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PSI-Cockpit: A Supply-Demand Planning System Focusing on Achieving Goals through Resolving KPI Conflicts

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Abstract— **Manufacturers often use key performance indicators (KPIs) that are in conflict with each other. For example, to meet sales targets, sales teams tend to focus on fast-selling rather than slow-moving items. However, this requires production flexibility to respond to demand fluctuations, which negatively impacts the KPIs of the production or SCM departments. This report describes a best practice to optimize KPIs by improving the supply-demand planning process. We propose a communication-based supply-demand planning strategy for the supply-demand planning process. This strategy focuses on communication among departments as they establish their production, sales, and inventory (PSI) plans in order to prevent the occurrence of conflicts. Further, we developed the PSI-Cockpit visualization system to support communication-based supply-demand planning. The system's features support communication between departments and allow users to establish plans to optimize KPIs.**

Keywords— Supply-demand planning; Data visualization; Dashboard; Key performance indicator (KPI)

I. INTRODUCTION

Supply-demand planning refers to the production, sales, and inventory (PSI) plans respectively established by sales, production, and SCM departments. Supply-demand planning is important for manufacturers because it affects companies' key performance indicators (KPIs)[1]. All manufacturers have their own business objectives. Based on organizational structure, each of these objectives is divided into several sub-objectives, which are evaluated according to the KPIs of each department. However, KPIs often conflict with each other, even if they were established to achieve the same overall objectives. In such cases, when a particular department achieves its KPI, other departments may report failures in their KPIs.
In order to resolve such conflicts among KPIs, we propose a communication-based supply-demand planning strategy that allows the KPIs of different departments to be synchronized. Further, an information system is developed to support the realization of the strategy. This paper introduces KPI optimization practices through the improvement of supply-demand planning and the development of a new system to implement the strategy.

II. THE PROBLEM WITH TRADITIONAL SUPPLY-DEMAND PLANNING

The problem we tackled is how to resolve conflicts among KPIs. In this chapter, we clarify the problem typically faced by manufacturers. To describe the problem, we assume a traditional company model including production, sales, and SCM departments. Each department is specialized in a particular function, but their KPIs are often in conflict with each other.
For example, the KPI for the sales department is the overall sales figure, not the sales of individual products. Therefore, the sales team tends to focus on fast-selling items. Consequently, the sales of these items may exceed their planned targets, which could cause unexpected production demand for the production department, whose KPIs include the on-time delivery rate, production efficiency, and production cost. Responding to demand fluctuations could increase production costs[2]. At the same time, the sales of slow-moving items could fail to meet their targets, thus negatively impacting the KPIs of the SCM department, such as through excess inventory[3]. If the production department revises the production plan to respond to the sales of fast-selling items, it will likely revise the production plan of the fast-selling item as well, increasing its production volume to a level higher than the sales plan in order to maintain the on-time delivery rate. However, such a revision could increase the inventory of the item and lead to excess inventory. Then, the SCM department might have to tell the sales department to focus on selling slow-moving items so that it can reduce inventory levels to achieve its KPIs. However, focusing on the slow-moving items could negatively affect the sales of other items, including the fast-selling item whose production plan was revised to increase its volume. Consequently, decreasing the sales of the fast-selling item could cause excess inventory.

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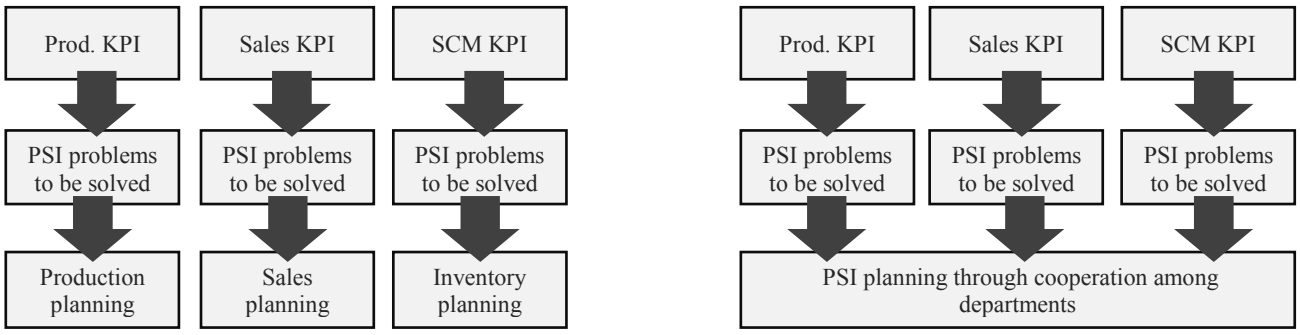
In this example, the KPI of the sales department would be achieved. However, the KPIs of the production and SCM departments would not be achieved. This is a typical problem of traditional supply-demand planning. The main cause of this problem is that individual departments tend to focus on their own KPIs individually and do not care about those of other departments.
The key points of the problem are the communication and monitoring among departments. They established PSI plans with little communication between departments and little monitoring of the KPIs of other departments. As a result, PSI plans may end up causing conflicts among the company-level KPIs of each department. When the conflicts happened, the communication is needed to search a room for negotiation as making compromises. And the effective monitoring of KPIs provides objective information about situation of each department. The important thing of the planning among departments as the negotiation and compromise is that they are convinced by this outcome, and the communication with monitoring is the way to realize that.

