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Smart Commuter Line (KRL) using IoT and SOA in Indonesia

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Abstract: ***Commuter line (KRL) one of the better public transportation for commuter people in Indonesia especially in Jabodetabek (Jakarta, Bogor, Depok, Tangerang, Bekasi). Passenger satisfaction is the one of the service quality factor in KRL. There is no real time passenger information in both train and station, the situation make an unpredictable activity for passenger that want to use or wait the commuter line (KRL). Most of passenger cannot enter the train because the crowded passenger. KRL management cannot manage train capacity and train time management to meet passenger needs. This paper proposed a smart commuter line system to provide real time passenger information using IoT by count people using Markov Random Field framework and integrate all KRL enterprise system using SOA to support data integration.***

Keywords: Commuter Line, IoT, SOA, Passenger Satisfaction, Markov Random Field, Public Transportation.

I. INTRODUCTION

Developed country has become the role model of developing country in all aspect include economic, technology and lifestyle[1]. How to Adopt technology in public transportation is one of the biggest highlights for developing countries. University of South Florida with their research in 2016 said that technology deployment in transportation offers the potential for significant benefits that will come with many consequences to travelers, the workforce, and the general public. There is a strong public interest in monitoring and most probably transportation as automation and robot deployment impact multiple economic sectors [2].

Indonesia is a developing country that has city train called commuter line (KRL) managed by PT. Kereta Commuter Indonesia as a very effective mode of transportation for people in five economic city of Indonesia Jabodetabek (Jakarta Bogor Depok Tangerang Bekasi). Some of technology deployed in this system to support company's business process. Digital information, digital train schedule, and real time train position are some of many technology applied.

Through train operation, KRL quality management need to be improved for being a better public transportation that meet passenger needs. Many problem must be addressed thoroughly. Passenger accumulation is one of the biggest problem occurred in daily operation. Mismatch train arrival schedules, lack of train capacity and no passenger crowds in the train and queuing in station. Making railroad decisions or even look for alternative public transportation others to be used is a difficult for passenger. Waiting for a train in a station become a gambling activity. Sometimes have a comfortable space in busy hour in KRL is impossible. Many passengers will even force their self to get into the train. But in the other train they can actually have a comfort space.

Real time passenger information is the most important things to help passenger to enjoy KRL as a better public transportation and help company to solve their problem. Passenger need to access this information in both of train and station to make a quick and better decision how they can manage their time for traveling in efficient and effective way [3]. This information become a big data that help company to make decision. Company can see the passenger behavior in daily. It will help them to manage train capacity, train schedule and deliver a better service to passenger.

To deliver public transportation passenger satisfaction, many countries invest much money to do research how technology applied to public transportation. One of the latest technology deployed to support public transportation in developed country is IoT (Internet of Things). IoT can gather information, send information back, or both. allows passenger and system to be more connected around them and to do more meaningful, higher-level work in real time. IoT adopted in smart city that can produce an intelligent information system which is one indicator of smart city [4]. This concept can be applied in public transportation.

IoT enables us to create an increasingly high-fidelity digital representation of the physical things. Devices and sensors are the components of the device connectivity layer. These smart sensors are continuously collecting data from the environment and transmit the information to the next layer [5]. Implement IoT in company will impact the current system.

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IoT information need to distribute to the whole system needed. SOA is one architecture concept that enable system integrate each other and promise of easing the development of rich applications integrating the physical with the virtual worlds in a multitude of domains [6]. Passenger information in KRL will send to SOA and distributed data to all systems. SOA enable internal system in KRL integrate each other in easy development.

II. LITERATURE REVIEW

2.1 IOT

The IOT implementation help management of passenger on bus in the country of Bangladesh by using sensors like Arduino Uno, Bluetooth HC-05 module, pressure pad, potentiometer and Arduino IDE, this system will help the bus management to monitor and calculate the amount of money the driver must give to the company [7]. According to Lavanya Raju IoT(Internet of Things) can integrate of communication, control and information processing across various transportation systems. This system make easier for users to get information about the location of users in real time, the location of the next bus, and the level of density on the bus [8]. The impact IOT in train can make a real time information of queue density in every station consider for passenger to be a illustration and decision in use the train [9].

2.2 Public Transportation

One of the most important issues in public transportation is passenger satisfaction, so we propose the new system that provide a perfect service design of public transportation and the optimization of travel route basing on the user's habits, scheduling and health conditions [10]. Public transportation is one of solution to reduce traffic jam. To make passenger interest, accessibility is one of the most important of mobility and sustainability [11].

