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2017 International Conference on Soft Computing, Intelligent System and Information Technology Replenishment Strategy Based on Historical Data and Forecast of Safety Stock Case Study: Safety Stock of PCBA at PT “X” Allysia Ongkicyntia, Jani Rahardjo Department of Industrial Engineering Petra Christian University Surabaya, Indonesia allysiaao@yahoo.com, jani@petra.ac.id Abstract—One of replenishment strategy that can be used to reduce stock out occurrences on fulfilling customer demand is safety stock. Safety stock generally influenced by supplier or manufacturing lead time, service level, and standard deviation. This research calculates and analysis the safety stock is between forecast data and historical data. ABC/FMR classifications help to give information to the company whether parts need to have stock or not. The result shows that safety stock based on historical data is better than safety stock based on forecast data. It is because safety stock based on historical data can describe the erratic demand than based on forecast data. Safety stock based on forecast data cannot be used because it has the low percentage of forecast accuracy. Based on ABC/FMR classification, several parts are suggested to have stock because has the highly frequent demand and several parts are suggested to have non-stock. Keywords—Replenishment strategy; safety stock; service level; ABC/FMR classification. I. INTRODUCTION Manufacturing is a production process to manage raw material into finished goods in an industry. Raw materials are one of the important factors in the manufacturing process. The manufacturing process cannot start if there are no raw materials and impact to customer delivery plan. This can be detrimental to a company in terms of time and cost. The availability of raw materials should be maintained to support production process. PT X has many types and the highest number of products that has 3 floors of production: Drive, Printed Circuit Board Assembly (PCBA), and Automation. Finished goods from Drive and Automation production floor are used to fulfill customer demand. Raw materials for Drive and Automation come from 3 sources; Inside Group (IG) supplier, Outside Group (OG) supplier, and 2nd floor production. Raw materials from the 2nd floors production are PCBA products. PCBA products are one of the most important products for Automation and Drives as its customer. As one of the most important parts, PCBA must be produced appropriate the demand from Automation and Drive, preventing of stop line production. One of the problems is the occurrences of stock out in PCBA in house customer’s need. This issue needs some improvement so it can reduce the cost in terms of time or cost by doing replenishment strategy. Replenishment strategy that will be done is by improving the value of safety stock. The purpose of this research is to define a suitable safety stock value per parts for PCBA by using replenishment strategy. Service level based on current calculation of safety stock without forecasting and historical data was low. II. LITERATURE REVIEW Demand in supply chain has 2 types: independent and dependent demand. Independent demand items are generally finished goods while the part of making finished goods is called dependent demand. An accurate representation of future demand is needed to reduce costs and maintain the customer satisfaction. Forecasting is necessary to represent the future demand. It can help to increase

profitability through better optimization, inventory management, and product promotions. The raw material cost and finished goods can reduce with a better demand forecast and more efficient at delivering the product (Altekar [[1]]). Inventory needs to be managed because it is impossible to control a thousand items accurately. ABC classification is used to classified items by prioritizing level of product value. Class A for higher value products, about 80% of annual sales; class B for products that have value around 15%; and class C for lower value products (5% of annual sales). Items classified to class A, B or C depends on annual dollar volume (Ray [[2]]). Frequencies of demand are described by using FMR classification. Class F is for products that very frequent demand, M for medium demand, and R for low demand frequency. The decision of ABC/FMR classification is used to determine the item as MTO (Make to Order) or MTS (Make to Stock). Items that have highly frequent demand with a low value is suitable to use make to stock strategy. Products that have highly frequent demand should have stocked but need to be controlled closely (Cortes et al [[3]]). MTO and MTS decision is supported by some decision process. Based on ABC/FMR Matrix, AR and BR are suggested to avoid stock; AF, AM, BF, BM can have stock and need to watch carefully; CF and CM can have stock and 978-0-7695-6163-9/17 $31.00 © 2017 IEEE DOI 10.1109/ICSIIT.2017.65 try to automate the management; and CR can have some stock by several exceptions (Oberle [[4]]). Safety stock helps