III. Communication-Based Supply-Demand Planning

To resolve this problem, the communication-based strategy should be adopted over the traditional approach. This strategy identifies top priority KPIs in the same manner as the traditional approach, with the exception that PSI plans are established based on communication among departments. The strategy aims at achieving KPIs when they make certain PSI plan ensuring to optimize other KPIs. Figure 1 shows the traditional approach (A) and the communication-based strategy (B). In the traditional approach, problems stem from the PSI problem and they must be resolved by individual departments. Meanwhile, in the communication-based strategy, the PSI plan is established through cooperation among departments. Unfortunately, there are no information systems focusing on communication during supply-demand planning. Traditional supply-demand planning systems have features that permit the editing of plan values and the visualization of PSI data for each item through simple graphs[4]. In fact, many companies do not use special software but the MS Excel for supply-demand planning[5]. However, they have few features that detect problems with planned or actual PSIs in a way that is easy for each department to understand.



(A) Traditional approach (B) Communication-based strategy

Figure 1. The traditional approach and the communication-based strategy

IV. The PSI-Cockpit: A System to Implement the Communication-Based Strategy

We developed a visualization system named the "PSI-Cockpit" to support communication-based supply-demand planning. The system graphs PSI and related data at the company, product category, and item levels. The lower-level graphs will be shown when the user selects a specified higher-level graph. The main features of the system are the Drill-down and the Alert. In this context, "the user" refers to the people in charge of PSI planning.

A. The Drill-down Feature

Traditionally, the user would identify problems by viewing item-by-item PSI data. However, this is a time-consuming way to identify problematic items. In the PSI-Cockpit, the user can see data from a higher perspective, which promotes efficiency in detecting problems and allows any such problems to be resolved in less time.
The system first visualizes company-level PSI data, then drills down into lower-item levels and creates or modifies plans for specific items. The user can access PSI problems that impact KPIs by drilling down into PSI data for KPI problems. Graphs

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showing KPIs are always displayed, even at the lowest level, so the user can edit plans while seeing KPIs, which are simulated automatically.
The system visualizes data through many graphs to allow users from each department to effectively understand the situation. The graphs can be grouped into three levels based on the item levels. Level 1 is the highest level and includes mainly company-level and some product-category-level PSI graphs, which are used for the same purpose as KPIs, representing progress measurement for business goals. Level 2 includes product-category- and item-level PSI graphs and level 3 includes only item-level graphs. The user can select a "topic" of production, sales, or inventory as the subject of the problem to be solved by indicating a certain graph element. The system starts at level 1 and transitions to level 2 once the user indicates a graph element in level 1. Then, the level 2 system shows graphs related the topic selected in level 1. The system transitions to level 3 if the user indicates a graph element in level 2 and shows item-level graphs and a tabular plan editor. Figure 2 shows the relations among the system levels and the elements of the communication-based strategy.

