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Database design with product structure, Bill of Material and Group Technology for supplier decision support systems (*Case study: hand tractor manufacturing*)

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Abstract. Supplier selection is a common problem for manufacturing industries because there are so many supplier options. The decision support system is one solution that can help industries in which one is the best supplier with specific criteria. In the case of manufacturing industries, to give decisions supports system input data, we need to identify the bill of materials. Furthermore, group technology also can be used to optimize the bill of materials. In this paper, we present the database design process from the bill of materials combined with group technology in tractor manufacturing industries. Product structure diagram, bill of materials table, database design diagram are created as results. From this result, we can develop a decision support system with some computing algorithms for the next study.

Keywords: Supplier selection, database design, product structure, bill of material, group technology, decision support systems.

1. Introduction

Industrial Revolution 4.0, inventory management is demanded to be more global because Industry 4.0 is an integration of the economy with information technology, it will create a process of flow of goods, services, investment, and capital, from one area to another with very high competitive rates. Thus, it requires a truly competitive local product policy that is valuable and highly competitive to be able to compete with similar products from other countries [1]. About industrial inventory management in the Industrial 4.0 era, the most influential factors were suppliers.

In industry 4.0 selecting suppliers who can fulfill raw material orders that are in line with company industry standards in the long term is necessary. These activities are categorized as strategic activities because the role of suppliers will also be instrumental in determining the success of the company. If the raw material provided by the supplier is of poor quality, then this will also affect the quality of the product produced, so that productivity decreases [2] [3] [4] [5] [6] [7] [8]. The accuracy of supplier selection greatly affects the cost-efficiency [2] [5]. The right supply of raw materials guarantees a good quality product. With a good supply of raw materials, increasing process efficiency so that the company's operating costs can be reduced. And affect the increase in marketing, which results in increasing company profits. If



the supplier cannot provide the raw materials according to the company's requirements, then it is certain that the production schedule will be disrupted [9].

The selection of new suppliers who have never been partners with the company, is a more complex problem, because data is not yet available, and supplier performance is unknown. To choose a new supplier, you cannot use assumptions but must be based on empirical data that can be accounted for, because it greatly affects production performance [10]. Unlike the case with the selection of old suppliers who have been collaborating with the company. Data on business capability, track record, and other performance already exists in the company's database, making it easier to select and evaluate suppliers who will become partners with the company.

Supplier selection is classified as a semi-structured problem, where some of these problems are sufficiently structured to be solved by computers (calculation of criteria, calculation of efficiency, etc.) and some require a decision from the manager (selection of evaluation methods, selection of criteria, inputting values) [11]. The process of selecting suppliers with various criteria can be completed by a computer system that can interact with decision-makers. The system is a decision support system (DSS) for supplier selection [12].

Online-Decision Support System which is an application of computer software programs using web-based internet media. Users access certain pages on the site on the internet then enter their company data to be analyzed by the company using the online application. Evaluation results are immediately updated interactively using the web media.

Decision Support System also has a requirement, such as a database and an algorithm to fulfill supplier selection task. In this research, we try to make a database design in the case of tractor manufacturing industries. Before we make a database design, we implement a product structure and a group of technology.

2. Methods and Materials

Supplier selection is a complex issue in the current Industrial 4.0 era. A large number of suppliers with varying quality of performance makes it difficult for the internal company to choose the right supplier to supply raw materials. On the other hand, various kinds of raw materials needed to make finished products, are very diverse. The suitability of the quality suppliers needed to supply the raw materials needed by the industry is important to be resolved. Likewise, with the hand tractor assembly industry, this small and medium industry is also very dependent on the availability of supply materials, and certainly also depends on the selection of the supplier itself.

In this research case study supplier data 153, raw material data 70 raw materials with variable supplier selection criteria as many as 10 variables. The location of this research is in the Center for the Flat Metal Industry Klaten Solo, namely in the Flat Manufacturing Polytechnic. While the implementation of his research in the Computational and Information Systems Lab and Jember State Polytechnic Information Systems Engineering Laboratory. Methods for designing a database for Decisions Support System (DSS) in the case of tractors manufacturing are four steps: (1) Product Structure, (2) Bill of Materials, (3) Group Technology, and (4) Database diagrams. These steps are described in Figure 1.