the flow production to have a smoother production process and avoid the stock-out raw material. It can increase production lead time from fluctuation in demand and supplier lead time (Kilger et al [[5]]). Hill [[6]] said safety stock is the average inventory when a new order of a product is received. Safety stock gives an impact to inventory if it is set too high or set too low. A high safety stock will create a high carrying cost and low safety stock will create a shortage cost. Safety stock is needed to control variable for balancing carrying cost and service levels (Hill [[6]]). Safety stock calculation can be defined by using statistical functions to achieving a specific service level. Service level and safety stock can be more effective by using standard deviation (Radasanu [[7]]). Standard deviation is calculated using the formula: (1) Where: : Total frequency of demand request : Average demand : Demand for the period The value of service level will be converted to k factor as a multiplier with standard deviation to calculate a specific quantity. Higher service level value impact to service factor and safety stock level (Radasanu [[7]]). The formula for safety stock calculation based on the extent of demand varies and the desired service level of safety stock is expressed with the formula (Ross[[8]]): (2) Where: : Safety stock : Standard deviation : Standard deviation corresponding to desired service level : Total lead time Service level is needed to shows inventory condition of a company in fulfilling customer demand. Increasing customer service level in production control and inventory is one of the main objectives in an industry. Customer, in this case, means internal customer (purchasing, production, etc) and external customer. Factors that must be considered in increasing service level are the quality of products, availability products, price, on-time delivery, and etcetera (Gaspersz [[9]]). The value of service level must be defined and measured to determine the service that provided to the customer is good or not. Higher probability values of service level impact the possibility of a company to fulfill customer need and avoid stock out. Service level is determined by considering carrying cost, backorder cost, and factor of lost sales/customers (Yunarto et al [[10]]). Lead time will enable the company to respond customer needs quickly (Cheng et al[[11]]). Lead time consists of queuing time, processing time and transportation time. Lead time is the most important one because it related to many costs. Lead times can affect the level of safety stocks in finished goods inventories, raw material inventory, and vendor inventory (Graves et al [[12]]). Forecast accuracy is the primary measure performance of product availability, customer service, cost, and inventory level. Focus on forecast accuracy can eliminate the risk of driving wrong behavior that will impact to another problem such as cost. Demand forecast accuracy also related to measures of forecast error. Forecast error is also known as Mean Absolute Percent Error (MAPE). MAPE is one of the most commonly used to know the Forecast error. MAPE can be calculated using the formula (Gattorna [[13]]): (3) Where: : Forecast value : Actual Value SAP stands for Systems, Applications, and Products in Data Processing, founded in 1972 by 5

IBM engineers in Germany. SAP is a creative organization that envision the appearance of EIS/ERP 20 years ahead of time. In E-business solution firms, SAP is recognized leader. SAP has a overwhelming benefit. Some leading companies in the computer industry are with SAP (Olson et al [[14]]). III. REPLENISHMENT STRATEGY Twenties families in PCBA in house have reduced into twelve families because eight families consist of all End of Life (EOL) products. EOL means the products will not be used anymore especially on 2017. One family also will be removed in this calculation because commonly used for CSR project. CSR project is a project to install solar lighting systems throughout some villages that have no electricity. Demand for this Family mostly from fellow company from PT X that will be used for charity project so it can be said the demand mostly depends on when / how many times that CSR project will be held. TABLE I. SERVICE LEVEL PER FAMILY Family Total Total Material usage (pcs) Average SL Analog Converter Hermes Momentum PCBA Option Phosphor RE48 RMC2 RS2 Solo Sprint Visu Mirano 16 1 9 42 1 10 18 2 9 22 12 14391 180 4021 76267 176 45480 22115 41978 44214 78703 374415 26.24% 11.67% 26.14% 16.19% 17.91% 35.74% 19.28% 64.43% 35.00% 26.24% 42.02% Total 142 701940 25.32% The value of service level in this research is obtained based on data per week for each PCBA references or parts. Service level can be calculated if there are any requests or demands from the customer. Table I shows that Visu Mirano has the largest quantity of usage with total 374,415 pieces and the value of service level is 42.02%. Family RS2 has the highest service level with 64.43% and the lowest is Hermes with service level 11.67%. The total