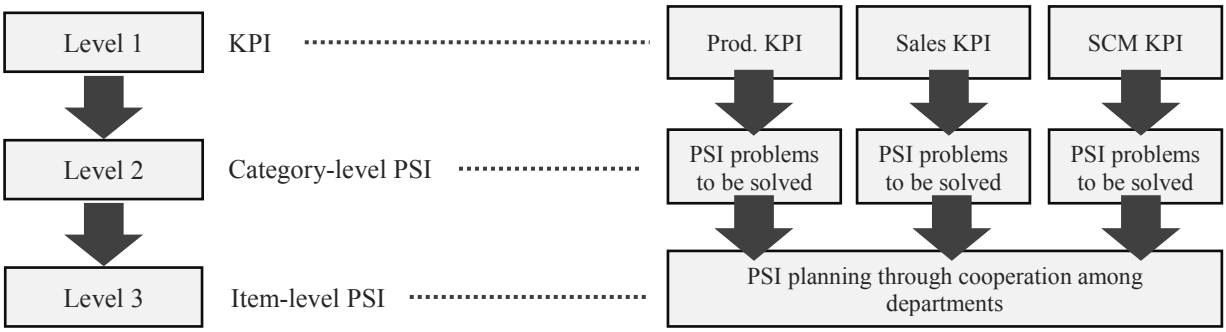

Figure 2. Relations among the levels of the system and the elements of the communication-based strategy

B. The Alert Feature

The Alert feature tells the user "what is happening" or "what is going to be happen" with KPIs. For example, the Alert could show the user that "estimated sales will fail to meet sales targets" or "the inventory level is too high," etc. The user does not have to look at the graphs carefully to grasp the situation but can rather just read the Alert. The Alert helps departments with different backgrounds and knowledge to share common perspectives. When the user edits a plan, the Alert is updated immediately so that he or she can know whether the revision will affect the KPIs.

C. System Details

In this section, we describe each level of the system in detail.

1) PSI-Cockpit Level 1

Figure 3 presents an example of a level 1 PSI-Cockpit window. The window includes 12 graphs displaying company- or category-level PSI. In practice, the user can select graphs according to his or her preferences.

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Figure 3. Example of a PSI- Cockpit window at level 1

Figure 4 shows four examples of graphs in the system at level 1. Graph (A) compares target and estimated sales and production figures. The leftmost bar shows the sales target and the second-leftmost bar shows estimated sales as actual sales plus planned sales in this fiscal term. This graph implies that the estimated sales are lower than the target and the Alert below the title states, “Sales are not expected to reach the target,” clearly describing the problem. Graph (B) in Figure 4 shows the difference between the company’s target and estimated sales (described as “ALL” in this graph) and individual categories in this fiscal term. This graph shows that estimated sales are $6.3M short of the target at the company level and the estimated sales figures for categories 4 and 5 are substantially underperforming. Graph (C) in Figure 4 shows the ratio of estimated resources (such as manpower or facility operating time) required based on the production plan to capacity, showing an Alert saying “The resource requirements for Resources A and C will exceed their capacities.” The line chart implies that the requirement for Resource A will exceed its capacity in September, which means items using Resource A could not be satisfied the demand. The requirement for Resource C will also exceed its capacity in October. Graph (D) in Figure 4 shows inventory days for the company and individual categories. This graph displays an Alert stating that “The inventory days for categories 5, 3, and 4 exceed 100 days,” meaning that the inventories in these categories tend to be excessive or stagnant. Graphs (A) and (B) are related to the sales KPIs, (C) is related to the production KPIs, and (D) is related to the SCM KPIs. By showing these graphs on the same screen, the user can see the other departments’ KPIs. Other level 1 graphs show items such as the stock-out ratio, share of category sales, and average inventory, among others. All level 1 graphs show production, sales, or SCM KPIs.

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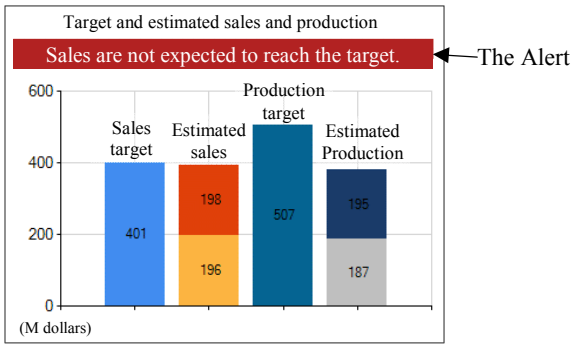
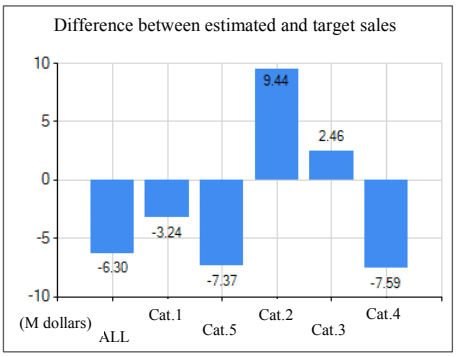
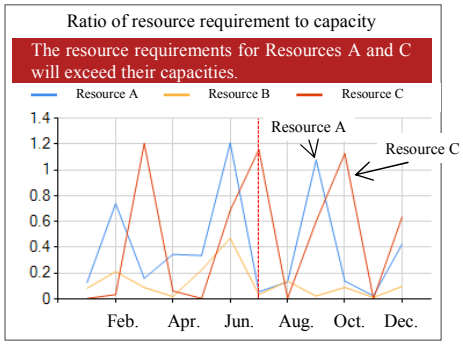


