Designing Performance Dashboard for Monitoring Post-harvest Loss in Transportation

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***Abstract*—A poultry company has a problem in monitoring the loss of its main raw material, namely, Soybean Meal (SBM), which was imported from e.g. Brazil and Argentina to Surabaya. The material is lost while it is transported from port to the factory. The company created a monitoring system, called raw material transport which recorded the process in transported the SBM from port to the factory. This study aims to monitor the SBM loss due to transportation using the RMT data recorded. The monitoring process is developed using a dashboard, which is designed using PowerBI. The designed dashboard can answer the company needs for visualizing the RMT data and help the management to control and to evaluate the performance of each third party which is contracted to transport the SBM from port to factory.**

Keywords—Dashboard, Post-harvest loss, Data visualization, Business Intelligent.

I. Introduction

A company in Surabaya which operates in the poultry industry has a problem in monitoring the loss of its main raw material, namely, Soybean Meal (SBM). This material was imported from e.g. Brazil and Argentina to Surabaya. The exported SBM shipped either to Tanjung Perak port or Teluk Lamong port. The distance from Tanjung Perak to the factory is 34 Km while Teluk Lamong is 45 Km. The SBM is transported from port to factory using dump trucks. The company uses third party logistics (TPS) to transport the SBM from port to the factory. The material is lost while it is transported to the factory. To reduce the lost material the company created a monitoring system, called raw material transport (RMT). The RMT recorded the police number of every dumb truck. The empty truck will be scaled in the factory, then in the security post the truck will be scanned and got a pass ticket. Here the departure time is recorded. When the truck arrives at the port, the empty truck will be scaled again, loaded the SBM, and then scaled the loaded truck. Once the loaded truck arrives in the factory, the truck will be scanned in the security post. Here the arrival time is recorded. The loaded truck will be scaled before it unloaded the SBM to the store location. The scaling and unloaded process in the factory is hectic. There is queuing in the scaling and unloaded process. Those two queuing times are recorded in the RMT system. The company didn't have a monitoring system to evaluate the TPS and the RMT performance. Therefore, this study aims to design a performance dashboard for monitoring the RMT processes. Soybeans is one important commodity that has attracted much attention from many researchers. Research on soybeans includes the production process, post-harvest and supply chain. Supply Chain management of soybeans has been researched widely [1]. Performance dashboard for monitoring soybean meal is important since there is lost weight of soybean contributed by transportation, even though the loss is low for short transportation distance [2]. The international standards of soybean losses find 0.25% of losses acceptable. Although the loss percentage is low. when the scale of business is applied the total loss is significant [3]. Soybean transportation needs to be made more efficient and some research was conducted in this area such as policies for improving transportation efficiency of soybeans logistics and development of instruments probe to acquire significant information related to postharvest loss during transport [4]. Transportation optimization for logistics have been researched widely such as simulation-base optimization for external trucks appointment scheduling [5], and bulk grain transportation central control systems [6]. Lost weight and transportation optimization of soybeans and any foods need support from good information systems and technology. Information systems and technology in transportation, logistics and supply chain have been researched and applied widely. There are some vital technologies, opportunities and challenges for Food Logistics 4.0 [7]. The application area of food logistics is quite wide including resource planning, warehouse management, transportation management, predictive maintenance, and data security. One application of technology and information is business intelligence (BI). The application of BI in the field of logistics can improve the whole decision-making process and performance [8]. One tool that can be used is Business Intelligence Dashboards. Business Intelligence dashboard can help organizations to get business insight and good decision making [9]. They applied a dashboard for one transportation industry to identify factors influencing driver performance in logistics.

A performance dashboard helps organizations to measure, monitor and manage business performance effectively [10]. It has been applied in many industries, e.g. for developing restaurant strategies [11], designing facility layout for an amusement park [12]. In this case monitoring raw material transportation is also a crucial step in ensuring the efficient and cost-effective movement of goods. It is well known that a well-designed dashboard can provide real-time information into key performance indicators (KPIs), such as the time needed in loading- unloading raw materials, time for queuing for scaling process and unloading the materials, and also the round-trip time needed from factory-port-factory. This allows the factory to identify bottlenecks of the process, to evaluate the third-party logistics (TPL) and to make data-driven decisions to improve the RMT operations. Additionally, an effective dashboard can provide a centralized location for stakeholders to access important RMT data and monitor progress towards goals. Overall, an effective dashboard can help the company optimize the RMT operations and improve the bottom line. Other than the Dashboard construction, Wijayanto et al. [13], used the data mining to solve the post-harvest soybean meal loss in transportation. The proposed dashboard solution is for monitoring the process, while the data mining approach is proposed for predicting the loss.

II. METHODS

This section explains the RMT processes from which the data was recorded and how we collected the dataset. The data scraping, and preprocessing are presented next, and in the final section, we summarize the dashboarding processes.