average of 11 families in PCBA in house is 25.32%. The low value of service level occurs because not being able to fulfill customer demand. One attempt to improve service level is by doing replenishment strategy. An accurate safety stock calculation is needed to make benefit in terms of both customers and companies. Safety stock was calculated by considering the cost that will be issued and also the frequency and quantity of customer order. Data that is used in this research is assumed normal distribution. Lead time that will be used is 4 days. It consists of total time that is needed to request and deliver the raw material and produce the raw material into PCBA reference. Lead time for delivering the raw material until come to PCBA floor production is 1 day and it takes maximum 3 days to produce the raw material to become finished goods or PCBA references. The company targets service level PCBA in house can achieve to 95%. It means the company can tolerate the stock outs of this product on no more than 5% of replenishment cycles. Using table Z factor for service level 95% is 1.64. Standard deviation has been defined using formula 1. After defining 3 factors that are needed in safety stock (SS) calculation, safety stock can be obtained by using formula 2. Based on historical data, Family with the highest safety stock value is Visu Mirano family but PCBA Option has the highest total price among 11 families below. It is because several parts in PCBA in house has the high price per unit compared with other parts. Table II shows the calculation safety stock and price value based on historical data. Total price value for 11 families is $ 171,426.911 where PCBA Option has the highest price value. Besides being influenced by total safety stock that is suggested, in PCBA Option family has long process than the other families. The long process to make a product is also impacted to the raw material that will be used, and it will be impacted to the price value. TABLE II. CALCULATION BASED ON HISTORICAL DATA Family Analog Converter Hermes Momentum PCBA Option Phosphor RE48 RMC2 RS2 Solo Sprint Visu Mirano Total Historical Parts SS Total 20 678 1 11 10 125 53 3857 1 9 10 857 25 2187 2 584 10 1674 29 4431 12 8001 Price SS Historical $ 7,230.22 $ 259.63 $ 9,291.22 $ 90,403.49 $ 154.50 $ 2,082.83 $ 19,802.57 $ 3,064.61 $ 8,889.69 $ 24,412.06 $ 5,836.10 Total 173 22414 $ 171,426.91 Safety stock based on forecast data shows that total price value from forecast data is $ 58,655.83. Table III shows the calculation based on forecast data. Different from Safety stock based on Historical Data, Sprint family has the highest total price value. TABLE III. CALCULATION BASED ON FORECAST DATA Family Analog Converter Hermes Momentum PCBA Option Phosphor RE48 RMC2 RS2 Solo Sprint Visu Mirano Total Total Forecast Parts SS Total 20 525 1 16 10 47 53 487 1 35 10 438 25 1382 2 584 10 741 29 2809 12 3558 173 10622 Price SS Forecast $ 5,425.57

$ 377.64 $ 3,902.25 $ 7,583.78 $ 600.84 $ 1,095.10 $ 13,138.97 $ 3,079.59 $ 3,805.87 $ 16,998.85 $ 2,647.36 $ 58,655.83 Sprint family is the highest safety stock value based on forecast data. Total value based on forecast data is smaller than based on historical data. It is because forecast data has stable demand. More stable data per month will impact to standard deviation value. Standard deviation value will be smaller than using erratic demand data. If company more consider in saving cost, it should be used safety stock value based on forecast data. Based on forecast data, the company can save cost around 65% from using historical data. ABC/FMR classification is used to know item classification based on the level of product value and frequency of delivery/order. The value ABC/FMR is calculated using historical data only. It is because the frequency cannot be defined if the calculation is using the forecast data. ABC/FMR matrix was formulated by crossing the ABC and FMR. ABC classification is established by looking at the product value. Product value is obtained by multiplying the total average usages in a month with the standard price for 1 unit. Total product value in percentage must be sorted from largest to smallest. The value then accumulated with conditions; 0%-80% will be classified A, 80% - 95% will be classified B, and the rest will be classified C. PCBA references can be categorized into FMR classification based on the predefined condition. FMR classification determines by looking the frequency of delivery where FMR means fast mover, medium mover, and rare mover. This company has some conditions to categorized parts into FMR classification. Parts that have a frequency less than 1 in a month will be categorized into R classification; parts that have a frequency less than 4 but greater than 1 in a month will be categorized into M classification. The rest of it (Frequencies > 4 in a month) will be categorized in F classification. If the parts have no frequency or movement in a month, it will be categorized into S or Sleeping item. Analysis data begins with the comparison between old