Figure 1 Steps for Designing Database Diagrams

3. Result and Discussions

3.1 Product Structure

In the initial stage of this database design series drawings of hand tractors obtained in the field. Technical drawings of hand tractors can be seen in Figure 2. Product Structure Pictures are shown in Figure 3, where the images show the product structure consisting of 3 levels. In the picture also explained how to get each spare part, some are obtained by purchasing, and some are obtained by making their own., the structure of the hand tractor product is made. To compile a database of raw materials the structure of this product was compiled from technical

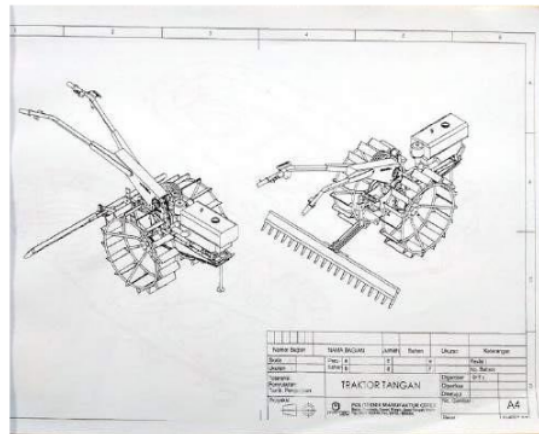


Figure 2 Technical Drawings of Hand Tractor

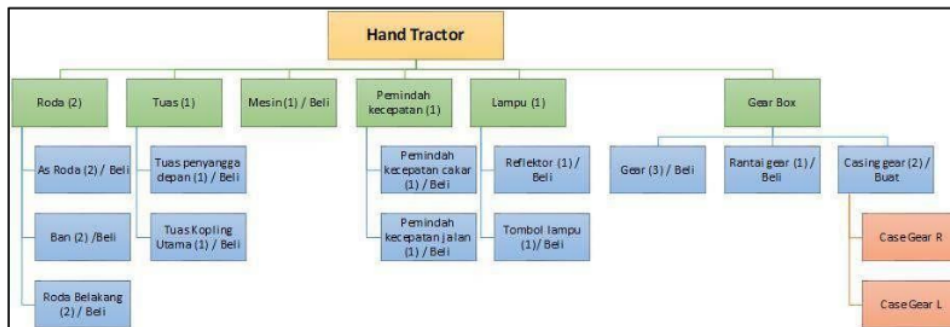


Figure 3 Product Structure of Hand Tractor

3.2 Bill of Materials (BOM)

Bill of material or product structure (sometimes called BOM or product structure list) is a list of raw materials, sub-assemblies, intermediate assemblies, sub-components, parts, and the amount of each needed to produce the final product. BOM can be used for communication between manufacturing partners or limited to a single factory. Bills of material are often associated with production orders whose issuance can produce orders for components in the bill of materials that are in stock and demand for components that are not in stock ("Bill of Materials," 2020).

Based on the Product Structure that was created in the previous step, a Bill of Material table is prepared as shown in Table 1 below.

Table 1. Bill of Materials

| Code | Description | Qty | Metrics | Order | Materials | Process |
|------|--------------------|-----|---------|----------|-----------|-------------|
| 1000 | Wheel | 2 | pcs | Purchase | | |
| 1100 | Axle | 1 | pcs | Purchase | | |
| 1200 | Tire | 2 | pcs | Purchase | rubber | printed out |
| 1300 | Rear Tire | 2 | pcs | Purchase | | |
| 2000 | Lever | 1 | pcs | Purchase | | |
| 2100 | Buffer lever | 1 | pcs | Purchase | | |
| 2200 | Main Clutch Lever | 1 | pcs | Purchase | | |
| 3000 | Machine | 1 | pcs | Purchase | | |
| 4000 | Speed shifting | 1 | pcs | Purchase | | |
| 4100 | Claw speed shifter | 1 | pcs | Purchase | | |
| 4200 | Road speed mover | 1 | pcs | Purchase | | |
| 5000 | Lamp | 1 | pcs | Purchase | | |
| 5100 | Light switch | 1 | pcs | Purchase | | |
| 5200 | Reflector | 1 | pcs | Purchase | | |
| 6000 | Gear Box | 1 | pcs | Develop | | |
| 6100 | Gear Chain | 1 | pcs | Purchase | iron | printed out |
| 6200 | Gear casing | 1 | pcs | Purchase | steel | printed out |
| 6300 | Gear | 3 | pcs | Purchase | iron | printed out |

Based on the Bill of Materials, most of the spare parts are obtained by way of scanning, while the ones making themselves are gearbox components. The gearbox is manufactured by UKM in Ceper Klaten Solo, Central Java.

