International Conference on Global Optimization and Its Applications 2022 (ICoGOIA 2022),
Melaka, November 19-20, 2022

Dashboard Design of Shipping Container Reparation

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Abstract

This paper presents the shipping container reparation dashboard, which was designed based on a dataset of a logistic company in Surabaya, Indonesia. Based on the logistic company business model, containers are inspected and repaired first after being used by customers. Thus, the data from shipping container repair work are recorded and used for our study. MTBF (Mean Time Between Failure) and other important parameters that indicate the shipping containers' performance and reliability are post-processed and analyzed in this study using the data mining method. The post-processed data are visualized using a dashboard to make it easier to monitor at a glance. In short, the data visualization dashboard (in this study) depicts the post-processed data of damaged containers, repair works, MTBF value, types of damage, damage location, types of repairs, supplies of the component, and other parameters. Therefore, the dashboard is expected to help the company make decisions to improve the container's reliability based on MTBF values and other data that affect the container's reliability and availability. The availability of empty containers will reduce the shortages and heavy demand for shipping which have been increasing recently.

Keywords: MTBF, dashboard, shipping-container, reparation.

1. Introduction

Shipping lines play a major role in World Supply Chain because almost all goods are transported using ships between islands, countries, and continents. The pandemic has caused Supply Chain problems, and many countries that depend on other countries face shortages because of city lockdowns, closed ports, reduced workforces, tightened borders, and rapid shifts in demand. Containers are piled up in depots waiting for unloading before they can be used for the next customer, and some are still on boards of vessels waiting to enter the port. The number of containers available worldwide is limited because each container has its ID number registered. There are 40% containers in balance; out of 100 containers, 40 can be exported back, but 60 accumulated in the depots. The shortages and heavy demand for shipping caused the logistics cost to increase four times than the previous year and more than ten times before the pandemic in some countries. This problem has triggered global inflation in many countries (WEF, 2022).

Shipping companies should see the situation as a good opportunity because the need for containers and shipping has increased tremendously. One of the shipping company's problems is that they need to repair damaged containers in home depots, and this will take time until it can be used again. Time spent on container damage repair becomes opportunity lost. Shipping companies need information about the type of damage, part of the container damage, ports that cause damage, and Mean Time Between Failures (MTBF) to minimize the cost. Business Intelligence (BI) provides handy information to control the repair and maintenance process in the home depots, with a huge amount of data impacting the time needed to identify and solve the problems (Ranjan, 2009). Additionally, Yoon et al. (2014) identify factors that affect an individual's decision to adopt a BI application. The BI provides user-friendly and better-quality information to the decision makers to see the current situation in the home depots and will help the company to make a good strategy by preparing the components and depots capacity to make sure all containers can be used again for the next customers.

In recent years, BI applications have been implemented in many different industry sectors; for example, Halim et al. (2019a) designed a marketing strategy for a restaurant using BI, and Halim et al. (2019b) applied BI to designing facility layout of an amusement arcade.

2. Literature Review

2.1 Mean Time between Failure (MTBF)

MTBF is one of the indicators needed in the dashboard, which will be the calculation results of each container damage occurrence, damage type, damage location, and repair time combination. The process requires data mining using R software (2022) from the company database. MTBF is often used to predict the mean-time failure of a facility or machine to do its intended function (Stephen, 2010). The operating time already excludes when the facility or machine cannot be used (Cheng, 2018).

$$MTBF = \frac{Operating\ Time}{Number\ of\ failure} \quad (1)$$

The MTBF calculations (1) can be used to anticipate the damage to the components in any equipment. The MTBF is calculated for each container ID and sliced into several parameters, such as the type of damage, the repairing procedures, and the spare parts.

2.2 Business Intelligence

Business intelligence (BI) is a process that combines all strategies and technologies used by enterprises for the data analysis and management of business information (Dedić & Stanier, 2016). Some BI functions used in this research are data analysis, dashboard development, and predictive analytics through MTBF calculation. The MTBF results will be visualized with other supporting data affecting the container condition in the form of a dashboard using Microsoft Power BI.

A dashboard is a data visualization of the essential information needed on one page to simplify and highlight the story (Few, 2006). The dashboard usually shows many diagrams, visual indicators, and warning mechanisms that are put together in a dynamic information platform Malik (Malik, 2005). The shipping container reparation dashboard, which was designed for logistics companies, will give the critical parameters that indicate the shipping container's performance and help the company to make good decisions and improve container damage problems.

