The Impact of an Operational Information System Design when Controlling the Operational Costs of an Urban Rail Transit System in Surabaya

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Abstract: Urban rail transit systems are excellent systems that should be used in Indonesia, especially in the city of Surabaya. This type of transportation system is currently being planned by the Surabaya city government. This planning has resulted two ideas for future transportation systems: “Boyo Rail” for the monorail system and “Suro Tram” for the tram system. The presence of these two new transportation systems is expected to help the government solve the congestion problem in the city of Surabaya. This research will help the government to determine the selling price of tickets for each passenger through an operational information system (OIS) whose design is based on the operational costs required to support the success of the urban rail transit system in Surabaya. This research used a qualitative approach to answer the question with using the literature on the subject in order to create an operational information system that can control operational costs. The results of this research will be used to compare the costs-of-goods-sold (COGS) report, the income report and the internal control of operational costs.

1 INTRODUCTION

Surabaya, as the capital city of East Java and the second biggest city in Indonesia, has a population that reached over 2.7 million in 2010 and a wide territory of up to 326,81 km² (Surabaya Central Bureau of Statistics Department, 2010). Rismaharini, the current mayor of Surabaya, stated that this city is a major growth center for the East Indonesian region’s manufacturing and agricultural sector (Rismaharini, 2008).

Furthermore, Surabaya can be classified as the busiest city in Indonesia, where congestion has become a major problem. This problem has happened due to the increasing number of vehicles in the city; there were 1,368,000 vehicle units in 2008, then increasing by 31.53% four years later (Surabaya Central Bureau of Statistics Department, 2014). The escalation of vehicle numbers has resulted in two consequences: 1) a decrease in the average vehicle speed (from 34.31 kph in 2010 to 28.96 kph in 2014) and 2) the appearance of both material and non-material losses, where the material loss caused by congestion reached Rp. 2,530,654,563,00 in 2012 and non-material losses caused some bad social and environmental impacts.

Therefore, a strategic plan has been created by the current government in an effort to solve the ongoing problem by developing the transportation system (Rismaharini, 2008). Based on information from the Surabaya Development Infrastructure (2015), Rismaharini has planned three strategies with which to develop the Surabaya transportation system (Fig. 1). Developing mass transportation systems, particularly the monorail (MRT), is the Surabaya city government’s initial plan. Suro Tram and Boyo Trail are the two new concepts in the transportation system offering to improve mass transportation in the city.

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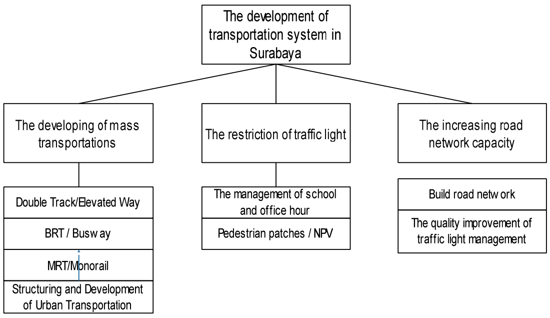


Figure 1: The Development of Transportation in Surabaya (2015)

In summary, the main focus of this study is how to control the operational costs of mass public transportation, particularly for urban rail transit systems (Suro Tram and Boyo Rail) by implementing operational information design. Further research about budgeting can be conducted in order to manage all the costs and to generate more profits in relation to the introduction of a new transportation system.

1.1 The Limitations of Research

There are two limitations to the findings of this research process. These are as follows:

1) The report examining the operational costs related to Suro Tram and Boyo Rail cannot be obtained and analyzed due to confidentiality reasons (according to the Surabaya Ministry of Transportation).
2) There is a lack of previous research related to the operational design of public transportation in Indonesia. This would have been useful as a supporting reference when designing a new operational system that is more suited to today's needs.

2 LITERATURE REVIEW

2.1 Previous Research

Previous studies which usinh in this subject derived from twelve journals, both international and local. Decision making when setting the selling price of transportation tickets can be measured by assessing the operational costs incurred during the activities (Hermanto and Daniel, 2017). The measuring of operational costs can be recouped through the design of an operational information system. This system can include suitable sub-systems, such as an accounting information system to collect driver transaction data, an operational engineering subsystem to obtain procedural data, and an operational intelligence subsystem to collect external data to act as a reference for operational design (Fitriani and Daniel, 2016).

