Internet of Things Implementation for Train Tracking Information (Case Study: UK and Indonesia)

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ABSTRACT

The Internet of Things (IoT) has revolutionized information gathering and daily activities, particularly in train operations. However, the implementation of IoT in Indonesia has not been optimally used, leading to delays in train location information. This research aims to explore the application of IoT for train location tracking systems in two countries, namely the UK as a developed country that adopts technology more quickly compared to Indonesia. This study employs qualitative methods with case studies approach to analyze IoT implementation in train tracking in Indonesia and the UK, focusing on regulations, and technology which support train tracking systems. Several research has discussed about how to use IoT in designing systems to produce train locations information and how this can help improve the safety of train operations. The originality in this research is exploration of how the implementation of IoT related to train tracking has been utilized and the benefits that have been felt by each stakeholder in both countries. The UK has implemented privatization, which has positively impacted infrastructure development. In addition, Office of Rail and Road (ORR) as an independent organization in UK regulates passenger information conveyed by train and station operators. In contrast, Indonesia's infrastructure is owned by the government and managed by KAI, the passenger train and station operator for mostly intercity train. The Ministry of Transportation supervises operators, implementing regulations from construction to operations. The comparison results indicate that specific regulations, data openness, and Darwin system in UK are the factors in real-time train information provision.

Key word: IoT; real-time train tracking locations; UK railway; Indonesia railway; ORR; KAI.

INTRODUCTION

Current technological developments make information easier to obtain. All organizations can gather data about practically anything, anywhere, and instantly. Due to advancements in semiconductor technology, cloud computing, and mobile connectivity, IoT technology is becoming more and more accessible every day. Furthermore the IoT is a developing technology (Sparks, 2017) and called as a network of networked computers (Jayasinghe and Kathriarachchi, 2021). The IoT is also applied in transport systems. Designate the scope of the study in the railway area, it also adopts the newest technology. However, its implementation varies across countries. Varied lower middle income countries regions have varied relationships between technology adoption and innovation (Salam et al., 2019). Commonly, countries with higher incomes adopt technology faster than other countries.

In Indonesia, focus on intercity train operated by KAI, there are a few issues that result in customers being unsatisfied with KAI's services. Among these issues is the fact that customers are unaware of train arrival delays. In addition, customers do not have up to date information of the train vehicle's existence (Chaniago et al., 2020). This information is beneficial for customers because helps travelers make more confident decisions and feel less anxious to plan their journeys (Amrozi, 2010). The train location information is one of the things that give a reassuring for passengers. Moreover real-live train tracking is important for other aspects, for example safety, providing a fast report to any stakeholder to monitor or evaluate and provide the decision to increase the train service. In fact, the availability of this information is easy to get in other places, in this case looking at in the UK

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compared to Indonesia. The differentiation encourages to look how the implementation the technology to provide the train tracking information in both countries.

The development of technology in combination with IoT provides many ideas for creating designs for monitoring train tracking. Several journals discuss the use of several devices such as Global Positioning System (GPS), Global System for Mobile Communications (GSM), Google Maps, Arduino microcontroller and combinations with web-based network services and systems or desktop applications to display information. In addition, Mohamed (2014) discussed the use of GPS for tracking train location is relatively cheap. This is proven by the interest of several researchers in using GPS as one of solutions for train tracking information. The integrated GPS module pinpoints the train's location with the greatest precision and transmits the data to the central system via GSM (Jayasinghe and Kathriarachchi, 2021). Moreover, using case studies in Indonesia to help users obtain train tracking information Chaniago et al. (2020) also created a design for monitoring tracking using Arduino and GPS sensor module. Beside the combination of GPS and Arduino, Djanali et al. (2015) with a case study also in Indonesia for trains managed by KAI designed a web-based application for real time train monitoring in combination with Google Maps. KAI can track all train positions simultaneously with this real-time railway monitoring system.

Knowing live train location information with IoT support provides several benefits for many groups, including the government, train operators, and the community. Safety is the critical aspect, Velayutham et al. (2017) by utilizing IoT, GPS, Triangulation and SDK (Software Development Kit) designed a train tracking system with GPS to control railway gates. Statistics indicate that a substantial number of accidents were caused by human error. Optimize management of information and resources plays an important role in reducing the number and impact of accidents (Mohamed, 2014). Beside safety aspect in railway operations, real-live tracking train information also increase comfort of passengers. Chaniago et al. (2020) noted that train tracking monitoring helps users to obtain specific information about the existence of train vehicles without having to inquire with train officers about the location of the train and provides effectiveness and efficiency benefits.

Previous research has discussed a lot about how to use IoT in designing systems to produce train locations and how this can help improve the safety of train operations. Meanwhile, the following research is a new study to explore information on how the implementation of IoT related to train tracking has been utilized and the benefits that have been felt by each stakeholder by taking a case study in a highly developed country, namely the UK and comparing it with the situation in Indonesia.