3. Results and Discussions

3.1. Data collections

The data used in this study are secondary datasets that were collected from August 2017 to December 2020. There are two datasets, i.e., the Estimate Of Repair (EOR) and the shipping container status. The EOR dataset is recorded when the containers enter the repair depo and start the reparation procedure. The EOR attributes consist of container register number, EOR type, cargo alias, code, container yard name, port of loading, port of discharge, component, location ID, location, damage ID, damage, repair ID, repair, repair action, material size, quantity, date in, and booking number.

The status dataset has attributes such as booking number, container number, container size, cargo, vessel, vessel date, previous status, previous container yard, previous date, status date, vendor date, day, open stack date, and time update.

3.2. Data Preprocessing

The data preprocessing was conducted using R. The preprocessing data consists of two steps, i.e., data cleaning and data relationship preparation. This paper will use two data sets: Estimate of Repair (EOR) and container status change data. EOR data is input to the system when a container enters the home depot for repair. At the same time, container status changes data after the container is ready to be used again by the user. All data is in a different folder based on month and year. Both files need to be merged to become one dataset. Data cleaning is done by sorting the data based on the port of discharge (POD), deleting duplicate data, and changing the data format so the computer can recognize it. In addition, other data attributes not needed in the process are deleted. Finally, both data are merged based on the booking number to determine when a container enters the Home Depot for repair and when it is finished.

The data set needs new columns to calculate MTBF (total time, downtime, and the number of failures). Total time is the availability time of each container based on no container, component, ID damage, ID repair, and ID location. The downtime column is the time when a container is available minus when it enters depo for repair. The number of failures filled with "1" is to be aggregated later in the process. The next step is filtering the data set to differentiate HC and DC-type containers. Data with negative downtime and > 180 days are also filtered because there is the possibility of data input error. The result is clean EOR data ready to be used in the dashboard.

In the data relationship preparation, first, we constructed dimensional tables that consist of a port of loading (POL) table with two entities: No and POL, Loc table with three entities: ID_loc, Location, No; Damage table with three entities: Damage, IDDamage, No, damage ID; Component table with two entities: Component and No and Repair table with three entities: IDRepair, No, RepairAction; Date table with a single entity that is Date. Second, we rearranged the EOR table by joining the EOR dataset and Status Dataset based on the Booking Number. The EOR table consists of nine entities: BookNo, Cargo, CodeAngka (Code in number), CodeHuruf(Code in Alphabet), Component, CYName, and Damage. Finally, we calculated the MTBF following equation (1) and constructed the MTBFValue table. The MTBFValue table consists of nine entities: Component, Downtime, EndDate, ID_Loc, IDDamage, IDMTBF, IDRepair, MTBF,NoContainer. Two additional tables were added for visualizing the Top N Repair and Top N Damage. Those two additional tables are not connected to the other ones. The data relationship is depicted in Figure 1.