SS, forecast and historical data. Old SS is data safety stock for several parts that have been implemented in PCBA in house but didn't review periodically. Old SS cannot be used in the future but it's needed to shows if there's any difference or improvement based on Old SS, historical data, and also forecast data. The comparisons that will be done in this analysis are the comparison of safety stock value, price value and also Days of Inventory. Number of safety stock that will be compared is based on 3 data. Table IV is shown the different value that has been defined. The value of safety stock among three data above has a huge difference number of safety stock. Safety stock value based on forecast data has the smallest total amount (47.4% from historical SS value) compare with old SS and historical. Normally demand based on forecast data is more stable than historical and Old SS. Because of the stable demand on forecast data, the standard deviation value will be smaller than the other data. It can be said that standard deviation value also will be impacted by the number of safety stock value. TABLE IV. COMPARISON VALUE OF SAFETY STOCK Family Safety Stock based on (pcs) Old SS Historical Forecast Analog Converter Hermes Momentum PCBA Option Phosphor RE48 RMC2 RS2 Solo Sprint Visu Mirano 1134 678 525 42 11 16 448 125 47 0 3857 487 42 9 35 2922 857 438 1152 2187 1382 1288 584 584 2646 1674 741 3276 4431 2809 12000 8001 3558 Total 24950 22414 10622 As shown in Table IV, Old SS is highest than other data but doesn't mean same with price value. Historical price value is the highest than Old SS and Forecast data. The detailed comparison of price value can be seen in comparison price value per family. Table V shows the price value if the safety stock values apply based on Table IV. The highest total price value is obtained based on historical data with total $ 171,426.91. TABLE V. PRICE VALUE Family Analog Converter Hermes Momentum PCBA Option Phosphor RE48 RMC2 RS2 Solo Sprint Visu Mirano Price Old SS $ 12,571.32 $ 942.83 $ 35,328.33 $ - $ 651.95 $ 8,604.23 $ 10,800.36 $ 7,819.30 $ 13,697.98 $ 24,631.10 $ 10,443.90 Price SS Historical $ 7,230.22 $ 259.63 $ 9,291.22 $ 90,403.49 $ 154.50 $ 2,082.83 $ 19,802.57 $ 3,064.61 $ 8,889.69 $ 24,412.06 $ 5,836.10 Price SS Forecast $ 5,425.57 $ 377.64 $ 3,902.25 $ 7,583.78 $ 600.84 $ 1,095.10 $ 13,138.97 $ 3,079.59 $ 3,805.87 $ 16,998.85 $ 2,647.36 Total $ 25,491.29 $ 171,426.91 $ 58,655.83 Comparing the value between historical data and old SS, the price value has increased 36.6% from old safety stock value. 73 parts from old SS have bigger value

than price value based on historical data and 90 parts based on historical data have bigger value than old SS. As shown in Table V, 9 Families based on historical data has the lowest value than old safety stock but total price value based on historical data is bigger than old SS. It's strongly influenced by price value of PCBA Option family. It because based on old SS there is no safety stock for PCBA Option family and suddenly based on the forecast data, it's suggested to have safety stock with the high-value SS. TABLE VI. DEMAND OF SPRINT FAMILY Month PCBA Reference HRB17689 HRB17691 HRB17674 HRB17688 Feb-17 Mar-17 Apr-17 Mei-17 Jun-17 Jul-17 Agu-17 Sep-17 Okt-17 Nov-17 Des-17 Jan-18 97 69 32 68 34 216 62 32 182 58 30 216 65 33 166 58 30 280 65 32 235 69 34 183 65 32 195 53 26 208 67 34 212 65 32 335 935 902 793 754 845 755 855 903 855 685 878 854 Total Demand Average Forecast Stdev Safety Stock 792 65.963000 10.833310 7.253195 418 2460 34.847170 205.00020 10.917310 71.58938 7.309435 47.93104 10014 834.50830 73.49404 49.20626 Comparing the Price value based on forecast and old SS, forecast data is smaller than old SS with total $ 58,655.83. Price value between old SS and forecast has decreased from $ 125,491.29 to $ 58,655.83. From total 173 parts, it consists of 54 parts that have no SS value based on forecast and also based on old SS, and 123 parts that have difference SS value. If investigated further, 74 parts have decreased SS value from old SS to forecast. The value has been decreased with a huge difference amount and impact to decreasing price. As shown in Table V, the price value on forecast has been decreased 53.25% from old SS. Safety stock and price value between historical and forecast data also have a huge difference. Value price of forecast data is almost a third of value from historical data. The huge differences of price value occur directly proportional with the quantity SS value based on forecast data. Quantity number of safety stock based on the forecast is smaller than based on historical. One causes that makes the price value has bigger different strongly influenced by SS value from PCBA Option family. As shown in Table V, the price value has decreased 65.78% from historical data. Different SS value and price value is affected by high fluctuation demand from historical data while contrary with fluctuation based on forecast data. As the impact of high different demand between forecast data and historical