Since the train existence is one of the important types of information, this study contributes to look at the different implementations of two countries and to learn from it that might be improved the way to provide train tracking information in Indonesia. In addition, this research can be as consideration for the Indonesian government in advancing Indonesian railways, especially in managing information for customers and the can give a new suggestion to help evaluating and monitoring railway operation.

RESEARCH METHODS

The main objective of this study is to compare IoT implementation for railway tracking information in two countries. Qualitative research method is used to answer the question of how the implementation of IoT is done. As part of the research planning and to simplify the research process, the stages of the research start with the observation of the research question. Then, a literature review is needed to discover the gap between the previous study and then gain understanding about IoT for railway tracking information. After that, data is collected, data was gathered from several sources. Then, data is analyzed with qualitative analysis by organized and identifies any kind of the similarities and the differentiation between two case study of how the IoT Implementation in Indonesia and the UK. The finding is then used to draw the conclusion and then produce recommendation. The research steps were arranged in the form of a flow chart as shown in Figure 1.

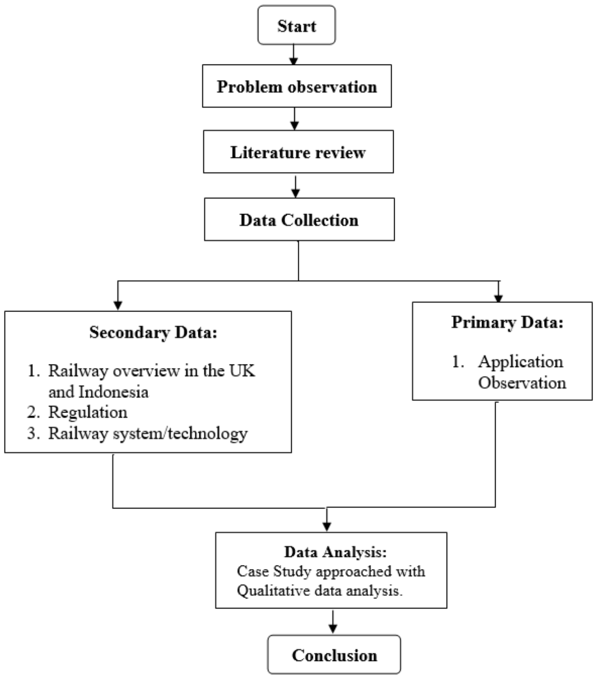

Figure 1. Research flowchart

Methods

The ground for comparison of IoT implementation for railway tracking information is two different countries based on income categories. The reason is that technology development in line with economic growth. First country which chosen is the UK as a case the presented a highly develop economic and the second case study is Indonesia as a country that the author took concern for this research.

In this research the primary data was collected by observing the existing applications for passengers that can be accessed using the internet and digital platforms. In the UK using existing applications such as Trainline provided by travel company, application/website provided by operator such as LNER, Avanti West Cost, TransPennine etc., and application provide by rail organization. In Indonesia observation has done using the application provide by KAI namely KAI access and travel company such as Ticket and Traveloka. Beside the primary data, the secondary data was also collected. Gather qualitative data relevant to the railway overview, regulations, and technology that related for train tracking. Data were collected from relevant publications, such as books, theses, dissertations, journal articles, reports, publications, blogs, websites, news, and government reports, including regulations, annual reports, presentations, and press releases.

Data Analysis

The research looks at case study implementation of IoT for train tracking information in two locations namely the UK and Indonesia. Case studies retain the distinctive attributes that are characteristic of qualitative research (Quintão et al., 2020). The purpose of the case study is to concentrate on a specific issue, characteristic, or unit of analysis (Kaman and Othman, 2016). In this research focus on implementation of IoT related to train tracking information. To collect data for a case study, direct observation requires the investigator to visit the location. The activities under observation may be formal or informal, but their dependability is the primary concern. Multiple observers are one method of preventing this issue (Tellis, 1997). The observation is done by using the official application and the experienced travel by train. The activity has done several times to gather different scenarios for example during disruption and without disruption.

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The researcher was further aided in the organization and documentation of the gathered data by the utilization of a case study database. Formally distinct from the final case study report, a case study database comprises a compilation of evidence (Yin, 2009). This was done by separating the following documents: data gathered from official website such as UK Government: DfT (Department of Transport), Indonesia Government: MoT (Ministry of Transportation), Network Rail, ORR (Office of Rail and Road), and KAI regarding British railway and Indonesia railway, and the personal notes/report of the researcher (i.e. in article, report or book form). Finally, a series of proof was utilized to ensure the dependability of the case study. A clear and direct connection exists between the questions posed, the data gathered, and the conclusions reached, forming a chain of evidence.