A. RMT Processes

This study discusses the process of sending raw materials in SBM (Soybean Meal), which has several delivery stages or is commonly called RMT (Raw Material Transport) Flow. There are three types of SBM imported by the company right now, e.g., SBM Argentine HiPro (50%), SBM Brazil Lopro (26.4%), and SBM Brazil HiPro (23.6%).

The shipping process originates from the ship, raw materials that have arrived at the port will be transported using a dump truck, then the RMT flow begins to be recorded from the truck, which is weighed before leaving the port, truck trips, scanning factory entry tickets, queue weighing, trucks being weighed in the factory, queuing unloading the unloading process, the truck is weighed at the factory in an empty state, scans the ticket out of the factory, the truck returns to the port.

B. Datasets

The data were collected from the Systems, Application and Products (SAP) of the factory from January 2020 to August 2022 and from scraping data from Google Map to get the Estimated Time Arrival (ETA) from port to factory. There are three datasets excerpted from the SAP, namely, RMT Duration time, RMT Date-Time, RMT Quantity and Port Origin. The RMT duration time dataset recorded the duration in one shipment from port to the factory. It is recorded through barcode scans on the travel document. The RMT Date-Time dataset recorded the Date-Time activities and its PIC at the factory. The RMT Quantity dataset recorded the weight of the SBM when the dump truck arrived in the factory. The data consists of two times dump truck scaling: when the truck was loaded from port, and when it was empty and departure from the factory. The weight of SBM can be calculated as the weight difference of a loaded and empty truck. In total there are 39 recorded features.

C. Data Scraping and Prepocessing

Data scraping [14] from Google Maps was performed to get the Estimated Time Arrival (ETA) from port to the factory. The scraping started on the 26th September 2022 at 00.00 for seven days, using a Google extension called Instant Data Scraper. The ETA was averaging for every 15 minutes. The ETA dataset consists of 4 features i.e., recorded time, duration in minutes from port to factory, distance, selected route from port to factory. The data preprocessing is carried out using R [15]. It consists of handling missing value, removing outliers, scaling features, transforming and organizing the data.

D. Performance Dashboard

A performance dashboard is a type of management system and a type of decision support systems that brings together key performance metrics of an organization on a display [16]. A visual interface of a performance dashboard is a part of an information system for decision support which is built on business intelligence technology. The performance dashboard should be interactive performance management systems that gathers the Key Performance Indicators (KPIs) on a display [10], [17]. Dashboards are multilayered applications built on business intelligence (BI) and data integration infrastructure [18] [19].

III. RESULTS

The dashboard consists of four sections: Overview, KPI, Daily Truck Volume and Store Location. Each section contains one page with the same filter or slicer feature.

A. Dashboard Overview

The first page of the dashboard is the Dashboard Overview (see Figure 2). The dashboard consists of cards, a table, a line, and a donut chart. The cards exhibit the general performance of raw material shipments from the port to the factory, which include, e.g., the total trips of the fleet and total material loss, the average duration of trips from port to the factory, average of material loss, and the average of material loss percentage. The table shows the top ten fleets with the highest material loss. The line chart shows the duration performance by time. Besides the duration needed from the port to the factory, which occupied 30.37% of the total cycle time in the RMT, the queuing time for scaling and unloading took 60.95% of the total cycle time in the RMT. The transportation time from the port to the factory depends on the traffic situation, which the factory is hard to control. However, the queuing time is under the control of the factory decision-maker. This dashboard tells the decision-maker that there is a problem in the queuing process which can be improved. Using the six slicers, the users can slice the information monthly, type of loss (Negative - loss, Positive - surplus), type of raw material (Argentine HiPro, Brazil HiPro, Brazil LoPro), port (Teluk Lamong, Tanjung Perak), day of the week (Weekend, Weekday) and period of the day (Early morning, morning, afternoon, night).

The dashboard is interactive. Users can trace the performance history of each truck. For example, a truck with police number L 8009 XX travels 124 times, with an average loss of -99.92 Kg and a total loss of 12.390 Kg. The decision-makers can evaluate the performance of the third-party logistics (TPL), using these scorecards, specifically for each truck the TPL assigned to transport the SBM from the port to the factory (see Fig. 1)