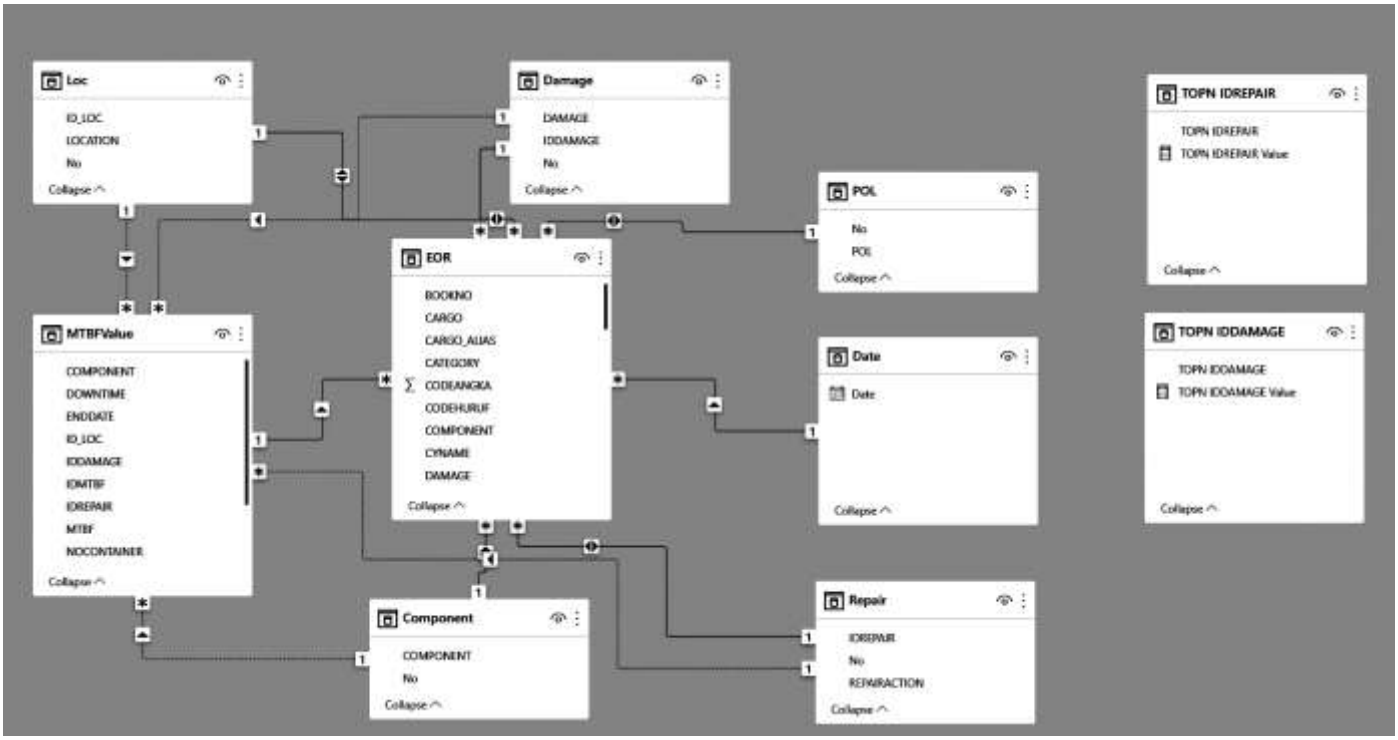

Figure 1. Data relationship diagram

3.3 Designing Dashboard

The dashboard consists of three major pages: Background, damage report, and repair type report. The background page summarized the general overview of container repair in a Liner Company in Surabaya, Indonesia. The page visualizes three cards that report the MTBF's Min, Max, and Average. It also consists of a table that presents the total damage per year as well as the line chart to visualize the total damage trends; a map that depicts the port of loading and the TOP 10 charts of damage, damage location, repair action, and components used in the reparations process. Most of the container's damage is caused by bent, and it occurs the most in the rear right positions of the containers. Most often, the bent damage can be repaired by straightening the damaged part. The depo can also prepare the components used for repairing the damage, and for bent damage, panel components are the most needed for repairing the bent damage. It also can be seen that the damaging trend is increasing. However, it is slightly decreasing in 2020, since container demand is slightly decreasing at the beginning of the Covid-19 pandemic. The dashboard is constructed using Power BI. The background page is presented in Figure 2.