RESULT AND DISCUSSION

Railway industry in the UK and Indonesia

New Opportunities White Paper and the Railways Act legally laid the groundwork for British Railways privatisation (Department of Transport, 1992, 1999). Afterwards privatisation, the output of the industry increased substantially, while real expenses decreased. The new structure provided substantial incentives for the TOCs (Train Operations Companies) to increase outputs while decreasing expenses (Pollitt and Smith, 2002). These featured independent and different organisations responsible for running trains (the TOCs), as well as Railtrack/Network Rail (Railtrack/NWR), a big overarching infrastructure manager for track and signalling (Jeffcott et al., 2006). The UK Railways initially operated under private administration (1825–1921) before switching to nationalisation management (1948–1988) and then returning to privatisation management (1992–2000), reducing government interference (Pamungkas and Muthohar, 2017). Under Network Rail, all infrastructure, including stations, tracks, and signals, has been in the control of the public since 2002, and officially since 2014 (Department for Transport, 2021).
The current industry structure of the UK railway is shown in Figure 3.1 (Department for Transport, 2021). Railway infrastructure in the UK is owned by Network Rail. The railway infrastructure has 20,000 miles of track, 30,000 bridges, viaducts, tunnels, and thousands of signals, level crossings, and stations. All of it is also operated and developed by Network Rail in additional for the management it is regulated by ORR (Office of Rail and Road) (Networkrail, 2023). ORR is a non-ministerial agency. The role of ORR is guaranteeing that railway operators follow health and safety regulations, governs Network Rail's activities, enforces consumer protection law in regard to the railway (gov.uk, 2023).

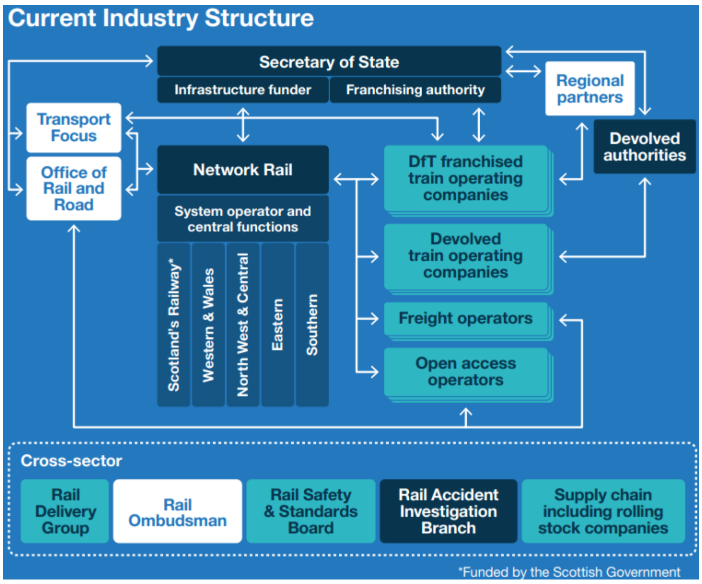

Figure 2. Current industry the UK railway structure (Department for Transport, 2021).

The UK railway divided the railway into five regions namely Eastern, Nort West and Central, Scotland's Railway, Southern, and Wales Western. In Great Britain, Nash et al. (2016) mentioned practically all train passenger service sector were allocated into 25 companies that were franchised by the central government between 1994 and 2007. Currently, the companies have grown into 29 train companies and 4 station operation companies (Nationalrail, 2023). Network Rail manages twenty of the main stations in the UK, while the remaining 2,500 are maintained by the country's train operating company (Networkrail, 2023). The operation of railways in the UK is divided into two parts: passenger services managed by Train Operating Companies (TOCs), including franchises operating specific routes from DfT (Department of Transport). In contrast, Network Rail manages rail and station leasing services. Both TOCs and Network Rail cooperate in the operation of the rail (Networkrail, 2023). All rail companies provide features for passengers, like ticketing and live train tracking information.

Indonesia is the second country in Asia (after India) with the oldest rail network (DJKA, 2023). Based on archival records in Indonesia, ANRI (2015) August 10, 1867, was when railroad transportation was opened to the public. The network of interconnected lines supplies most of the heavily populated island of Java, and there are three disconnected groupings of lines on Sumatera. The concept of a 'national' railway system is unfathomable in Indonesia due to its geography, which dictates the need for inter-island maritime travel, among other reasons (Black, 2016). The Railways Law of Indonesia, Law Number 13/1992, was enacted for the first time in 1992 (DJKA, 2023). Law No. 13 of 1992 stipulated that State-Owned Enterprises (BUMN) play the role of providers and operators of railways and train services. Later in operation, it can be delegated to corporations or other organizations (Lubis and Nurullah, 2007).

The government owns, regulates, and operates the Indonesian railway system. Figure 3 (Muthohar et al., 2009) displays the prior Indonesian railway institutional architecture and structure. The government designated KAI as the service provider and operator of the infrastructure. The creation of government or public sector institutions is a key step towards optimising the government's function as a railway administrator. The Directorate General of Railways (DGR) was established in 2005. The DGR oversees developing and implementing railway policy as well as technical standardisation (DJKA, 2023). Another goal of the restructuring is to allow the private sector and local governments to participate in national railway construction and operation. The primary issue facing the railway business is a lack of funds controlled by KAI (Lubis and Nurullah, 2007). Indonesia is the only country where a government ministry is responsible for rail infrastructure, out of the 25 or 30 railways throughout the world that have separated rail infrastructure from operations (Wachi et al., 2011).

