilization, increase productivity, and improve the system.

Inventory control increases profitability by lowering expenses related to material storage and handling. Inventory control is a method of making materials of the appropriate quality and quantity available as and when they are required, considering the economy of shortage, ordering cost, purchase price, and working capital [15]. Inventory control determines the quantity of materials held in stock. It also enables materials managers to carry out accurate and efficient manufacturing organisation operations by decoupling individual segments of the whole operation, which includes the process of assessing goods into the store house and distributing stock. In comparison, a lack of materials can cause a disruption in product sales, customer relations degrade, and equipment and machinery are underused. As a result, a firm can only achieve significant cost savings by applying a sensible inventory control system.

Excessive materials on storage items would cause issues for the management. Storage of resources can raise the cost of manufacturing, raising the project's final cost. Furthermore, if the storage facility does not have enough space to hold all of the materials, the management may be forced to hire other storage facilities, which will add to the hassle and cost. 40% of the time spent on storage is due to poor management, a shortage of supplies when needed, poor material identification, and insufficient storage. An inadequate materials management strategy can have a negative impact on cost, quality, and timeliness, all of which can influence project completion [15].

METHODOLOGY

Research methodology starts with identifying the research problem and understand Material Management at Original Equipment Manufacturer (OEM). Then proceed to data collection by two main methods which are observation and interview the company by online platform. Based on the data collected, create the IDEF0 development to represent the flow of material management at Original Equipment Manufacturer company. Next, proceed to the software development, design and coding the material management system data.

Observation

For observation, the OEM company is separated into three phases: prepare resources, produce product, and ship order. The OEM company will be given according to the batch and age of the product. Qualitative techniques contribute by focusing on 'natural' settings that allow for the comprehension of social processes and phenomena, whereas observational data collection methods bridge research paradigms. We may be able to assist others in comprehending what we do and how it evolves in response to events and through time, which is especially important when individuals struggle to define their own practise. We focus on the potentially problematic areas of sampling, permission, and ethics, data collection and recording, data administration, and analysis in observational research.

Interview

Interviews are used to get data from a small group of respondents on a wide range of topics. Structured or unstructured interviews can be used. Structured interviews are compared to questionnaires in that they ask the same questions in the same format for each subject and allow for multiple choice responses. There is no fixed set of possible responses for unstructured interviews; questions can vary by subject and can be affected by answers provided to previous questions. In this research, interviews were held with a Original Equipment Manufacturer company. This interview intends to obtain information on establishing material management at OEM, material management issues, and how they avoid or counter inefficiency in their company's material management system. The flow process of material management at OEM is the focus of this technique. As a response, determining the issue of material overstock and understock is also crucial

information in this interview. One factor that contributes to understocking is the poor material planning, material estimating problems, storage problem and etc.

IDEF0 Approach

IDEF0 is used as a functional model to show the flow of the material management system in Original Equipment Manufacturer (OEM) as shown in Figure 1. The IDEF0 functional model has five elements as in Table 1: The activity (or process) is represented by boxes; inputs are represented by arrows flowing into the left hand side of an activity box; outputs are represented by arrows flowing out the right hand side of an activity box; constraints or controls on the activities are represented by arrows flowing into the top portion of the box; and the mechanisms that carry out the activity are represented by arrows flowing into the bottom of the activity box. ICOMs are also defined as inputs, control, output, and mechanism arrows.

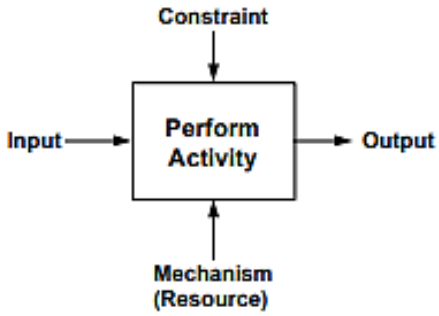


Figure 1. IDEF0 Representation

Table 1. Description of IDEF0 elements

Elements	Description
Function Name	Activity, process, operation or transformation
Input	Data, object, and material are all required.
Control	The function is managed by conditions, directions, or guidelines.
Mechanism	Long-term resources are required to carry out crucial tasks.
Output	Data, object, and material are examples of what it produced.

