

4.3 Disturbances Analysis Based on Association Rules

One stage of the association analysis that attracted the attention of many researchers to produce efficient algorithms is the analysis of high frequency patterns. The importance of an assumption can be known by two benchmarks, namely: support and confidence. Support (supporting value) is the percentage of the combination of items in the database, while confidence (the value of certainty) is the strong relationship between items in the association rules.

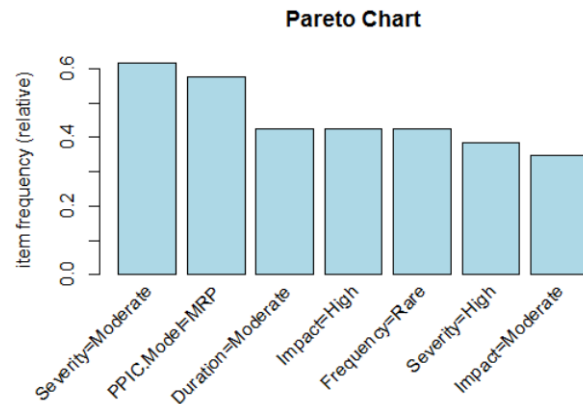


Figure 5. Disturbances Characteristics Pareto Diagram

The Pareto diagram at Figure 5 describes the disturbing factors that often occur, among others, are disturbances with moderate severity that are more common when compared to disturbances with high severity. Furthermore, the disturbances that occur most often are related to the Material Requirement Planning (MRP) function in PPIC when compared to other PPIC models such as Demand Management (DM), Master Production Scheduling (MPS) and Scheduling. Next, the results of the mapping of production system disturbances that occur indicate that most of the disturbances that occur have a moderate duration, causing an impact on high KPIs and rare frequencies. Then, the disturbances that occur have a high degree of severity and moderate impact have a number of events that are not much different from one another.

To find the pattern that occurred, an analysis was performed using the a priori algorithm association rules method. The following below is a pattern obtained by using the association rules method a priori algorithm. By using the the rules graph at figure 6, we know that The high severity disturbances associated with the MRP PPIC Model, with the type of disturbances of raw materials having a high impact on KPI.

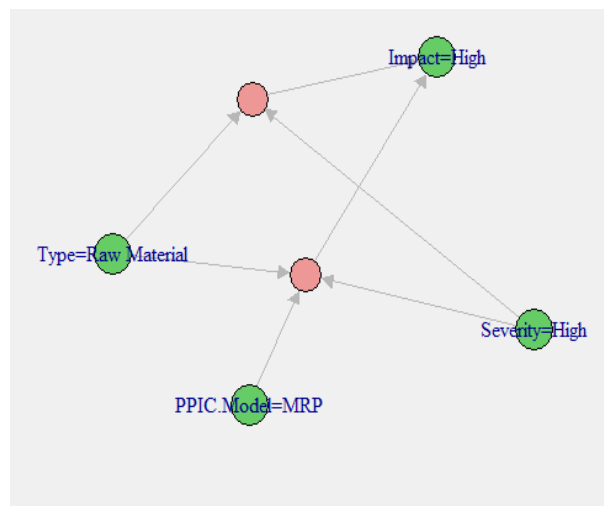


Figure 6. Disturbances Impact Factor based on Association Rules

4.4 Analysis

Disturbances that occur at PT. ABC related to the business process of producing heavy equipment components include disturbances at the Sales, PPIC, Purchasing, Production and Quality Control divisions. What is meant by this disturbances is the cause of non-achievement of the KPI of each division. Sources of disturbances can occur from both external and internal, but more disturbances comes from external sources.

The business process of producing heavy equipment components starts from the Sales Division. The Sales Division is dealing with customers both in receiving orders and handling complaints. The difference in forecast with real orders will interfere with production planning. This difference occurs because there are changes / additions to the number of requests from customers that are often accompanied by changes in leadtime. The lead time set by the customer < lead time of the production section. This change in customer demand will also disturb the production section. The disturbances experienced by the sales division actually comes more from external customers and internal unpreparedness in planning. This Sales Division does not have fast and accurate access to production capabilities, and there is no integrated information with all divisions.

Next the PPIC Division plans to meet customer requests received by the sales. PPIC will deal with production and purchasing divisions for purchasing raw materials and subcontracts. Disturbances at the purchasing division will trigger disturbances in the production and purchasing division. The change in the number of requests will trigger an error in determining the amount of production. Disturbances mapping show also that there is engine damage and the delay in sending raw materials from the supplier. Indirectly the disturbances in the production division comes from the sales division.