data, safety stock value and price value has a huge difference. Forecast data sometimes has a stable demand than historical data. As shown in Table VI, there are 4 parts from Sprint family as an example of forecast demand. Because of stable demand on forecast data than historical data, the number of safety stock that will be obtained based on forecast data is smallest than based on historical data. Days of Inventory (DIN) is calculated using total price value from 11 families. DIN can be defined by dividing total price value of number safety stock with the total price value of Average Daily Usage (ADU). Table VII presents the result of days of inventory from Old SS, historical, and Forecast data. TABLE VII. DAYS OF INVENTORY Data based on Old SS Historical Forecast SS Price Value $ 125,491.29 $ 171,426.91 $ 58,655.83 ADU Price Value $ 14,884.44 $ 13,587.46 $ 7,341.82 Days of Inventory 8 days 12 days 7 days As shown in Table VII, safety stock based on historical data can cover until 12 days. Data based on historical has the highest value of DIN comparing with other data. It can cover until 3 times lead time that is needed to produce finished goods in PCBA in house. One of the advantages of having the bigger value of DIN is can secure more stock and support to fulfill customer demand. Not only the advantages, it also has the disadvantages if the company has the higher value of DIN. It makes the company must spend more cost comparing with using Old SS & forecast data and also need more space to store the items. From 173 parts that have been discussed before, there are 164 parts that have ABC/FMR value. 9 parts have no value of ABC/FMR as new parts in 2017. 9 parts have no value of ABC/FMR because there are no demands for this part based on historical data. There are 73 parts that categorized into category AF, AM, BF, BM are suggested to have stock or implement safety stock. These parts have high-value product and also high frequencies of customer demand so need to be watched very carefully. The F and M frequency show that customers often order this part and need to have stock to reduce risk if there's any issue. Category AR and BR with total 12 parts are suggested not to have stock because it has a high risk to keep stock for these

parts. These parts have the high value and also categorized into rare frequent. The rest of it is suggested to have stock but for CF and CM can use the automatic replenishment. Based on the background of this research, one of replenishment strategy that can be used to increase service level is by using safety stock. Safety stock can be calculated based on historical data or forecast data but it needs to be review quarterly because of the erratic demand from the customer. More often frequency to update the safety stock value, it can describe approach the real situation. Safety stock needs to be reviewed quarterly based on the standard in Company Production System. Review safety stock value is needed to maintain customer demand or to reduce more cost. The company should be considered on ABC/FMR classification. The classification gives information whether parts need to have stock or not. It can save more space in the warehouse and also save more cost because there are several parts that are no need to have stock. Comparing price value based on historical and forecast data, company is suggested to use the number of safety stock based on forecast data. If the company concern to maintain customer service level to 95%, company is suggested to use based on historical data. Forecast data is also cannot be used because forecast accuracy is not eligible. Forecast accuracy is needed to know the percentage that represents the exact demand. Forecast accuracy is calculated to prove that Safety Stock (SS) value based on forecast data cannot be used. It is calculated per month and it has calculated for 3 months (February-March) because the existing usage data which support this research only available for 3 months. Based on PT. X rules, forecast error has the standard level that can be received in this company. Table VIII shows the example of forecast data. TABLE VIII. FORECAST DATA W816616511511 Forecast Demand Feb 2017 Actual Usage on Feb 2017 Total Error Percentage Error Forecast Accuracy M-3 M-2 2 0 51 51 49 51 96% 100% 4% 0% M-1 88 51 37 73% 27% Standard forecast error based on PT. X policy are 30% for M-3, 20% for M-2, and 10% for M-1. In this research, if the forecast error is more than company policy for each month, it means the forecast data cannot be used. The example of forecast accuracy calculation on February based on M-3 data is 4 %. As shown in Table VIII, part number W816616511511 is suggested to follow the number of safety stock based on historical data. It is because the forecast accuracy based on 3 data above has average around 10% It shows that the forecast only describes total 10% from the real situation. Total 127 parts that have the forecast data, data forecast accuracy that has qualified based on company policy are 10 parts. The rest of data forecast are not