Microsoft Excel Macro

Microsoft excel macro is used to generate a material management system data for OEM company. A macro in Microsoft Excel is an operation or group of actions that users may run as many times as they want. Users record their mouse clicks and keystrokes when they construct a macro as shown in Figure 2. They may edit a macro after they've created it to make minor changes to how it runs as in Figure 3. They can also generate a report for their accounting manager once a month. Users wish to highlight the names of clients with previous accounts in red and use bold formatting. They can write and execute a macro to quickly apply these formatting changes to the cells they selected.

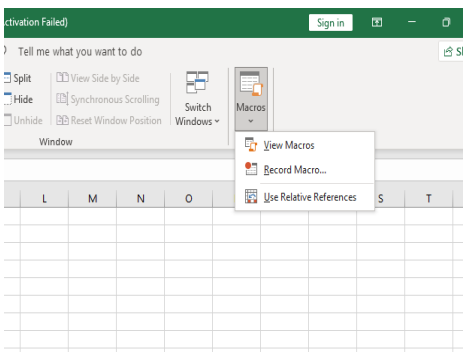


Figure 2. IDEF0 Representation

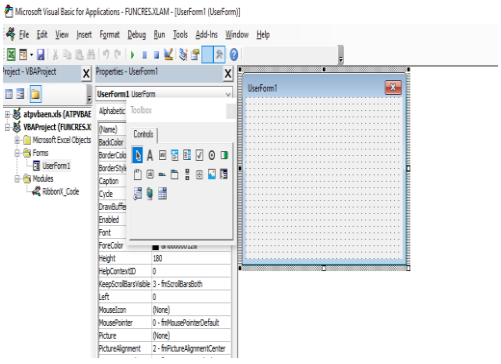


Figure 3. IDEF0 Representation

VBA USER FORM

A User Form is a customised dialogue box that makes entering user data more manageable and user-friendly. The User Forms class is a collection of things that represent each loaded User Form in an application. There is a Count property, an Item method, and an Add method in the User Forms collection. The element count of the collection is indicated by Count; Item (the default member) identifies a single collection member; and Add adds a new User Form element to the collection

RESULTS & DISCUSSION

Analysis System Characteristic of Material Management

Material management is an important aspect of OEM manufacture's operation because the most of costs in production are related to materials, which is why a manufacturing business should have efficient material management in place. In basic terms, materials management refers to the proper exploitation and management of materials entering the production unit in the form of raw materials, with the goal of minimizing waste and maximizing material utilization by the organization. Some of the key system characteristics of material management are (1) material management leads to uninterrupted flow of materials; (2) material management reduce material waste; and (3) material management improved budget accuracy and forecasting.

The material management should ensure an uninterrupted flow of raw materials so that production in the company does not stop due to a lack of materials. There are many instances where a company has a large order book but is unable to complete the orders on time due to production bottlenecks, resulting in a loss of business as well as the company's credibility. The flow of materials should never cease flowing since it would result in a halt in production, which would be bad for the firm in the long run.

Material wastage is common due to a variety of factors such as poor material handling, substandard material, lack of knowledge about material storage, and so on, which results in significant losses for the company during the production stage. This is where material management can help by ensuring that there is minimal wastage and maximum utilization of the company's resources.

In the case of materials management, the material manager's responsibility does not end with placing orders; rather, it continues until the finished product is sold to the consumer. As a result, aspects such as transportation of raw materials from supplier to company and from company to consumer are only part of material management; in addition, proper handling of materials is also the material manager's responsibility, making the entire material management process effectively.