It has also been shown that an operational information system is very useful to a transportation system, in that it can manage the maintenance costs (Gunawan et al., 2017). Operational costs in public services are affected by the complexity and the predictability of the system; as such, cost behavior must be determined as it can affect stakeholder decisions when using such services (Estrada et al. 2017). An operational information system should be designed in a way that allows it to support standard operational procedures (Handika et al., 2017).

The measurement of the operational costs of an urban rail transit system can be divided into three periods. There are: (1) when the new network is going through the application process; (2) before the urban rail transit system is operational; and (3) while the urban rail transit system is operational (Shang and Zhang, 2013). The performance of an operational public transport service can be valued by analyzing all the supporting factors; which will become the minimum standards (Ismiyati et al., 2016).

The characteristics of public transport users or passengers are strongly influenced by their travel routes (Currie and Delbosc, 2013). The increasing cost of public transport can be caused by the need to repeatedly transfer between different modes of transportation in order to reach a destination (Kumar et al., 2013). The evolution and development of a transportation line (i.e., a subway) will improve the efficiency of passengers' transportation and remove the pressure on passengers' movements (Zhu and Luo, 2016).

The development of a public transportation system cannot be separated from the development of spatial urban areas (Kołoś and Taczonowski, 2016). Finally, an operational information system should be applied to the current transportation system in order to maximize operational performance, especially in the terms of the total travelled distance, the number of passengers carried, energy consumption, and operational profit (Teoh et al., 2017).

2.2 Internal Control

Internal control is a process designed by a board of directors, management and other personnel in order to foster confidence in the achievement of their goals (Boynton and Johnson, 2006). There are five elements of internal control: the control environment, risk assessment, information and communication, control activities, and monitoring.

2.3 Cost

Systematic, comparative and analytical earning data can be used to determine the profit target, the departmental target for middle and operational management, the effectiveness of the planning, the operational performance, the strategy selection, and the corrective action (Carter, 2009). Carter also states that the controller role is needed to control and to plan all costs by coordinating all management levels.

2.4 Operational Information System

An organizational system is responsible for transforming things such as goods or services from input to output (Stevenson and Chuong, 2014). This system will be used to summarize and translate integrated operational flows (Fitriani and Daniel, 2016). In addition, an operational information system can describe a business activity or event, recording it and helping to manage all transactions (Smith, 2000).

When designing a good operational system for a transportation system, Khisty and Lall (2006) state that there are eight focuses that need to be considered in order to evaluate the system's performance. These are as follows:

1. Cost efficiency. This focus will compare the total operational cost (TC) and the total vehicle revenue (TRV) based on the size of the area (miles) or the time spent (hours). The calculation formula is:

Operational costs per vehicle revenue	:	TC / TRV

2. Worker productivity. This focus will compare the total vehicle revenue per hour (TR) or per miles (TRV) and the number of staff (TS), as follows:

Total vehicle revenue per staff member	:	TR / TS

3. Vehicle utilization. This focus will consider factors such as the total vehicle revenue (per miles or per hour) (TRV), the total number of passengers (TP), and the number of vehicles (TV). The calculation formula is:

Total vehicle revenue per vehicle	:	TR / TV
Total number of passengers per vehicle	:	TP / TV

4. Energy efficiency. This focus applies two calculation components: the total energy consumption (TEC) and total vehicle revenue (per miles or per hour) (TRV). The calculation formula is:

Total energy consumption per total vehicle revenue	:	TEC / TR

5. Size of service utilization. This focus considers three elements: the total revenue every passenger (TRP), the total vehicle revenue per miles (TRV), and the total population of the service area (TSA). The calculation can be formulated as follows:

Total revenue every passenger per vehicle revenue per miles	:	TRP / TRV
Total revenue per passenger per the population of the service area	:	TRP / TSA

6. Accessibility. This focus measures the percentage of the service used based on the total population of the service area (TSA) and the total population of area covered by this service (TSC), as follows:

The percentage of the population in the service area	:	TSA / TSC

7. Service quality. This focus considers the total number of on-time trips (TOT), the total number of trips (TT), the total vehicle revenue per miles (TRV), and total square miles of the area served (TAS). The calculations can be explained as follows:

Reliability of the system	:	TOT / TT
Total of vehicle revenue per miles per total square miles of area served	:	TRV / TAS

8. Financial performance. This focus measures the operational costs based on the total operational revenue (TOR), total operational costs (TC), total number of trips (TT), and total number of passengers per miles (TP). The calculations can be explained as follows:

Operational ratio	:	TOR / TC
Operational cost of each passenger trip	:	TC / TT
Operational cost of each passenger (miles)	:	TC / TP

3 RESEARCH METHODOLOGY

This current research applies a holistic single case-study through a literature observation method. Several components will be used to compile the current research (Yin, 2012):

1. Research question
   This research will focus on the design of an operational information system. This will produce output in the form of operational cost controlling for an urban rail transit system; specifically, Suro Tram and Boyo Rail. The basis of the current research question is "How can the design of an operational information system be applied to control the operational costs incurred by an urban rail transit system?"
2. Unit of analysis
   Previous research serves as the unit of analysis in this current study. Furthermore, the analysis was conducted by studying the operational costs of an urban rail transit system or light rail transit system that have been incurred by such transport systems in other cities across the world.
3. The logic that links data with propositions
   A transaction process system will generate accounting information related to operational costs such as recruitment costs, maintenance costs, payroll systems, investment costs, utility costs, and other costs that are linked to operational cost control.
4. The criteria for interpretation of the findings
   This current research used some theories to design an operational system that can control the operation of an urban rail transit system (specifically, Suro Tram and Boyo Rail). The theories consider accounting information systems, transaction processing systems, management information systems, and operational management systems.

4 ANALYSIS

4.1 A General Overview of The Planned Urban Rail System

Surabaya Government is planning a new breakthrough transportation system in the form of a fast mass-transit service. This type of system is generally known as an urban rail transit system. This consists of two types of public transport: Suro Tram (the monorail product) and Boyo Rail (the tram product).

Fig 2 shows a diagram by Array Motor Blogspot (2014) which explained that Suro Tram will pass the route from west to east (17.4 km) that have 25 stops, and Boyo Rail will cross from northern route to southern route (24km) which have 29 stops.

This new transportation system project is still entering the investigation phase and the project team is in the process of constructing the prequalification documents that will determine the bidders. Investment in the project, which has reached ten trillion rupiah , includes the station construction costs, the track and construction costs, the transport stop costs, socialization costs, design costs, study and supervision costs, fleet costs, and *depo* charges.

Figure 2: A Route Map Showing the Routes taken by Suro Tram and Boyo Rail (2014)

Furthermore, the successful of urban rail transit system in Surabaya will be reached when it can fulfill the three requirements (Ristia,2009) as follows:

1. There is an integration of supporting systems such as feeder system and non-motorized transport system especially for bicycle and pedestrian path
2. There is an healthy institution of provision in public transport with the transparently licensing mechanism and giving priority to the high quality of service
3. There is a well-preparation and well-socialize stage to the public. The socialization material must cover the reason of every action taking and anticipation efforts by government for every consequences facing by society relating with the implementation

4.2 The Planned Operational Costs of Urban Rail Transit System in Surabaya

The operational costs of an urban rail transit system cannot be separated from the capital costs (which usually cover all planning and construction costs) (Wright and Fjellstorm, 2002). These costs depend on a multi-level separation and a special path extension (e.g. special geological conditions and the material costs of building and labor). There are some factors that can affect these costs:

1. Dominant factors:
   a. Costs of quality management or organization
   b. Costs of a new system or progressive expansion of the current system.
2. Important factors:
   a. Cost of land maintenance (construction and foundation)
   b. Costs of topography (error costs, insurance costs, etc.)
   c. Design costs
   d. Utilization costs (water, electricity, etc.)
   e. Cost of funding.
3. Moderately important factors:
   a. Land costs
   b. Cost of supplying the tools needing for construction
4. Minor factors:
   a. Labor costs
   b. Tax and liability costs
   c. Cost of supporting facility systems (air-conditioners (AC), special access, televisions, etc.).