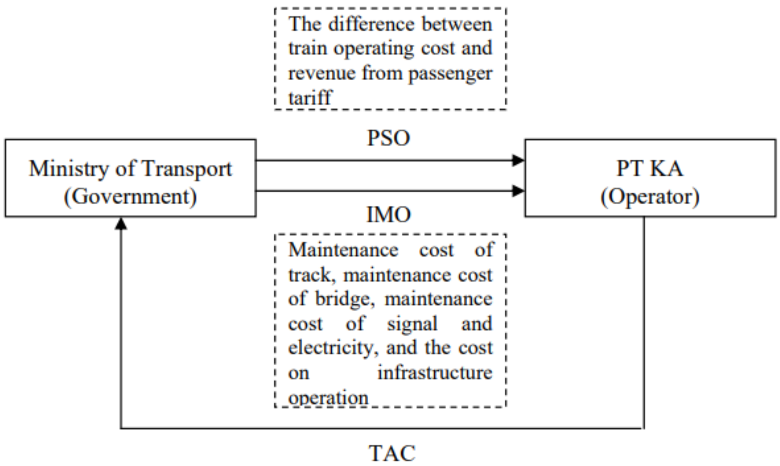

Figure 3. Model of railway budget mechanism (Muthohar et al., 2009).

KAI was created as a state-owned enterprise on June 1, 1999. It provides railway transportation services. The Indonesian government owns all of the shares (Prihatin, 2017). Prior to 2007, KAI was

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the only organisation in Indonesia authorised to operate and manage railway services. KAI is a 100 percent state-owned enterprise (Persero) with shares held by the Ministry of State-Owned Enterprises. KAI owns its rolling stock and locomotives; however, it does not produce enough revenue to meet its renewal demands. The country's railway network is operated and regulated by KAI, which maintains infrastructure under ministry oversight while the Ministry of Transportation (MoT) retains ownership. The Ministry of Transport is in charge of rail infrastructure management. In theory, MoT is in charge of the railway network's ownership, maintenance, and investments (KAI does maintenance on MoT's behalf) (Wachi et al., 2011). The private sector was only granted the ability to provide train service as an operator, while infrastructure administration and operation are still wholly overseen by KAI. KAI's operations region includes the Indonesian islands of Java and Sumatra. The operational area (Daop) divides the working area on Java Island. Operational areas for Java consist of nine regions and Sumatra regions, it consists of Regional 4 region.

Regulation

The United Kingdom decided to fully privatise the railway sector, relying largely on competition and unbundling to encourage investment in the sector (Sampaio and Daychoum, 2017). The research indicates that investment has been significantly higher following privatisation than during the previous BR period, particularly in the critical sector of infrastructure investment (Pollitt and Smith, 2002). On other side in Indonesia, the aim of restructuring is in accordance with Railway Law No. 23/2007. The KAI monopoly has gone, and private sectors and/or local governments are now permitted to enter the railway business not just for train transportation but also for track building, maintenance, and operation. According to Law No. 23/2007, the suitable restructuring method is vertical separation, which means that both infrastructure and services are administered by separate authorities (Mahardi and Malkhamah, 2011).

The ORR was established as Railtrack's independent regulator. Railtrack has a license with asset management and safety standards, establishes rail costs, and approves access agreements (Finger, 2014). In 2002, Railtrack transferred ownership of the infrastructure to Network Rail, a non-dividend corporation (earnings are reinvested or used to develop a financial reserve). Network Rail has taken seriously its responsibility under the Railways Act of 2005 to serve as a performance leader (Chapman, 2010). From Northern Ireland Statutory Rules 2005 No. 537, in Article 13, it is mentioned, “The infrastructure manager must establish a performance scheme as part of the charging system to encourage railway undertakings and the infrastructure manager to minimise disruption and improve the performance of the railway network” (legislation.gov.uk, 2005). In gov.uk (2023) mentioned ORR is in charge of governing the operation of Network Rail concerning passenger information and train tracking information. First, it is based on the schedule plan they require the train company to deliver precise and timely information, especially throughout disruptions. Furthermore, ORR is looking at these three points: “provision of rail timetable information, passenger information improvement plan, and passenger information licence conditions” (ORR, 2023).

In Indonesia, Law Number 23 of 2007 concerning the railway. In the case of train tracking information in Indonesia, several regulations have to do with passenger information support by signalling and telecommunication equipment and timetable planning. In addition to Law 23/2003, the government, in this case DGR, as a regulator under the ministry of transportation, produces *Peraturan Menteri* (Ministerial Regulation), namely: PM No. 45/2018 regarding Railway Telecommunication Equipment Technical Requirements, PM No. 69/2019 Concerning the Minimum Service Standards for the Transport of People by Train, PM No. 44/2018 regarding Railway Signalling Equipment Technical Requirements, and PM No. 35/2011 regarding Procedures and Standards for Making Train Travel Timetable.