Flow of Material Management

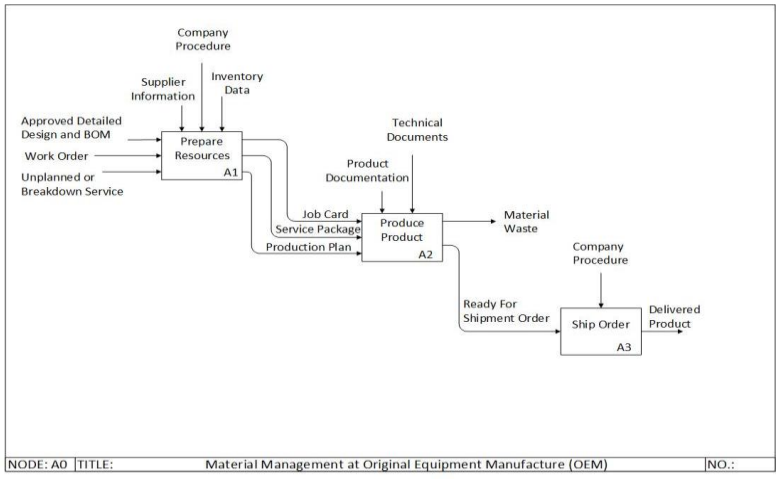


Figure 4. Material management overview process

Figure 4 shows an overview of the whole process of Material Management using the A0 diagram. This diagram was used to develop a model to display general information with inputs, controls, mechanisms, and outputs, where the input will move through the use of the control and mechanism to produce output. The A0 diagram shows the structure created by IDEF0, which includes three parent diagrams engaged in OEM flow managementand each parent diagram is detailed by child diagrams in nodes A1, A2, and A3. Thus, all of the elements required for each activity, as well as the interrelationships between activities.

In order to produce the acceptance customer order from the work order. First of all, the work order will go through from check resources, check inventory, generate production schedule and production plan to issue Job Card to prepare the parts according the customer requirements. For check resources, the admin staff will check the parts availability and do the data arrangement and the data will record in material record. After that, the next process will be take order of the parts. Secondly, after take order process is done, the inventory management will check inventory in term of inventory record and measure quantity of the parts before do the process planning. Thirdly, The design engineer will generate production schedule and production plan according to the customer requirement, work schedule and then do the production layout. Lastly, the admin staff will create the job card to ensure the stock entry to manufacture and then will proceed to the acceptance customer order.

The first important phase in the produce product is setup machine according to the requirement machine and production line system. The setup machine including calibration and process parameter after that material preparation will be final step in the setup machine before machine ready to work. Secondly, the assemble parts by production operator according the machines and facilities resources according to the standard operation procedure, SOP. Then after the finished goods parts are produced, the quality control staff will play the role to do the inspection of the parts and then they will record and do the part complete status then the after the completed parts are done, the last process in the produce product is storing the final product by packaging operator, before that the packaging staff will do the packaging process of the finished goods and then will do the warehouse record before proceed to the final product shipment process.

The flow of ship order process starts from arrange the delivery from sales department staff and also arrange the load trucks for transportation. The sales department staff also will generate the purchase order to record the order system. Then the shipping process and deliver order can be proceeded. The sales department staff also will give the tracking order to the customer to ensure them track their order easily. After product delivered, the finance department will obtain customer sign-off and approve the invoice then the ordered finally completed.

MATERIAL MANAGEMENT SYSTEM

Material Management System created with Excel Macro VBA, which is enough for the system to remember the stock of materials or parts. As a result, the company can keep the material in storage. As a result, this platform might be used to assist the company in updating stock levels in the departments, including warehouse and production. As a result, analysing a system employing this platform is a great option. For this Macro Excel, we must first construct three userforms with the names calendar, form search product, and form update product.

Figure 5 shows a UserForm for a Material Management System created with Excel Macro VBA, which is enough for the system to remember the stock of materials or parts. As a result, the company can keep the material in storage. As a result, this platform might be used to assist the company in updating stock levels in the departments, including warehouse and production. As a result, analysing a system employing this platform is a great option. For this Macro Excel, we must first construct three userforms with the names calendar, form search product, and form update product. As shown in Figure 6, we will use the calendar userform as a platform to select the stock in date. Users can perform two types of images in this userform to signify the left and right arrows for changing the date's year. In addition, two combo boxes are utilized to pick the month and year. We just utilize a button to choose a date and have the date display in the Excel sheet.