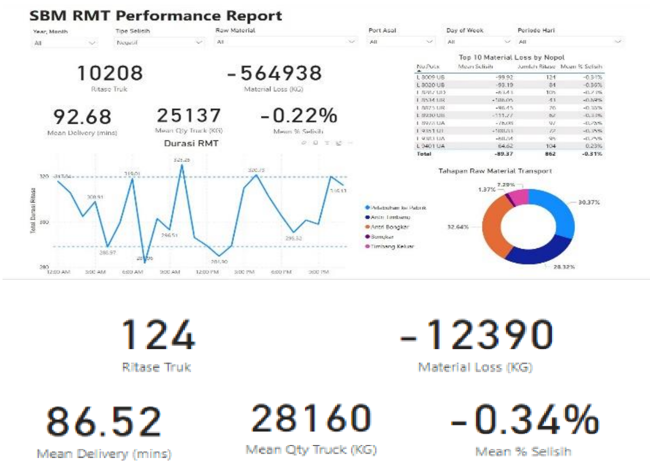


Fig. 1. Display of scorecard from dashboard: Overview

B. Key Performance Indicator (KPI)

The second page contains the KPI for monitoring the targets and the monthly performance measurements (see Fig. 2). Initially, the company has yet to have those targets and assigned this study to formulate those targets based on historical data. Therefore, this study clustered each activity: The duration trip from the port to the factory, queuing time for scaling the truck, unloading queuing time, and cargo unloading time, for setting those targets. The clustering analysis was performed using K-mean [20]. Then, the number of clusters was deduced using the Silhouette score [21], [22]. The highest score was achieved when the number of clusters was two. Therefore, in this study, each activity is clustered into two classes, i.e., C1 for the standard time activity and C2 for the non-standard time one (see Fig. 3)

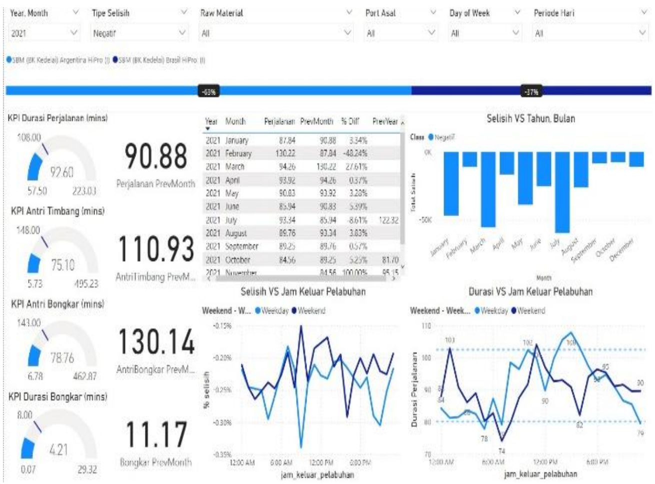
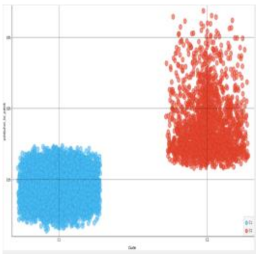
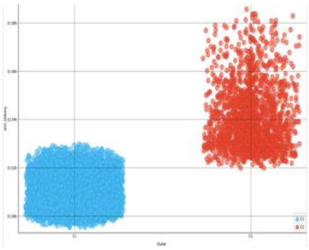


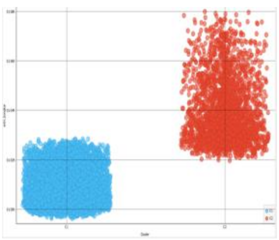
Fig. 2. Key performance indicator dashboard



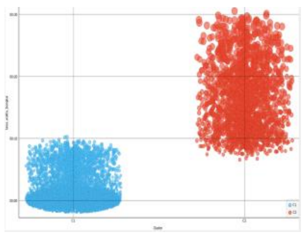
The duration trip from port to the factory cluster



Queuing time for scaling the truck clusters



Unloading queuing time clusters



Cargo unloading time, for setting those targets cluster

Fig. 3. Clustering (Blue – C1, Red – C2)

The cluster characteristics for each activity are determined by the minimum and maximum time needed for each (see Table 1). The target is deducted as the maximum time needed in cluster C1, which indicates a reasonable limit for the duration of the RMT activity. Additionally, the minimum and maximum values in cluster C1 and maximum values in C2 indicate the minimum, target, and maximum values in the donut chart in the KPI dashboard, respectively. Through the dashboard users can evaluate the monthly average trip duration compared to the previous month and previous year at the same time. Users also can trace back each activity performance based on SBM type.

TABLE 1
CLUSTER CHARACTERISTICS

RMT Activity	Cluster	Min	Max
Trip duration	C1	00:57:12	01:48:42
	C2	01:48:45	03:43:02
Weighing queues	C1	00:05:07	02:29:31
	C2	02:29:32	08:22:01
Unloading queues	C1	00:06:47	02:26:28
	C2	02:26:33	07:45:52
Cargo unloading	C1	00:00:04	00:08:26
	C2	00:08:29	00:29:29

C. Truck Volume by Hours

The third dashboard controls the average truck volume vs. the average time needed for four activities, i.e., trip duration from port to factory, queuing time for scaling and unloading, and cargo unloading (Fig. 4). It can be seen that the average trip duration from the port to the factory and queuing time for scaling have similar characteristics. Those two activities have lower average times from 12.00 am to 6.00 am and after 6 pm. It is very crowded from 6.00 am to 6.00 pm. In contrast, the queuing time has different behavior. Compared to the volume of the queueing truck, the unloading queuing time is longer from 12.00 am to 12.00 pm than from above noon. The unloading time needed is proportional to the volume of trucks in this activity.