Although number of regulations in the UK appears to be lower compared to those in Indonesia for regulations related to tracking information number of operators in the UK is increase, it is also stated that privatization in the UK shows an increase in investment in infrastructure. In table 4.1 shows one result of regulations issued by the government related to access, management, and licensing of railway undertakings and for more supervision and updated regulations were obtained from the ORR report. Meanwhile, in Indonesia, KAI is currently one of the infrastructure managers and a railway operator, especially on intercity trains. The government, as the owner of the infrastructure, assigns operational duties to KAI. The issue arises when a new train operator wishes to utilise this service. Permission is required from KAI, the existing infrastructure operator. KAI, on the other hand, operates as a train operator company, using the same facilities as the new candidate operator firms and competing with them. In the case of KAI, infrastructure decisions are frequently unjust (Mahardi and Malkhamah, 2011). In terms of DGR supervision, there is no special organization, so regulations are issued for each aspect to guarantee supervision. In terms of train tracking information, there are several regulations that allow it to be related. The comparison can be summarized as shown in Table 1.

Table 1. Regulation comparison.

	The UK	**Indonesia**
The Authorized	Regulated by ORR and infrastructure owned by Network Rail	Regulated by the government and specific regulations by DGR under the Ministry of Transportation Infrastructure owned by the government
Government document	The Railway Infrastructure (Northern Ireland) 2005	Law 23/2003 concerning railways
Specific Regulation	ORR's concern about passenger information	PM No. 45/2018, PM No. 69/2019, PM No. 44/2018, and PM No. 35/2011.

In terms of the content of existing regulations, Network Rail, whose role is to coordinate data from all train companies, then publishes a train timetable and is supervised by ORR. Then ORR also supervises passenger train operators and station operators to ensure they provide the information needed by passengers. In Indonesia, the timetable is prepared by the infrastructure operator, in this case KAI, which is then approved by the government (DGR). Regarding the information conveyed to passengers, in Indonesia there are special regulations regarding the minimum service for passenger transportation by train, but in terms of the available information, there is no related live tracking information. In the case of signalling and telecommunication, where these two things are related in the provision of information, it only conveys the specifications of the equipment that can be used.

Technologies

Network Rail has provided funds to improve on-board announcements through improvements to the GSM-R system and new functionality in the rail operator's control room. The use of GSM-R allows for improvements to the provision of customer information. Changes were transmitting information directly from the control centre to the customer via the train's Public Address (PA). Powered by a new cloud-based application, it will play the ordered messages in real-time using the text-to-speech capabilities of the GSM-R cabin radio as part of the proposed solution. The increasing use of GSM-R for TOCs has the effect of producing better information for consumers (raildeliverygroup, 2022).

In the UK, ORR request train passenger operators and station operators to provide accurate information to passengers. In response, the train industry announced the Smarter Information, Smarter Journeys Programme (SISJ) which aims to improve customer information. In presenting the information, SISJ divides it into four stages. First, information can be obtained from the timetable plan when preparing for a trip. Secondly, when at the station, passengers will receive information such as platform information, departure time and changes happening. The third stage is during the journey, such as the next station, including live updates of the arrival time. The final stage is the overall journey experience. In collaboration with ORR and DfT, weekly checks are also carried out to ensure consistent provision of customer information across all rail operator websites and National Rail Inquiries (raildeliverygroup, 2022).