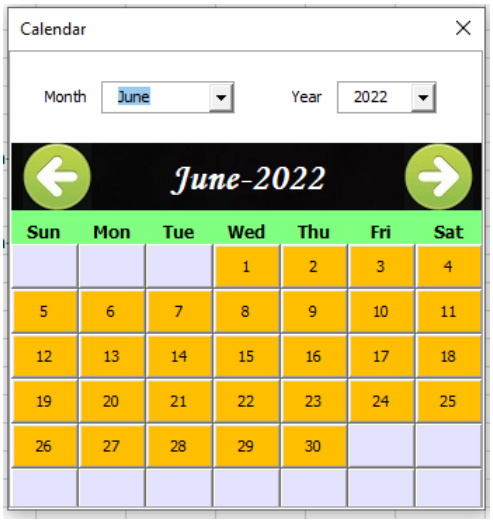


Figure 5. Calendar UserForm

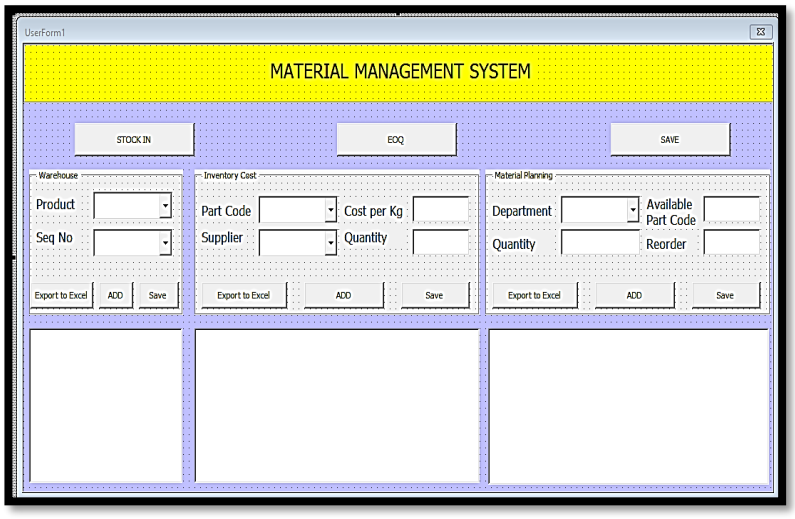


Figure 6. Material Management System

Figure 7 shows the Stock_In userform. The function of this userform is to record the stock in materials. The function of the product textbox to help users key in the classification of the products either automotive, electric and electronic or telecommunication product. Then for the product_name, the user can fill the type of a product for example blender, electronic button and etc. Next, the part_name textbox function is to enter the part of the product_name for example top cover part for blender. Furthermore, the part_code represent the type of material that use to manufacture the product_name. Later, the purchase_price indicate the price of the part_code per kilogram. Finally, the quantity represents the amount of part_code that has been purchase. After key in all the data requirements, the users can save the data or transfer the data to the Microsoft excel for documentation or data record.

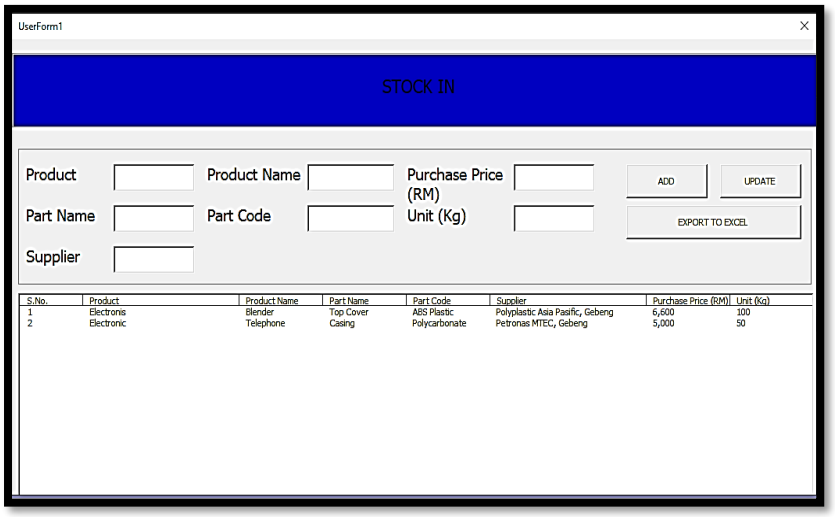


Figure 7. Stock in

Figure 8 shown economic order quantity (EOQ) Userform is the ideal order quantity a company should purchase to minimize inventory costs such as demands, holding costs and order costs. The user will enter the value of demands, holding cost and order cost and the Userform will calculate automatically the optimal EOQ and the total inventory cost per unit.