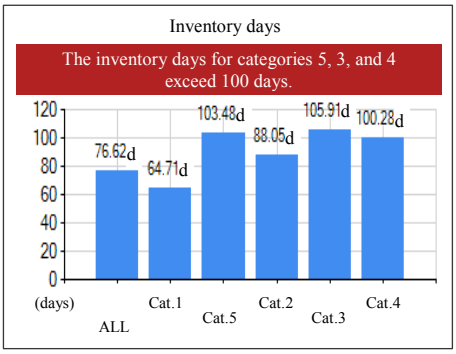
(A) Target and estimated sales and production



(B) Difference between estimated and target sales for each category



(C) Ratio of resource requirement to capacity



(D) Inventory days for each category

Figure 4. Examples of level 1 graphs.

2) PSI-Cockpit Level 2

The system transitions to level 2 when the user selects a topic by clicking an element in a level 1 graph. For example, if the user clicks the "sales target" bar in graph (A) in Figure 4, then the topic will be the "company sales." If the user clicks the "category 1" bar in graph (D) in Figure 4, then the topic will be "category 5 inventory." In short, the system drills down into level 2 and shows graphs related to the selected topic.

Figure 5 shows an example of a level 2 window after a user clicks the category 4 bar chart in the graph on the difference between the estimated and target sales (graph (B) in Figure 4). The graph at the bottom of the window (the largest part of the window) shows the difference between the estimated and target sales of the individual items included in category 4, arranged in ascending order by the volume of the difference. The graph indicates to the user that the item that most contributed the unachieved estimated sales is I024.

In level 2, the system has different "Views," or graph types, which aim to make the data understandable to all departments. Figure 5 shows the sales figure in the "Pareto view," which displays data in a Pareto graph. Figure 6 shows inventory time series data for each item in the same category in the Thumbnail view [6][7], a visualization system used to report inventory data through small charts of daily inventory time series within a grid to enable the efficient and precise identification of problems. Based on the Thumbnail view, it can be said that the inventory of I024 is stagnant due to slow sales. In contrast, some stock-outs are seen in the inventory of I145, which has the best sales compared to its target according to the Pareto view. As seen in both views, the user can learn that the sales department (or the sales person responsible for category 4) concentrated on selling I145 over I024, which led to the simultaneous stock-out of I145 and excess inventory of I024. In this way, the level 2 View feature helps departments achieve common understanding through effective data visualization.

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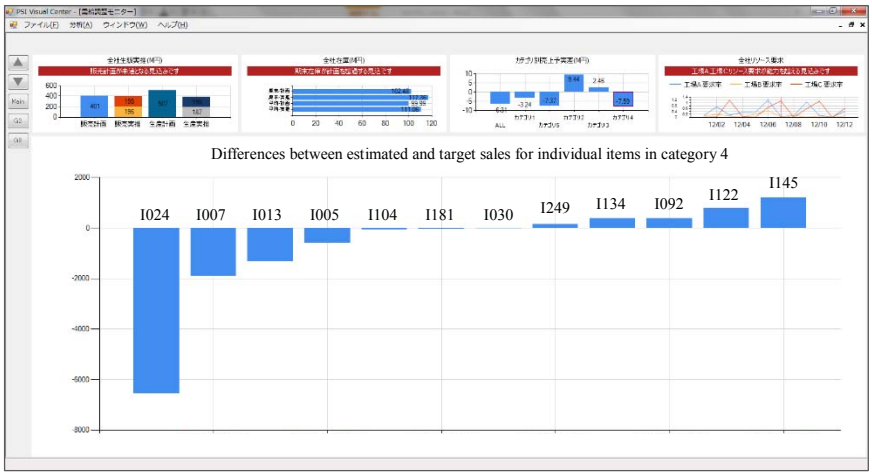