The source of the disturbances of the PPIC division came from internally both in the planning system and in HR. While external sources indirectly come from customers, suppliers and subcontracts. Disturbances in the production division will have an impact on the delay in product delivery, and the low quality of the product. While the source of the disturbance comes from internal, both in planning, capability and availability of operators and machine reliability. While sources originating from external sources come from the ability of suppliers and subcontracts. The calculation of PPIC ABC company currently uses Microsoft Excel and manual, so that it can make calculation errors by PPIC operators and subsequent accumulation of calculation errors in other PPIC functions and actions that must be carried out by PPIC staff. The company's PPIC data is still not integrated so that it is very potential to cause miscalculation of PPIC functions such as Determination of Master Production Schedule, Ordering Planning of Raw Material Requirements to suppliers, Production Scheduling, Production Capacity Check and Determination of Customer Order Completion Time. With the integration of the company's current PPIC data calculation file, coupled with the possibility of insertion or order changes, PPIC operators have difficulty updating the calculation data in the PPIC file and the potential for causing data updates is not carried out and the next is PPIC calculation data to be not accurate.

Careful calculation of production capacity in accordance with the data of the master production schedule and calculation of the availability of production hours for each work station is a matter that must be prioritized by the company. For heavy equipment producing industries with a make to order strategy and engineer to order with company characteristics that highly prioritize customer satisfaction while minimizing customer complaints, it is very potential to experience an external production system disturbances (demand change). This condition causes companies to determine the policy of providing safety supplies for finished products for requests for 2 months. Supplier of raw materials with the procurement of imports and locales as well as variants of raw materials that vary according to customer demand (with a variant of finished products that are also many) causes the company to require a non-simple Material Requirement Planning module.

In general, based on global analysis of the PPIC model applied by the company today, companies need an integrated information system to maximize the PPIC function in the company. Taking into account the number of finished product variants with the need for variations in the production process for different product variants, sufficient time and thought is needed to obtain accurate mapping and analysis of the PPIC model applied by the company today.

Customization of customer orders is carried out, among others, resulting in a backlog of customer orders. Based on the results of interviews with company resource persons, it is known that there are many incidents of production system disturbances that occur and the potential causes disturbances to the target of meeting customer demand cause the company to require a non-simple Material Requirement Planning module. The company also needs an

information system to support the Production Scheduling module which is integrated with other PPIC modules to streamline the PPIC function in the company. Considering so many disturbances in the production systems faced by the company, both internal and external, related to the company's need to continue to increase customer satisfaction, the company has a policy of providing safety stock for both raw materials and finished products.

In the case of PT ABC, the available information system has not been integrated with all production units so that there is an error in translating production orders that have an impact on the procurement of raw materials, determining the amount of production and the delivery schedule to customers who are often late. Input for the MRP system in the form of Master Production Schedule often changes due to changes in the model and the number of products requested by the customer in less than 4 months. Figure 4 shows the flow of information in the form of orders obtained from internal and external customers and material flows in the form of raw materials, semi-finished products and finished products that occur on the production floor which is input and output in the company's MRP system.

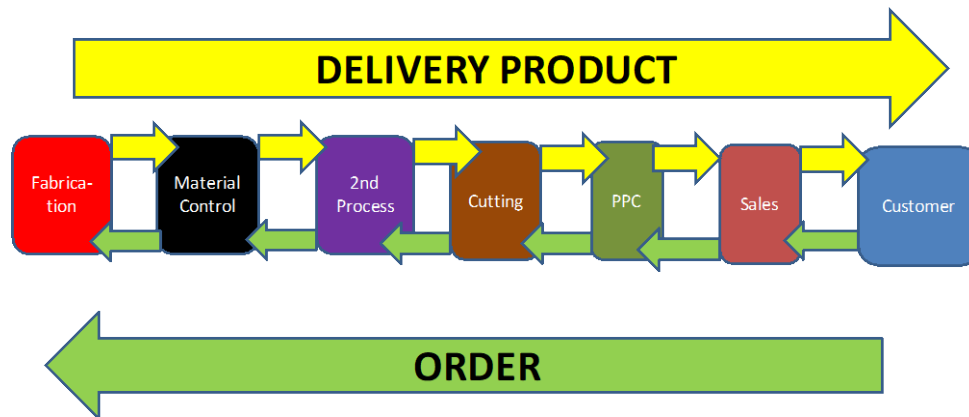


Figure 7. Information Flow (Order) and Product Flow (Delivery Product)

Next, the calculation of the actual capacity has not been done correctly which results in the load profile of available resources not always in accordance with what is needed. As a result of the disturbances of the production master schedule and the inconsistency of the load profile it affects the inventory status of raw materials which will affect the material ordering schedule and delay in production due to unmet resources. To avoid material shortages, often the material planning part estimates the purchase of raw materials in excess of the required amount. Furthermore, the production department also does the same thing by increasing the amount of production from the number of PO to anticipate additional PO from the customer. But this cannot anticipate the fulfillment of customer requests that always change in the middle of the production schedule that has been carried out.