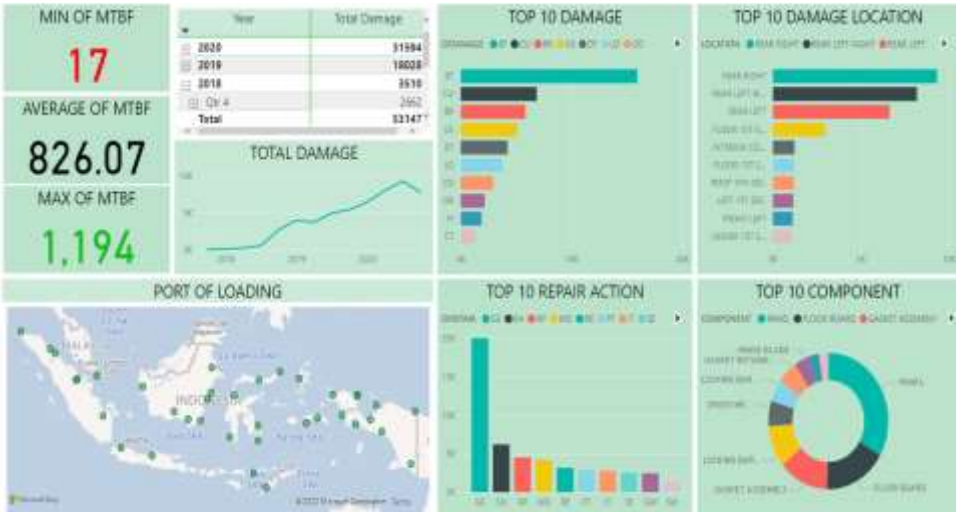

Figure 2. The background page

The second dashboard is the damage report (Figure 3). The second-page dashboard aims to help users analyze the type of damage that occurs to the container. The dashboard view can change based on the date, damage type, and container. In addition, the slicer is available to help users filter the data more precisely. The third dashboard (figure 4.)

page shows the report based on the type of repair. This page's purpose is to help users analyze the type of repair that occurs to the container. The dashboard view can change based on the date, repair, and container type. The dashboard reports the Min, Max, and Average of the MTBF; a table that presents the total repair per year as well as the line chart to visualize the total repair trends; and the TOP 10 charts of repair, repair location, repair action and components used in the reparations process.

The container is generally categorized as A, B, and C. The A container is a food grade container, while the B container is general cargo, the last the C container is the scrap metal and steel container. There are also two types of containers, i.e., the 20-dry cargo (DC) and 40-high cube (HC). This page presents the daily damage reported to the depot for the types of damage. The dashboard also presents the Top N damage per year, the top 10 repair actions done in the maintenance depot, the Top 10 components used to repair the damage, and the top 10 damage locations. The interaction between graphics enables us to present the main report sliced by container category and type. Visualizing the damage enables the management to decide on the components inventory and be aware of the locations with the most damaged containers. The top three damage types that occurred in the containers are bent, cut, and broken. This damage can be repaired by straightening the bending part. It mainly occurred in the rear left-right. The component needed to repair the damage is the locking bar rod. The third dashboard focuses on repairing the damage process. The page reported the percentage of downtime in days, the trend of daily repair action the time intelligence of repair action per year. It also presented the downtime statistics, i.e., the max, min, and average. The information can be sliced by container category and container type.

The dashboard verification is done to confirm that the logic used in the data process and visualization is correct and represents the actual situation. The MTBF results are checked with manual calculation randomly for several data. The dashboard is verified by checking the function of the slicer and the reports. Validation is done by confirming the result to the company. It is essential that the dashboard represents the actual condition and can answer the needs of the users in the company. There are some revisions requested:

1. Adding the average MTBF
2. Graphic for global damage on the first page
3. New page to show data based on container category
4. Changing the downtime range to days when the data is less than one week
5. Adding a slicer for the type of container on every page

Based on the dashboard (see Fig. 3), it can be seen that there has been a trend for container damage increase since 2020. The highest damage type is BT, bent cross member, and locking bar rod. The most extensive damage location happened at the rear right, so the most repair done is straightened. This repair purpose is to strengthen and straighten the material. The component most used in the repair process is the panel. Knowing the downtime, the company can forecast the availability of the containers. The bent damage only needs less than 1 to 3 days to repair, mainly if the repair action is only to straighten the bending part of the container. The MTBF range is between 17 to 826.07 days, and the max is 1,194 days. The minimum downtime is one day, the maximum is 179 days, and the average is 826.07 days.