2.3 Markov Random Field

This paper use the same concept according to journal Haroon Idress,2013. Base on the problem of count million train passenger in a single image, so we propose Markov Random Field framework as the method to get the real time number of passenger in train wagon and station platform [12].

2.4 Passenger Satisfaction

(Thomas Kolawole OJO, 2014) said customer satisfaction is the most important things for public transportation. They give recommendations for improving public transportation service quality in Ghana [13].

According to (Sheeba. A. A, 2013), Indian Railways is the one of the largest and oldest public transportation in India. Passenger satisfaction is highly important for service quality. It is important to made repeated initiative for analyzing and improving railways services due to costumer satisfaction [14].

2.5 Service Oriented Architecture (SOA)

(Luis Felipe Herrera-Quintero, 2016) propose a new transportation planning using IoT and bigdata approaches for Bus Rapid Transit system. They use SOA paradigm to handle integration between system used by company to this new approaches. Integration subsystems is using web services and follow REST architecture principle. SOA paradigm handle vast amount of data inside and integrate them to IoT [15].

III. RESEARCH METHODOLOGY

The objective of this paper is propose a new system with IoT and SOA to provide passenger information in train and station. This analysis is using systematics literature review, document literature review and observation to get information about how KRL daily operational is run. Systematics literature review gathered and examined from academic journal like science direct, research gate, IEE, etc. in order to acquire a good understanding of SOA concept and IoT in operational technical and management. The analysis using observation to get a real case and see the activities in commuter line train as public transportation. IoT and SOA will be the solution to solve problem in passenger management and train management.

IV. IMPLEMENTATION

4.1 IoT Architecture

To meet commuter line passenger services new architecture proposed as figure 1. IoT devices consists of camera to take the picture of passenger in both of station platform and train wagon. Camera devices connected to wi-fi as IoT Gateway to send Images to Integration Hub in the cloud. Using the cloud as IoT Integration Hub is important for aggregating data and drawing insights from that data. Data can be delivered to KRL Integration system through cloud. Using the cloud also allows for high scalability. When KRL system needs hundreds, thousands, or even millions of images, putting large amounts of computational power on each sensor would be extremely expensive and energy intensive. All the images would be proceeded in internal system to count the people inside the images and send to mobile application in passenger's smartphone and information monitor in every station as display monitoring.

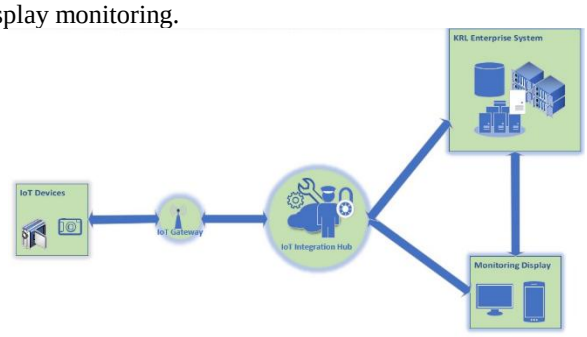

Figure 1: IOT Architecture.

4.2 IOT Tools

The workings of this framework by manually calculating using the object sampling method. From the results of the sample method, it can be estimated the estimation of the number inside the object. After that the estimation of the independence assumption is removed and placed in the multi-scale Markov Random Field to model the dependence on calculations among the closest patches [12].

4.3 How It Works

Base on figure 2 explain the results after MRF-based inference: Three nonets from different images are shown in first row. The second row shows the ground truth counts, and the estimated counts before and after MRF inference are shown in third and fourth rows, respectively. The patches from only one layer are shown in this figure [12]. From the result of MRF framework implementation the writer want to adopt this framework to count the number of large passenger in station platform and train wagon. Because the MRF framework can proceed a million of image and show the accurate number of passengers.