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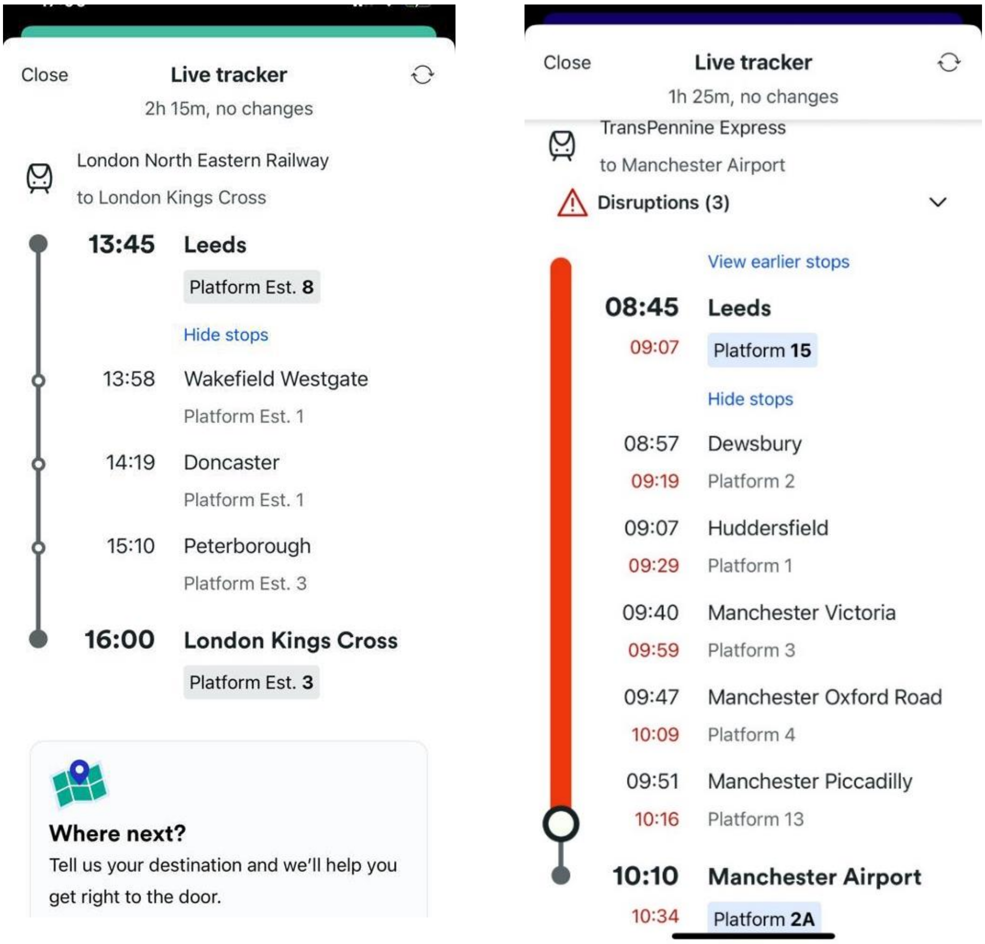
In addition, for real-time information, there are several data for public can be found such as open data feeds, TRUST and Darwin. Network Rail makes a variety of operational data feeds available to the public. This data can be used by people who want to help improve railway services. In addition, it can be used by developers interested in railway data. The data consists of static and real-time data. Static feeds are the schedule, which is sourced from an integrated train planning system with JSON and CIF format; SMART is a train describer berth offset, which is used for train reporting; CORPUS is the location reference data; TPS is the detailed information on the network model. For real-time feeds such as Movement data consisting of train positioning and movement event data, TD consists of train positioning at signalling berth level, TSR the temporary reduction, and VSTP the train schedule, which is unavailable in the schedule feeds (Networkrail, 2022). TRUST's principal function is to serve as a historical record of train movements, allowing comparisons between scheduled and real time and recording cancellations. When a delay of more than a specific threshold occurs between two TRUST reporting points, a secondary system called TRUST DA (Delay Attribution) demands that the delay be explained and credited. This data is not currently available in real-time, nor is it updated in real-time, and a delay may be attributed several times until it is agreed upon (openraildata, 2018).

In the early to mid-2000s, National Rail Enquiries (NRE) developed the Darwin system to improve the accuracy of information provided to passengers. Darwin forecasts arrival and departure times along a train's path using its own proprietary algorithms. It can also record extra and skipped stops before they occur, as well as report known delays, such as if a train will depart late owing to an awaiting train crew. Darwin obtains data from a multitude of sources, including TRUST and TD for real-time data, as well as the additional sources listed below: Tyrell Messaging System, Darwin Workstation, and Customer Information Systems (openraildata, 2018). Furthermore, Darwin is a system in the UK that collects a live feed of each TOC customer information and then combines it with rail location data provided by Network Rail (Nationalrail, 2023).

Since the data feeds were made accessible in December 2012 (Networkrail, 2023). Besides applications from train operators in the UK several applications and websites have sprung up to provide up-to-date information on train operations, especially information that can assist passengers for their journeys. Additional train tracking information can also be found on the National Rail website, train ticket applications like Trainline, and the official websites of each railway operator. Figure 3.3 is an example of how they provide information to customers by Trainline application. Figure 3.3 A is a capture before the journey. It shows a journey plan from Leeds to King Cross for July 31, 2023. Figure 3.3 B shows the live tracker information when the journey happened and there was a disruption (Journey from Leeds to Manchester Airport on July 7, 2023). Figure 3.3 depicts the information includes detailed time and every station that which is passed.



A B

Figure 3. Live tracking information.

Compared to Indonesia, a real-time monitoring system for public or passengers unable to found. Customers are frequently required to wait in the station for an extended period of time for the train without being told of its whereabouts (Djanali et al., 2015). The application currently available for train passengers in Indonesia is KAI Access, provided by KAI and an online travel company such as Tiket.com and Traveloka. Based on observation the application relates to train tracking information the available applications, it only shows the name of the initial station with the departure and arrival times at the destination station. There is no detailed information on the station that will be passed along with the detailed time, and when traveling happened it also does not display updated information.

The availability of complete information increases passenger satisfaction. In the UK, the provision of this information is of great concern, as can be seen from the establishment of the SISJ program. In addition, Network Rail also provides easy data access to the public, where there are currently several independent companies engaged in providing live tracking information. Whereas in Indonesia, currently the information available to the public is only a timetable plan and published after validation and availability of data, sometimes only for a certain time. Then the ticket service provider company also only conveys information on the arrival and departure of trains according to the schedule plan. The current state of applications that support train passenger information services can be summarized as shown in Table 2.