Some operational costs depend on the number of vehicles needed to provide the service. The higher the speed of the operation, the lower the circulation period; this will affect the number of vehicles needed for a single-line service.

Based on a World Bank study, there are some aspects that can be used as standard parameters to determine the operational costs incurred by an urban rail transit system (Hefrianto, 2008). These can be explained as follows:

1. The average number of passengers which can be carried by every vehicle in a day
2. The number of vehicles operating in peak hours
3. The average speed of the vehicles in a day
4. The number of vehicles in maintenance
5. The consumption of the engine in each of the vehicles
6. The number of workers
7. The length of the route travelled
8. The service costs of the vehicles (operational costs, depreciation costs, etc.)
9. The total amount of income earned.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

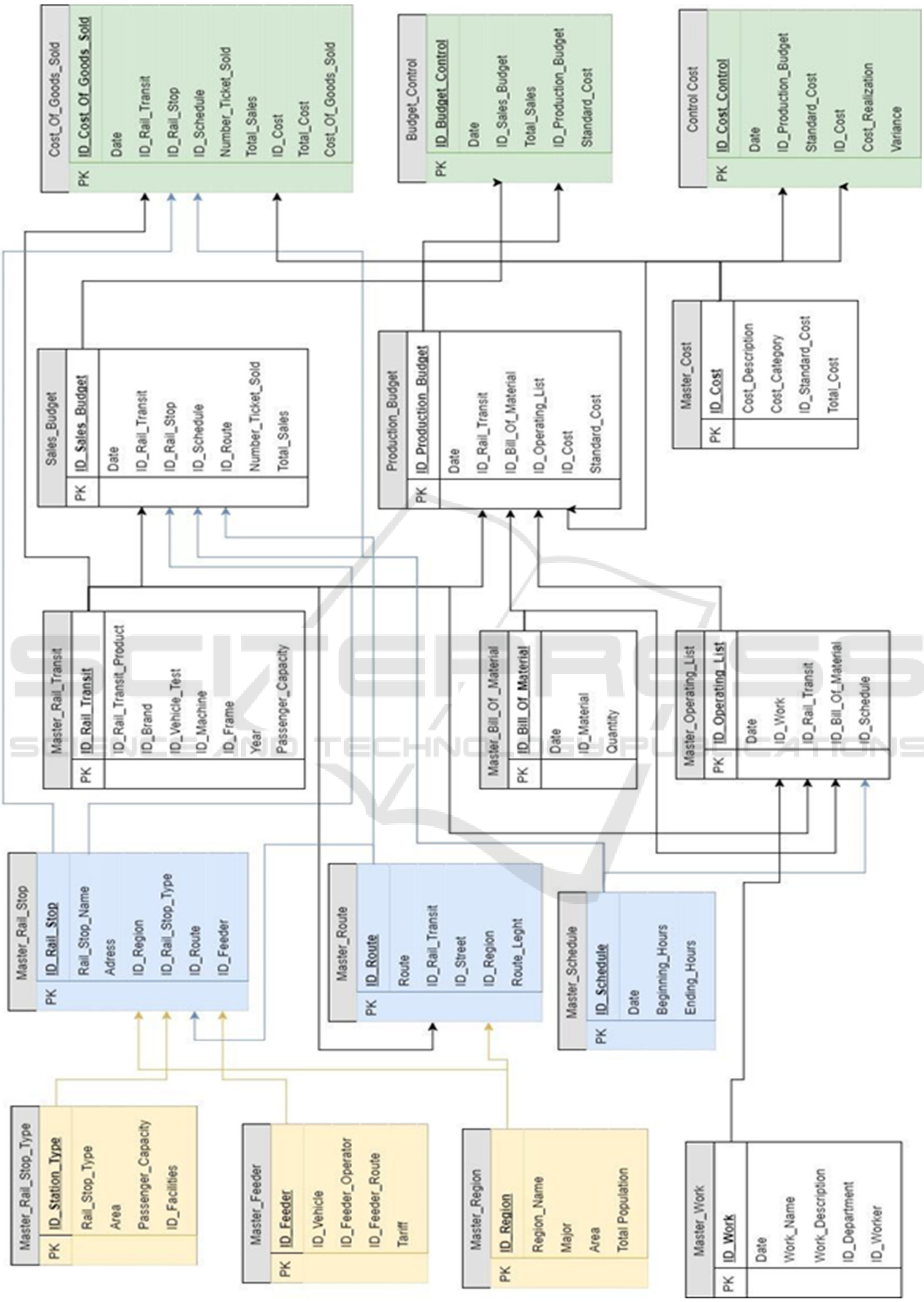
Based on the results of our analysis, we can conclude that, in order to be effectively managed, an urban rail transit system must be supported by an integrated operational information system.