Figure 5. Example of the Pareto view in level 2 of the PSI-Cockpit

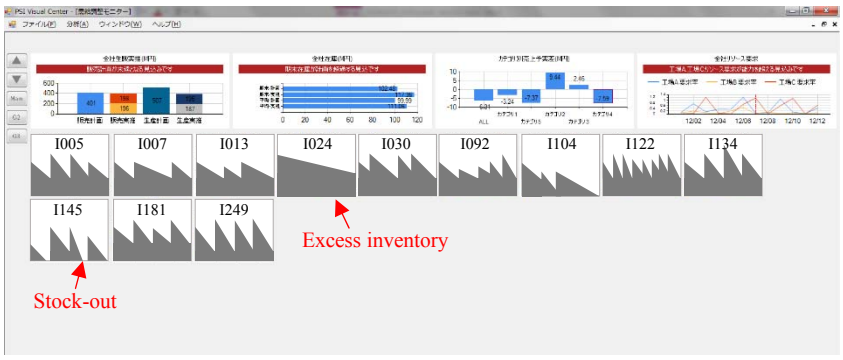

Figure 6. Example of the Thumbnail view in level 2 of the PSI-Cockpit

3) PSI-Cockpit Level 3

When the user selects an item on the level 2 graphs or its elements, the system transitions to level 3 and shows detailed PSI time series graphs for the selected item. Figure 7 shows an example of a level 3 view displaying daily PSI data on the left-hand side, monthly resource requirement data in the center, and the data edit table at the bottom. The item in this example is I024, the leftmost item of the Pareto view in Figure 5. The graph on the left in this example is the daily PSI data showing production as a bar chart, sales as a line chart and inventory as an area chart. The central bar graph contains the monthly resource requirement data. The bottom tabular form is the data edit table, which allows the user to edit daily or monthly PSI data as in MS Excel. The level 1 view is shown at the top of the window, so the user can assess how editing the data will affect the KPIs, including those of other departments. The Alerts are also shown and displaying these effects if there are problems. The level 2 graphs are shown on the right-hand side of the window, so that the user can select items to see in level 3.

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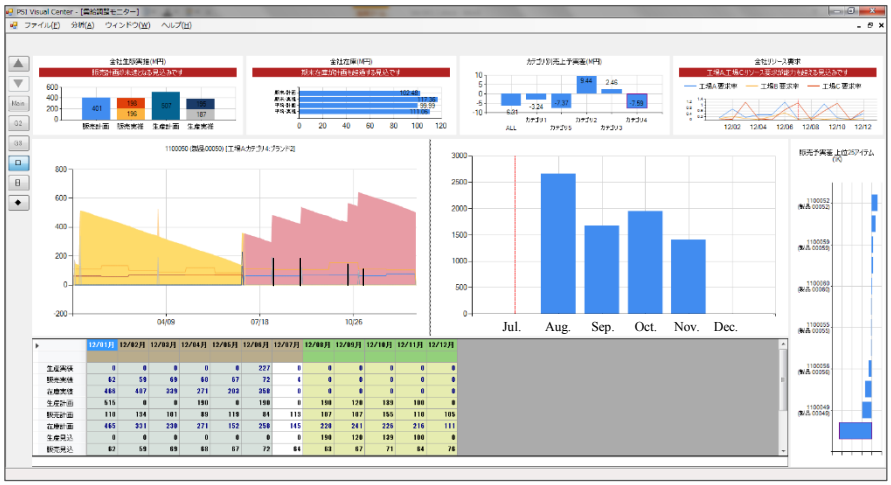

Figure 7. Example of level 3 in the PSI-Cockpit

D. Usage Scenario for the PSI-Cockpit

In this section, we describe a usage scenario for the PSI-Cockpit using the graphs described in this paper. In this scenario, a company revises its supply-demand plan for the next three months at a supply-demand planning meeting.

1) Sales plan revision scenario

The meeting begins with the visualization of the PSI-Cockpit's level 1 view. The Alert function lets the user know about the presence of some KPI-related problems. By looking at the graph showing the difference between the estimated and target sales shown in Figure 4 (B), the user can understand that category 4 contributed to the poor sales performance. The sales department might be especially interested in this Alert. Therefore, the sales department will select category 4 and the system will display the level 2 Pareto view shown in Figure 5. The sales department (and of course the production and SCM departments as well) can discover that the slump in the sales of item I024 is a factor in this situation and bring the item into level 3. This Pareto view also shows the items that contributed to positive sales results so that the sales department can identify slow-moving and fast-selling items. This view can alert the sales department to the balancing problem between sales of each item. If the sales department thinks that it can increase the estimated sales of the slow-moving item (I024), it will revise the sales plan to recover the unachieved sales. When the sales department edits data on the edit table, the graphs in the level 1 and level 2 views as well as the Alert on the screen are updated immediately and the sales department can see whether the new plan will work to achieve the sales target, while the users from the other departments can know the change's effects on their own KPIs. If the company still falls short of its sales target, the sales department will follow the same process of identifying items that have room for further sales and revise the sales plan. Such revisions can improve the KPIs of not only the sales department but also of the SCM department by reducing inventories. The SCM department could learn this by looking at the inventory graph shown in graph (D) in Figure 4.