3.3 Group of Technology (GT)

Group technology or GT is a production technique where parts that have similarities in geometry, manufacturing processes, and/or functions are produced in one location using a small number of machines or processes. Group technology is based on the general principle that many problems are the same and by grouping the same problems, one solution can be found for a set of problems, thus saving time and effort. ("Technology Group," 2019).

Technology Group or GT at this stage is needed to compile the Code Part Number that will be used in the compilation of the database. This Code Part Number is a grouping of spare parts according to their function. The code consists of 4 digits, the 1st digit shows the Spare Parts, 1 means the Wheel parts, 2 means the Lever parts etc. The 2nd digit shows the Parts Subdivision, 11 means Axle, 12 means Tires, etc. Digits 3 and 4 show the Parts Sub Variant.

3.4 Database Diagrams

The final step of making this database design is to make a database diagram that will be implemented in the Information System. Database diagrams arranged based on BoM and GT are shown in Figure 4 Database Diagrams.

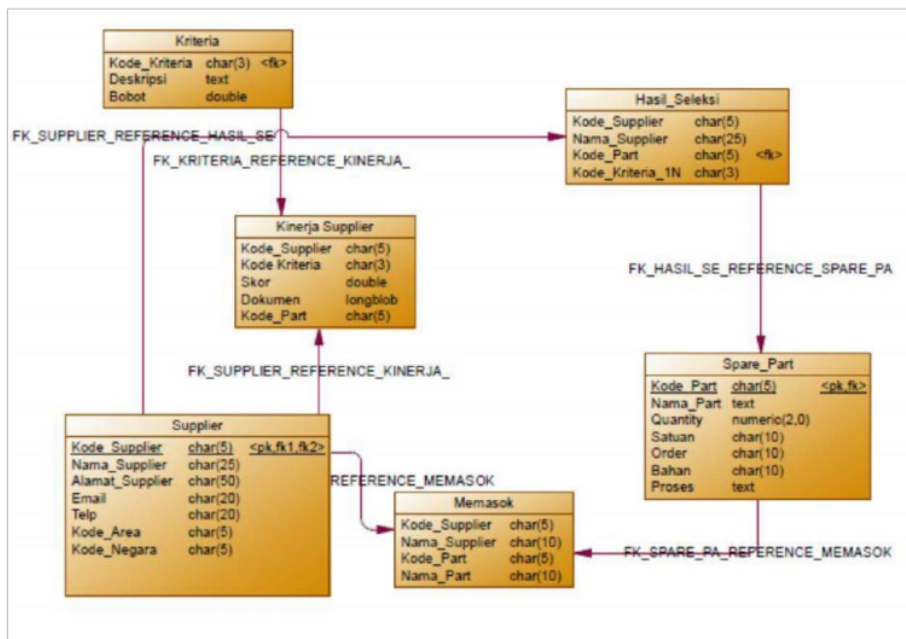


Figure 4. Database Diagram

The Database Diagram illustrates that 6 main database tables are used to process Supplier Management Information Systems. Namely Supplier Tables, Supplier Performance Tables, Criteria Tables, Supplying Tables, Spart Part Tables, Selection Results Tables. Each table forms relations between tables as described in Figure 4. In the database diagram also illustrates the existence of data items/fields columns that are used to manage information in the database management system.

4. Conclusion and Future Works

This paper presents an alternative solution to solving problems in a long series of activities selecting suppliers of manufacturing industries by compiling a database design using the Bill of Materials and Group Technology. After compiling this scientific publication, further research should be conducted to create a database design using manufactured products other than hand tractors. Besides, further research is needed to compile a more detailed knowledge base and product structure database.

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