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Table 2. Passenger information service comparisons.

	The UK	Indonesia
Transparency data	Provide static and real-time data.	Only provide static data (timetable plan or Gapeka).
Application provider	National Rail, an independent rail platform (Trainline), train operators, and several independent companies	Provided by KAI (KAI Access), an online travel company (e.g., Tiket.com and Traveloka),
availability of live tracking information	Yes	No

Regarding the regulation timetable in Indonesia, an evaluation is carried out every 3 months, and currently the reports received from operators are also still manual. From the search results there is an application providing real-time tracking information with plan report and the actual timetable. Real-time information reporting will certainly make easy evaluation, which in the end can provide faster solutions so that increased customer satisfaction can be obtained earlier. Moreover, That information is open to the public.

Roadmap adopting a similar technology

If similar technology is planned to be implement in Indonesia namely provide reliable information for train location using benchmark current process and technology existing in the UK. There are several stages can be propose based on finding and results of this research. As a general process the stages will begin with providing the raw data then collect and process, after that distribute and do maintenance. Figure 4 describes the steps that could be done by Indonesia Government to adopt the similar technology from the UK to increase the provision of passenger information.

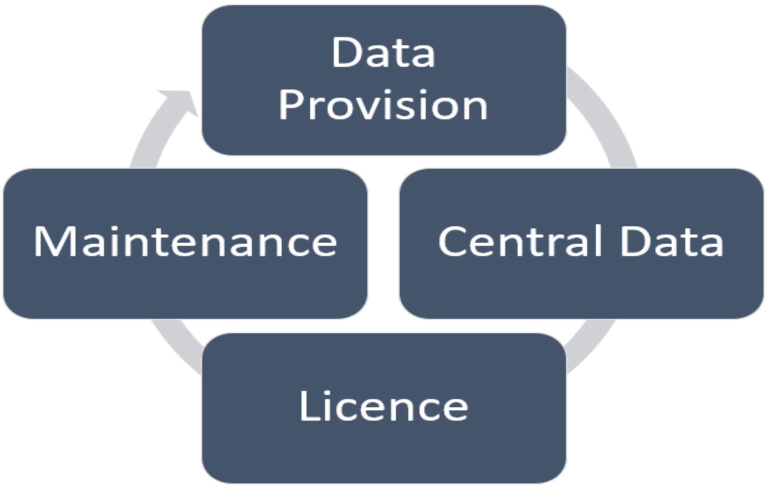

Figure 4. Roadmap implementation plan.

Stage 1: Data provision

The constant task is to provide precise, comprehensible, and timely information to the public that have traveling. The railway operates according to a schedule, which can provide data that can be shared with all users who support and promote train use. Nevertheless, like in any form of transportation, the occurrence of delays and disruptions can lead to deviations from the scheduled timetable, whether they are planned or unexpected. During these periods, the provision of information becomes crucial, and the rail sector has faced the ongoing difficulty of effectively collecting and disseminating reliable updates regarding service operations to the relevant parties. The UK follows a system of information supply which includes three categories: Off-station information, On-station information, and On-train information (ATOS, 2013).

The Darwin database, operated by the U.K.'s National Rail Enquiries (NRE), utilizes raw data from many sources within the rail sector to forecast train arrival times. Darwin is a Real Time Train Prediction system that collects data from multiple sources, analyzes the information, and makes intelligent predictions about the impact on the current train operation. The available sources are (RailEngineer, 2011) :

1. Integrated Train Planning System (ITPS): This is the Network Rail fundamental timetable, which is compiled biannually but refreshed daily and disseminated nightly to all railway companies and external entities that necessitate timetable data.
2. TRUST (Train Reporting Using System TOPS): A system that records and tracks train movements and timing at specific locations along the network, and then shares this information with train and network control offices.
3. Train Describers (TDs): The signalling system includes a component that provides signallers with real-time information on the identity and location of each train on the control panel. This information is transmitted as data messages and includes details about the train's current position.
4. Control Room Information Controllers: This is known as the Tyrell system is utilized to deliver organized messages to TOC personnel regarding cancellations, abbreviated train configurations, and other related information.
5. Customer Information System (CIS): CIS refers to control desks that are responsible for making local decisions on train departure updates.
6. Darwin Workstations: Accessible in the National Rail Communications Centre (NRCC) and TOC control offices, where users can directly input data into the system.

In Indonesia currently has schedule data (GAPEKA) to passenger this type of this information similar with ITPS. However, the daily update not yet distributed. This is become a challenge because the schedule created by operator which is KAI itself. The second data is TRUST similar with the actual data, that KAI reported to DRG every month. TDs, Control room information controllers, CIS is the data come from rail operation in this case from KAI side. To get this data the first thing is to decide the full authority of the GAPEKA. DGR as owner infrastructure can be as suitable organization to handle this. Then for the logs of train movement, operator must create a system to provide this data. Government can require operators through regulation in timetable licence or passenger information licence. The other information will be supported kind of technology, Indonesia Railway, in its existing development, can start planning to adapt communication to GSM-R. Meanwhile, GPS can be investigated as a solution to obtain train location information. This process can be carried out in stages by considering cooperation between DGR and KAI. The final data is data that can be input directly by TOC control offices.