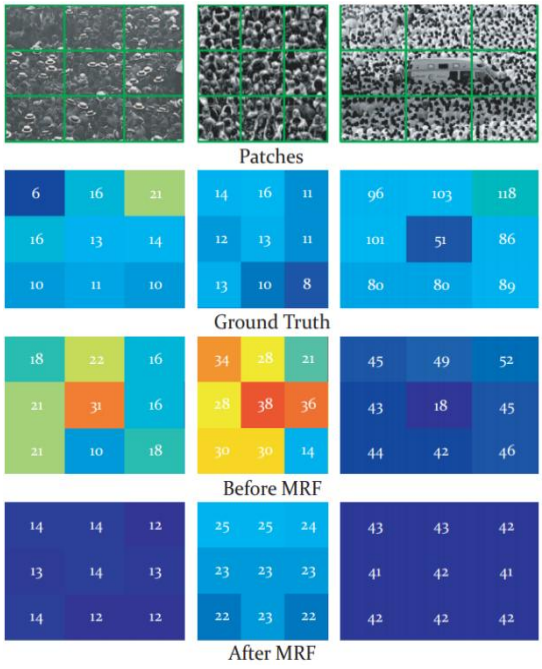

Figure 2: Result of MRF Framework

4.4 Application Mockup

Figure 3 explain the design of application dashboard for train users. This application displays the real time location of the station where the user is based on the nearest GPS and the closest train that will arrive at the user's near station.

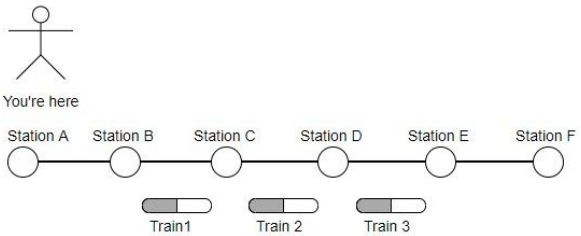

Figure 3: Application Mockup

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Figure 4 explain the detailed design of the application to help users get clearer information. There are 2 menu tabs in the details of this application: Train tab and Station tab. For the Train Tab displays a pie chart of passenger density in each train wain, while the Station Tab displays a table of information regarding the density of passengers on the train track of the user in real time.

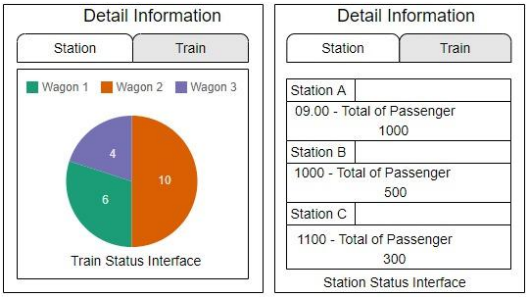

Figure 4: Application Mockup.

A. 4.5 SOA Architecture

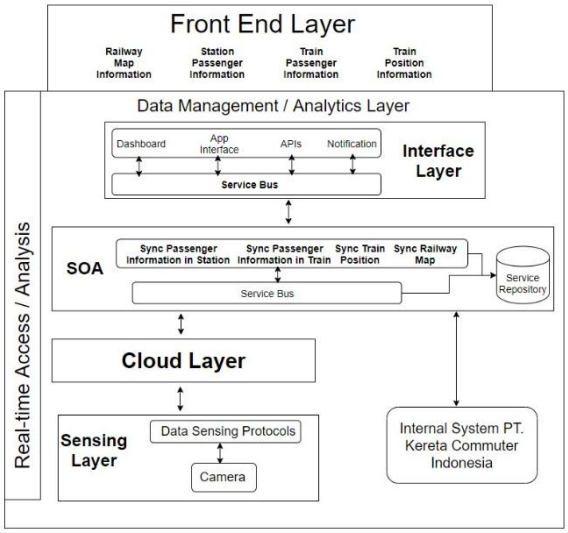

Figure 5: SOA Architecture.

The SOA concept this paper propose is divided into 4 layers. These are the function of each layer :

Front End Layer: It is the main layer that show the interface application for train user. At this layer the system will display like Station Passenger Information, Railway Map Information, etc. from the train user's smartphone or LED monitor in station and train wagon.

Interface Layer: On this system show application that link with services. If there are changes or addition in service the existing application will be automaticly update.

SOA Layer: This layer is the core of service. Because all of service will be register in this layer and the service will generate to count number of passenger using Markov Random Field Framework.

Cloud Layer : This layer is the storage to collect data from camera device.

Sensing Layer: the lowest layer that functions for sensor interaction with the cloud. Every data that was capture from camera will be transfer in real time to cloud.

V. CONCLUSION

In this paper we build IOT architecture in smart commuter line using MRF framework and SOA architecture, to propose a new commuter line smart system to help passenger manage their time by making decision to use commuter line (KRL) or use another transportation. Number of people in both of train and queuing in the station will be displayed in passenger smartphone and LED monitor in every station.

Passenger can decide either enter the current train or waiting the next train by information displayed in mobile application. This paper give an option to PT. Kereta Commuter Indonesia to get real time passenger information. This information can be processed by company to manage train schedule and train capacity to meet the passenger needs. Real time passenger information data will be integrated to all system in company using SOA to be proceed and fulfill company business process.

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