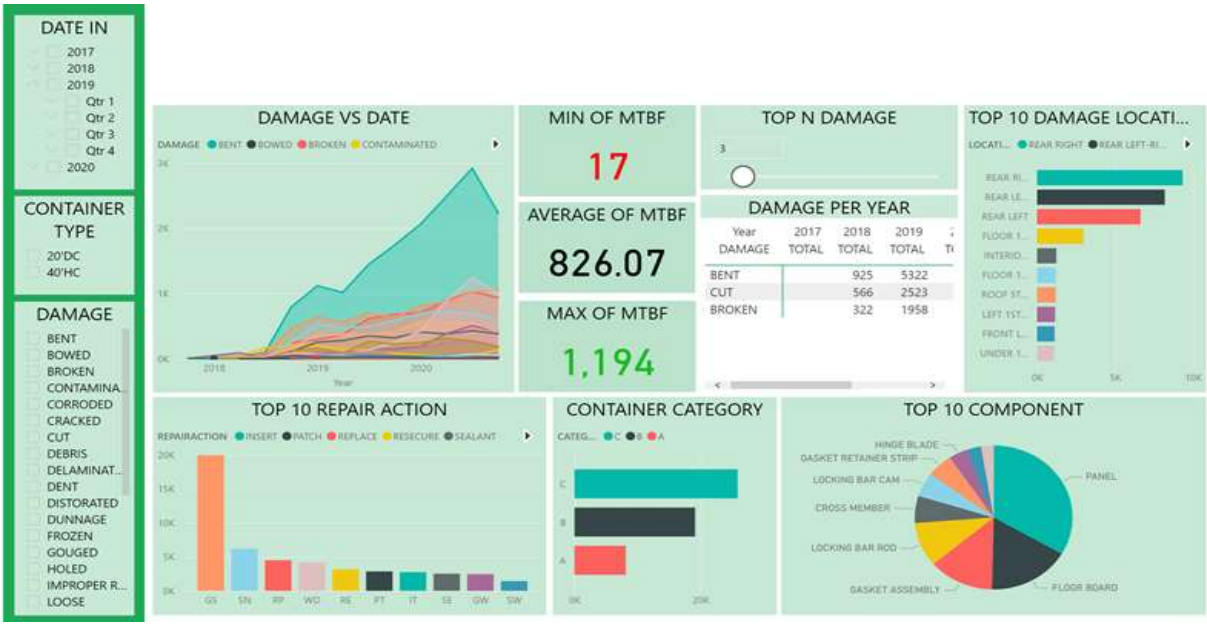

Figure 3. The damage report page

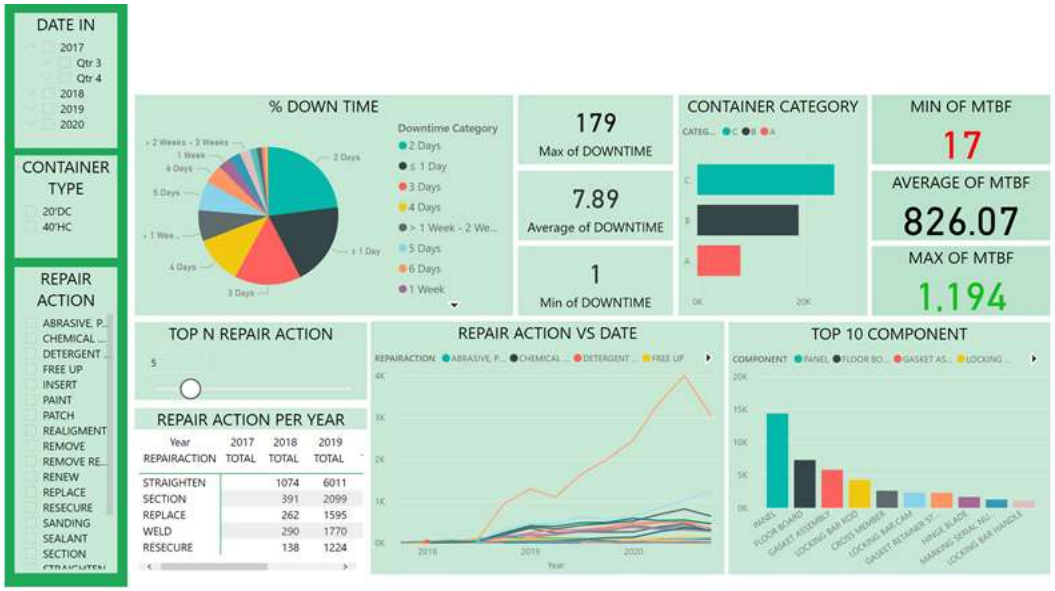

Figure 4. Repair types report

4. Conclusion

The design dashboard helps the company management to improve container reliability based on the existing data. For example, the container repair dashboards visualized various data such as container damage, the process, and the MTBF value. The MTBF was calculated based on each container number, damage type, type of repair, damage location in the container, and the needed spare parts to repair the damage. The MTBF can be used to forecast container availability and to help the management to do preventive action to minimize container damage.

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