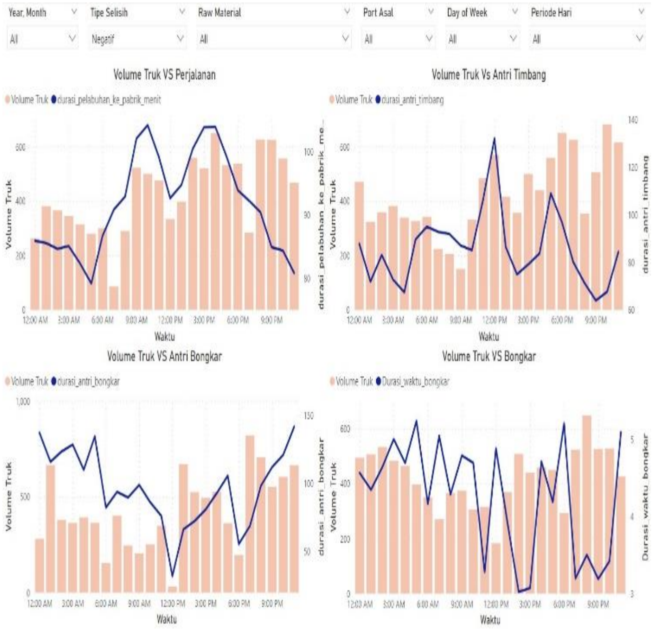


Fig. 4 Daily truck volume

The increase in duration occurs due to some conditions in the factory, e.g., the workers recorded the queuing time before they had a break. This habit makes the recorded time look longer than it should be. The other outliers happened when the workers had two breaks, i.e., at 12 noon and 4 pm. This occasion also makes the RMT duration more prolonged than it should be. The raw materials received by the company are not only SBM, so the factory's handling capacity is also adjusted for each raw material received. Therefore, this particular page can be used for analyzing the causes of the extended time needed for each activity.

D. Store Location

In total, the factory has ten store locations. However, in each shipment period, not all store locations are unlocked. The store location dashboard shows the monthly relationship between the number of unlocked store locations and the average queuing duration in scaling and unloading processes. It also exhibits the monthly relationship between unlocked store locations and unloading duration time (see Fig. 5). For

Fig.5 Store location

example, in September, when the available storage is only two, the time needed for those three activities is high. Therefore, the factory should unlock five to six warehouses to reduce the time needed to complete those three activities.

The last step before the designed dashboard is ready to use is doing the verification and validation step. Dashboard verification refers to ensuring that the information displayed on a dashboard is accurate and reliable. Here, all features in the filters, pages, cross-filters, and multiple selections are tested. As a result, the dashboard is verified, and no errors are found in this step.

Dashboard validation refers to ensuring that the data displayed on a dashboard is accurate and relevant to the intended audience. The validation test involves the factory users, who check the raw data, and data preprocessing. The users also compare the visualized dashboard to the actual condition. As a result, it is validated and used in the factory to monitor the RMT process.

IV. Discussion

The dashboard also exhibits the Third-party logistics performance by listing the percentage of RMT loss during transportation from the port to the factory. Additionally, it is found that the queuing time for unloading has 32.64% of activities. While queuing for scaling has 28.32% of all RMT activities. In actual conditions, the time for scaling and unloading will be longer during rainy seasons. Since the trucks are covered by tarpaulin, they need a specific area to uncover the tarpaulin so that the SBM will not be wet. Therefore, the factory management should cover the unloading area to prevent the rainwater damaging the SBM.

V. Conclusions

The designed dashboard solves the company's problems in monitoring the performance of each RMT flow duration. It is verified and validated. The dashboard exhibits hidden information, which helps the decision-makers make policies to improve the RMT performance. In general overview, the material loss can be controlled. The trucks in the top ten list of lost material are traceable. The factory needs to reduce the queuing time in the scaling and unloading processes. The targeted hours of four activities, i.e., the trip from the port to the factory duration and the queuing processes, can be deduced using clustering analysis. Finally, the number of store locations that should be opened to reduce the queuing time is discovered. The results show that soybean loss has been controlled well and the dashboard can help decision makers for controlling the loss. However, this research finds that queueing time needs to be improved, therefore minimization of queueing times research can be done for next research.

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