5. Discussion

Uncertainty is defined as any unpredictable event that disturbs the production process in a manufacturing system that is planned by MRP, MRP II or ERP system (Ho, 2003). In the Indonesian case, the limited national supply of heavy equipment manufacturers may jeopardize the availability of heavy equipment for construction since its share is about 20% of the total demand. The balance of future demand and conditions of heavy construction equipment availability seems not to be the focus of attention. Heavy equipment suppliers have not been able to respond to the demand because it is not possible for them to increase their production of heavy equipment in a relatively short time. This condition may hamper the development of the national construction industry as a whole (Simatupang, 2016).

Manufacturing planning and control entails the acquisition, use, and allocation of limited resources in production activities so as to satisfy customer demand over a specified time in the most efficient and effective way. The available planning tools like MRP, MRP II or ERP are very good for scheduling, but completely ignore the uncertainty and capacity, issues. Managing uncertainty effectively and efficiently requires balanced planning and control. One must understand which uncertainty to tackle, and how to tackle it, in order to obtain the maximum improvement of the system. The approach based on KPI and its measurement has the potential to solve problems of uncertainty in demand, supply and process (Wazed, 2010).

Heavy equipment component industry with a make to order strategy and engineer to order with company characteristics that highly prioritize customer satisfaction while minimizing customer complaints, it is very potential to experience an external production system disturbances (demand change). The industry has specific markets and are limited by market trends and also has customized demand characteristics, large product variants with not large quantities per variant, limited special market users, high quality raw material requirements, requiring sufficient raw material procurement lead times and big investment in raw materials, requires technology and high-skilled workforce to produce high-quality products. Characteristics of the industry cause the heavy equipment component industry need safety stock for raw material and safety lead time for component that can be adjusted based on the dynamics and disturbances that occur.

Based on a pattern obtained from the production system disturbances mapping by using the association rules method a priori algorithm, we know that the high severity disturbances associated with the MRP PPIC Model, with the type of disturbances of raw materials having a high impact on KPI, the company need Material Requirement Planning (MRP) which is supported by excellent information system design, with a good database management system, integrated and facilitates the flow of information and communication between PPIC support divisions, simple, flexible so that it is easy to adjust and has supporting functions:

- a. To find out the needs and availability of capacity of each production work station.
- b. To find out the needs and availability of raw materials.
- c. To find out the needs and availability of labor.
- d. To browse and find out the order fulfillment status.
- e. To find out if there is a disturbances in the production system and do action of controlling the disturbances that occurs.

6. Conclusions and Future Research

The results of the mapping disturbance analysis at PT ABC show that the production process cannot run in accordance with the planning and scheduling that has been made because of the misinformation that also has an impact on KPI achievement. Information flow and information flow and material flow that are the input and output of the company's MRP system do not match what happens on the production floor. The occurrence of a chain of disturbances is caused by a lack of integrated information between divisions and suppliers, so that each division processes based on their respective policies and information systems need to be built regarding MRP functions with integrated databases between each PPIC division where each department related to PPIC functions has access according to their needs. The company needs an improvement in the MRP system and Standard Operation Procedure (SOP) for each division in releasing production and ordering of materials. The company also requires an information system in the form of a dashboard that can display real conditions on the production floor as well as the status of each agreed order, while monitoring the disturbances of the production system that occurs, so that it can immediately control and make adjustments so as to meet the KPI of each PPIC division. Regarding the disturbances of production systems that occur, companies can control the disturbances of the production system that occurs by providing safety stock for raw materials and finished products in order to support the smooth running of business processes and fulfillment of KPIs for each PPIC division in the company.

For the future research, we recommend to apply the disturbance control model, as has been done in previous studies in the automotive industry, starting with mapping the production system disturbances in accordance with the relevant KPI, then by utilizing the classification technique approach we got the disturbances control model consists of sub-model of the risk level of the disturbance, sub-model of action status, sub-model action control of the disturbance, and sub-model of determining the safety stock to assist the automotive company in taking the decision to perform the disturbances control action in production system (Marie, 2017).

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Biography

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