An integrated operational system has some advantages, such as:

1. It can manage the calculation of the operational costs more accurately and effectively
2. It can measure the selling price of passenger tickets effectively
3. It can produce reports related to the operational system, such as operational reports, cost-of-goods-sold reports, etc.
4. It can measure the operational performance and service offered by the transit system
5. It can increase the effectiveness and efficiency of resources, thereby affecting operational performance
6. It can control the operational costs, budget costs, and control costs.

5.2 Reccomendation

The recommendation that can be applied to control operational costs from urban rail transit system in Surabaya is using E-Budgeting to control the operational cost. This can be generated by implementing an operational information system. Therefore, we suggest a design of Entity-Relationship Diagram (ERD) to create a good operational information system to be used by Surabaya Government (fig 3). As the beginning, this design is started by using master data relating with information needed and stored as a database. Then, this database will be processed by system to generate some reports i.e.: Sales Budget, Cost of Goods Sold, Budget Control, and Cost Control. Therefore, the result of ERD system can be functioned to evaluate the operational system performance such as : cost efficiency, worker productivity, vehicle utilization, energy efficiency, size of service utilization, accessibility, service quality, and control the operational costs.


Cost_Of_Goods_Sold
PK ID_Cost_Of_Goods_Sold
Date
ID_Rail_Transit
ID_Rail_Stop
ID_Schedule
Number_Ticket_Sold
Total_Sales
ID_Cost
Total_Cost
Cost_Of_Goods_Sold
Budget_Control
PK ID_Budget_Control
Date
ID_Sales_Budget
Total_Sales
ID_Production_Budget
Standard_Cost
Control Cost
PK ID_Cost_Control
Date
ID_Production_Budget
Standard_Cost
ID_Cost
Cost_Realization
Variance
Sales_Budget
PK ID_Sales_Budget
Date
ID_Rail_Transit
ID_Rail_Stop
ID_Schedule
ID_Route
Number_Ticket_Sold
Total_Sales
Production_Budget
PK ID_Production_Budget
Date
ID_Rail_Transit
ID_Bill_Of_Material
ID_Operating_List
ID_Cost
Standard_Cost
Master_Cost
PK ID_Cost
Cost_Description
Cost_Category
ID_Standard_Cost
Total_Cost
Master_Rail_Transit
PK ID_Rail_Transit
ID_Rail_Transit_Product
ID_Brand
ID_Vehicle_Test
ID_Machine
ID_Frame
Year
Passenger_Capacity
Master_Bill_Of_Material
PK ID_Bill_Of_Material
Date
ID_Material
Quantity
Master_Operating_List
PK ID_Operating_List
Date
ID_Work
ID_Rail_Transit
ID_Bill_Of_Material
ID_Schedule
Master_Rail_Stop
PK ID_Rail_Stop
Rail_Stop_Name
Adress
ID_Region
ID_Rail_Stop_Type
ID_Route
ID_Feeder
Master_Route
PK ID_Route
Route
ID_Rail_Transit
ID_Street
ID_Region
Route_Leght
Master_Schedule
PK ID_Schedule
Date
Beginning_Hours
Ending_Hours
Master_Rail_Stop_Type
PK ID_Station_Type
Rail_Stop_Type
Area
Passenger_Capacity
ID_Facilities
Master_Feeder
PK ID_Feeder
ID_Vehicle
ID_Feeder_Operator
ID_Feeder_Route
Tariff
Master_Region
PK ID_Region
Region_Name
Major
Area
Total Population
Master_Work
PK ID_Work
Date
Work_Name
Work_Description
ID_Department
ID_Worker

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