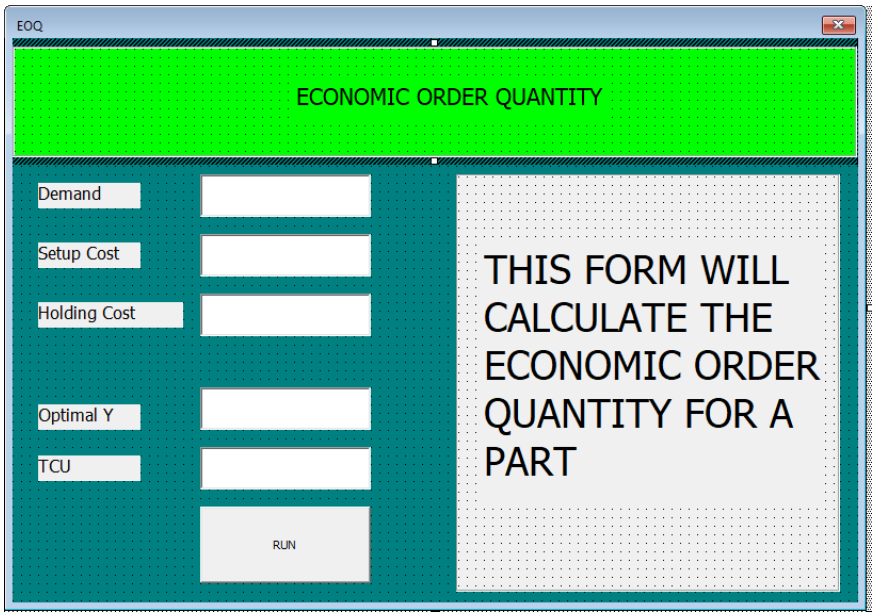
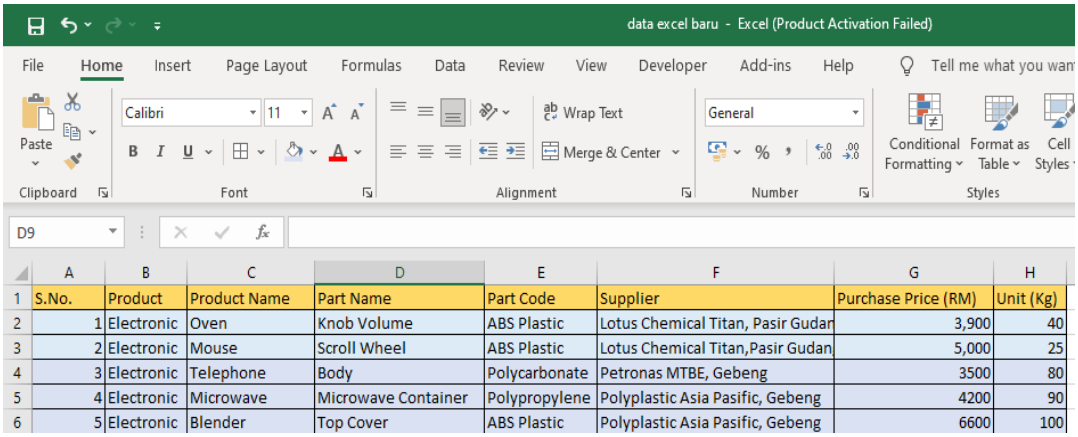


Figure 8. Economic Order Quantity calculation form

Then the five system above will be key in direct to the worksheet form which is Microsoft excel for documentation or record for the company as shown in Figure 9.



	A	B	C	D	E	F	G	H
1	S.No.	Product	Product Name	Part Name	Part Code	Supplier	Purchase Price (RM)	Unit (Kg)
2	1	Electronic	Oven	Knob Volume	ABS Plastic	Lotus Chemical Titan, Pasir Gudan	3,900	40
3	2	Electronic	Mouse	Scroll Wheel	ABS Plastic	Lotus Chemical Titan,Pasir Gudan	5,000	25
4	3	Electronic	Telephone	Body	Polycarbonate	Petronas MTBE, Gebeng	3500	80
5	4	Electronic	Microwave	Microwave Container	Polypropylene	Polyplastic Asia Pasific, Gebeng	4200	90
6	5	Electronic	Blender	Top Cover	ABS Plastic	Polyplastic Asia Pasific, Gebeng	6600	100

Figure 9. Worksheet Data

CONCLUSION

Material Management System especially in OEM industry as well as the main purpose of efficiency the whole material management system is controlling the product and service to improve the performance and competitiveness to meet customer's demand. Based on the current issue in the Company A where two materials management problems: stock-out and overstock occur frequently. It is good to have a high stock of part since the low risk of shortages can avoid the ran out of stock but it will impact the quality of the material management and cause obsolete stock. Furthermore, it also disturbing the production and increase the storage cost as the more stocks in hand; the more space is needed. Thus, manufacturing companies can implement new strategies to increase the material efficiency from the risk opportunities of stock control as preparations to overcome issues and challenges that might be happened in company A's production.