Stage 2: Build a system for Central Data

After the source of the important data has been provision the next step is to gather the data and then process. The Darwin concept is an initiative and development by the Train Companies, the Association of Train Operating Companies (ATOC), and Network Rail. Its purpose is to enhance the precision of train information data collection and its distribution to a growing user community (RailEngineer, 2011). The algorithms devised by Darwin are intended to:

1. Preserve the fundamental schedule information along with intended immediate modifications.
2. Collect train running data from multiple sources to accurately forecast the real-time performance of the train service.
3. Determine trains that are experiencing delays.
4. Gather the required data to generate revised train schedule information across the railway network.

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5. Send this data to passenger information communications distributors, which are third-party entities, including over 30 mobile phone providers, who will then distribute this information to customers.

In Indonesia, the construction of a comparable system can be implemented gradually, like how Darwin initially provided the service as standalone information but has now integrated it into route planners. Darwin is undergoing continuous evolution and has currently reached Generation 3 (Nationalrail, 2023). This task can be carried on by DGR. The process of system development can commence by initially picking specific locations and subsequently expanding to encompass all high-traffic regions. Additionally, collaboration with the original providers of the station's CIS equipment, who connect the station systems through an autonomous data network, is essential. The deployment of the Darwin development in phase 2 rollout to 1900 stations in the UK took around 2 to 3 years to complete. This encompasses the primary stations that are overseen by Network Rail (RailEngineer, 2011). Furthermore, the NRCC, situated in Doncaster, is tasked with overseeing the data's quality within the Darwin system. If the TOC control rooms require aid in maintaining Darwin's up-to-date status with regards to operational choices amid severe disruption, they can provide vital support (Nationalrail, 2023).

Stage 3: Licence

Granting permission to create a system as explained in the previous stages such as doing the development work, hosting the system, managing the provision of the service, and maintaining the entire new system architecture can be carried out by a third party who has the capacity. However, DGR should be own the intellectual property rights of the system and the programming code. Moreover, granting a permission to distribute the data must be considered.

In Indonesia the public broadcast of information is presently less transparent compared to other countries like the UK. Despite the UK being subject to criticism since 2010, NRE has seen severe backlash for its lack of openness over data access and limitations on its usage. Additionally, some users have been charged fees, even for non-commercial purposes. Critics have contended that the imposition of fees and the demanding licensing prerequisites for utilizing the API have significantly increased the difficulty for smaller developers, in particular, to integrate valuable real-time train data into their applications (RailEngineer, 2011). However, currently, Darwin XML Push Feeds are provided free of charge to all users, regardless of the amount of data they use. The Darwin SOAP APIs are available at no cost to all customers for a maximum of 5 million requests each 4-week period. Corporate or private users that above this threshold will incur charges for High Volume Usage (PDF, 192k). Usage charges would not apply to public sector organizations such as Transport for London, passenger transport CEOs, and local authorities (Nationalrail, 2023).

To maintain security, Indonesia can adopt how the UK maintains data security, namely by creating a Privacy Policy for the use of the Train Information Service. Use of information distributed under license. Every party who wants to access the data is required to provide certain personal information to establish who is using it and the purpose of its use. The openness of the data can influence of the smaller developers to collaborate with government to provide the passenger information. In a beginning of the process, possibility no other party involved, DGR also can make a program to invite the party who interest with railway development application.

Stage 4: Maintenance

The system that has been built needs to be maintained to sustain its continuity. The purpose of the maintenance phase is to provide three key outcomes: maintain system functionality, make upgrades to the existing system, and ensure any repairs needed to system are completed. At this stage it will also look at several obstacles during the process and decide whether the process needs to start from the beginning or to a certain stage.

Moreover, how to implement this roadmap it is needed further observation. To gather the readiness of the organization and funding for developing passenger information system.

CONCLUSION

The study examines the implementation of IoT in the UK and Indonesia for train tracking information. The UK has a fully privatized railway sector, with Network Rail and ORR as independent regulators. This privatization allows for rapid development and competition, while Indonesia has only two parts: railway regulation managed by the government and track and train operated by KAI. ORR supervises the rail network and train and station operators and produce specific regulation concern for passenger information and this leading to provision of real-time train location data to passengers. This also support by investing in GSM-R which is improve onboard announcements and Darwin system to collect a live feed of each TOC customer information and then combines it with rail location data provided by Network Rail. While Indonesia's government carries out all supervision however no specific regulations that required the live tracking information. Apart from that, the disclosure of information carried out in the UK shows the emergence of several companies that assist in providing information. Data openness possible to implement in Indonesia to allow new companies to contribute helping improve passenger information in case of train tracking location.

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