eligible company policy. Because the accuracy of forecast data still bad, safety stock value that is suggested to use is based on historical data and the company need to review or check the forecast data that is used. Forecast data in the company is defined based on forecast data that is received from the customer. To improve the forecast accuracy, the company need to communicate with the customer about forecast error and request to the customer to review and consider on historical data. The company is also suggested to consider data based on historical data not only based on forecast data. The company can combine based on forecast data and also historical data. Safety stock value that has been defined by using the historical data have been implemented on 7th March 2017. The result after 3 months implemented the safety stock value shows that the value of service level has been increased. The value of service level has been increased but it still not achieves to 95%. It needs some process to implement the safety stock. Figure 1 shows the service level value per month from total 11 families. Service Level Improvement 60.00% percentage 50.00% 40.00% 30.00% 20.00% 10.00% 0.00% March April May Service Level 40.88% 41.52% 49.06% Figure 1. Service Level Improvement As shown in Figure 1, service level value has been increased from March until May. Service level before implementing the safety stock value is 25.32%. It shows that implementing safety stock is useful for the company to increase the value of service level. The value service level in May shows it almost achieve 50% so it can be said that around 25% the service value has been improved. Airlock IV. CONCLUSION Based on the result of safety stock calculation, the company is suggested to use safety stock calculation based on historical data. It is because the forecast data cannot describe the actual situation very well. Forecast data has stable demand for each month compared with

historical data. In fact, customer demands not always stable for each month. In terms of price, safety stock based on forecast data has the smallest amount comparing another data influenced by demand from the customer. Because of the demand in forecast data has stable fluctuation, the standard deviation based on forecast data is small and impact to the number of safety stock value and total price. The price value has increased from old safety stock to safety stock based on historical data. It is strongly influenced by PCBA Option family. Based on old SS data, there are no safety stock values for PCBA Option but based on historical data, its suggested to have safety stock. The company must spend $ 45,935.62 than before. From Classification ABC/FMR, there are 73 parts that suggested to have stock, 89 parts are suggested have stock or not based on company decision, and the others parts are suggested to have no stock. REFERENCES [1] [2] [3] R. V. Altekar, Supply Chain Management: Concepts and Cases, New Delhi (India): PHI Learning, 2005. R. Ray, Supply Chain Management for Retailing, New Delhi (India): Tata McGraw Hill Education, 2010. P. Cortes, E. Maeso-Gonzalez, and A. Escudero-Santana, and (Eds.), Enhancing Synergies in a Collaborative Environment, Switzerland: Springer, 2015, doi: 10.1007/978-3-319-14078-0. [4] J. Oberlé, “Air Sea Ratio Reduction Initiative,” World Energy Congress. [Online] Available: https://www.yumpu.com/en/document/ view/4337724/air-sea-ratio-reduction-initiative-world-energy-council. [5] H. Stadtler and C. Kilger, Supply Chain Management and Advanced Planning: Concepts, Models, Software and Case Studies, Berlin (Germany): Springer, 2005, doi: 10.1007/b106298. [6] A.V. Hill, The Encyclopedia of Operations Management: A Field Manual and Glossary of Operations Management Terms and Concepts, FT Press, 2012. [7] A.C. Radasanu, “Inventory Management, Service Level, and Safety Stock,” J. Public Administration, Finance and Law, no. 9, 2016, pp. 145–153. [8] D.F. Ross, Distribution Planning and Control: Managing in the Era of Supply Chain Management, 2nd ed., Kluwer Academic Publisher, 2004, doi: 10.1007/978-1-4419-8939-0. [9] V. Gaspersz, Production Planning and Inventory Control berdasarkan Pendekatan Sistem Terintegrasi MRP II dan JIT Menuju Manufacturing 21 [Production Planning and Inventory Control Based on Integrated MRP II / JIT System Approach Towards Manfacturing 21], Jakarta (Indonesia): Gramedia Pusaka Utama, 1998. [10] H.I. Yunarto and M.G. Santika, Business Concepts Implementation Series in Inventory Management, Jakarta (Indonesia): PT. Elex Media Komputindo, 2005. [11] T.C. Cheng and S. Podolsky, Just In Time Manufacturing, London (UK): Chapman & Hall, 1996. [12] S.C. Graves, A.H.G.R. Kan, and P.H. Zipkin (Eds.), Logistics of Production and Inventory, vol. 4, North Holland, 1993. [13] J. Gattorna (Ed.), Strategic Supply Chain Alignment: Best Practices in Supply Chain Management, USA: Gower, 1998. [14] D.L. Olson and S. Kesharwani, Enterprise Information Systems Contemporary Trends and Issues, Singapore: World Scientific, 2010. 353 354 355 356 357 358