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REFERENCES

[1] Ahmed, M. B., Majeed, F., Sanin, C., & Szczerbicki, E. (2021). Experience-Based Product Inspection Planning for Industry 4.0. *Cybernetics and Systems*, *52*(5), 296–312. https://doi.org/10.1080/01969722.2020.1871222.

[2] Albert, I., Shakantu, W., & Ibrahim, K. (2018). Impact of Materials Management Practices in the Nigerian Building Construction Industry. *Journals.Co.Za*, *June 2018*, 1–10. https://journals.co.za/content/journal/10520/EJC-10a4fa1750?crawler=true&mimetype=application/pdf.

[3] Ammar, M., Haleem, A., Javaid, M., Walia, R., & Bahl, S. (2021). Improving material quality management and manufacturing organizations system through Industry 4.0 technologies. *Materials Today: Proceedings*, *45*, 5089–5096. https://doi.org/10.1016/j.matpr.2021.01.585

[4] Barletta, I., Despeisse, M., Hoffenson, S., & Johansson, B. (2021). Organisational sustainability readiness: A model and assessment tool for manufacturing companies. *Journal of Cleaner Production*, *284*. https://doi.org/10.1016/j.jclepro.2020.125404

[5] Bauzon, J., Murphy, C., & Wahi-Gururaj, S. (2021). Using macros in microsoft excel to facilitate cleaning of research data. *Journal of Community Hospital Internal Medicine Perspectives*, *11*(5), 653–657. https://doi.org/10.1080/20009666.2021.1954282

[6] Cano, J. A., Gomez-Montoya, R. A., Cortes, P., & Campo, E. A. (2021). Mrp systems considering fuzzy capacity, lead times and inventory availability. *International Journal of Simulation Modelling*, *20*(1), 29–39. https://doi.org/10.2507/IJSIMM20-1-538

[7] Daniel, C. O. (2019). Effects of Materials Management on the Productivity of an Organisation. *World Journal of Innovative Research (WJIR)*, *6*(1), 16–22. https://www.researchgate.net/publication/342069034_materials_management

[8] Das, S., Al-Amin Khan, M., Mahmoud, E. E., Abdel-Aty, A. H., Abualnaja, K. M., & Akbar Shaikh, A. (2021). A production inventory model with partial trade credit policy and reliability. *Alexandria Engineering Journal*, *60*(1), 1325–1338. https://doi.org/10.1016/j.aej.2020.10.054

[9] Donyavi, S., & Flanagan, R. (2009). The impact of effective material management on construction site performance for small and medium sized construction enterprises. *Association of Researchers in Construction Management, ARCOM 2009 - Proceedings of the 25th Annual Conference, September 2009*, 11–20.

[10] Duong, L. N. K., Wang, J. X., Wood, L. C., Reiners, T., & Koushan, M. (2021). The value of incremental environmental sustainability innovation in the construction industry: an event study. *Construction Management and Economics*, *39*(5), 398–418. https://doi.org/10.1080/01446193.2021.1901950

[11] Hasheminejad, S. A., Valipour, K., & Khoshnood, H. (2021). Applied real-valued genetic algorithm for an extended model of economic lot, purchase and delivery scheduling problem. International Review of Applied Sciences and Engineering.

https://doi.org/10.1556/1848.2021.00334 [12] Muda, I., Putra, K. B., & Dachi, V. N. (2021). Management material as a core of supply chain management. 2(1), 322–324.
[13] Patil, A. R., & Pataskar, S. V. (2013). Analyzing Material Management Techniques on Construction Project. International Journal of Engineering and Innovative Technology, 3(4), 96–100
[14] Govindaiah, S., & Petty, M. D. (2021). Applying reinforcement learning to plan manufacturing material handling. In Discover Artificial Intelligence (Vol. 1, Issue 1). Springer International Publishing. https://doi.org/10.1007/s44163-021-00003-3
[15] Joshi, B. R., & Gupta, A. R. (2021). View of Comparitive analysis of inventory control techniques in the construction project. Natural Volatiles & Essential Oils, 8(5), 12755–12762. https://www.nveo.org/index.php/journal/article/view/3981/3280