2) Production plan revision scenario

After the revision of the sales plan, a user from the production department will revise the production plan to cover the sales plan. Then, the production department will have to re-examine the production KPIs. Looking at the level 1 view, they will realize that there are other Alerts. According to graph (C) in Figure 4, the resource requirements for Resources A and C will exceed their capacities. The user can then click on the graph and transition to level 2, looking at the "Resource requirement view" as shown in Figure 8. This graph shows the monthly resource requirements for each resource; the user can then select a specific month for specified resource to breakdown the resource requirements of individual items. Figure 9 shows the Pareto view of the Resource A requirement for each item in September, arranged by required volume. The user will then be able to identify the item that requires the greatest amount of this resource and will also be able to reduce the amount of the resource required in September by decreasing or leveling the amount in the production plan of the item, if feasible. This revision makes the new sales plan feasible and could improve the on-time delivery rate. However, the SCM department will still have to monitor the inventory level by looking at the inventory graph. If there are problems with the inventory KPIs, the SCM and production departments will negotiate to adjust plans to get their KPIs adequate.

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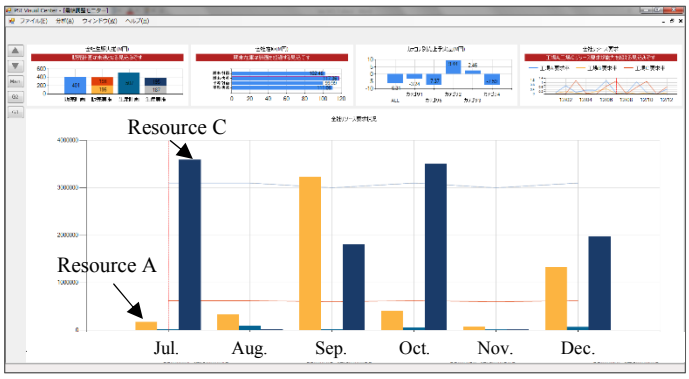

Figure 8. Example of the resource requirement view at level 2

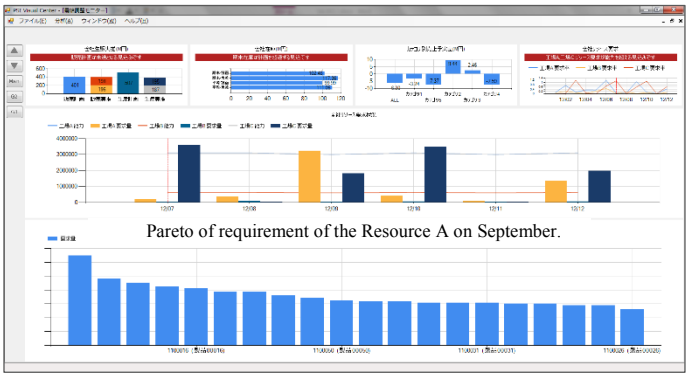

Figure 9. Example of the Pareto view for resource requirement at level 2

V. Discussion

We described that the problem of the manufactures is the conflicts between KPIs, and we raised to two issues such as the communication and monitoring. The Drill down feature of the KPI-Cockpit facilitate the filtering process to find the items needed to be monitored. The Alert and the View feature facilitate an understanding between the various departments. Therefore, the PSI-Cockpit resolves the conflicts between KPIs through the communication-based supply-demand planning. We are now evaluating the system in the actual supply-demand planning process of our customers and we will get the evaluation in the near future.

VI. Conclusion

This paper describes a best practice for KPI optimization through communication-based supply-demand planning. Manufacturers often face problems when supply-demand plans are established without considering KPI optimization among departments. We addressed this problem and proposed the adoption of the communication-based strategy, which focuses on communication among departments as they establish PSI plans. Further, we developed the PSI-Cockpit visualization system to implement this strategy. The PSI-Cockpit has features that facilitate communication. The system enables users to establish PSI plans considering the KPIs of other departments.

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