TEAM REPORT

TITLE	Developing a Smart Public Transport Service System Using AI
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1 Executive Summary

1.1 Product Description

This smart public transport service system using AI is an advanced public transportation solution that utilizes Artificial Intelligence to improve passenger experience, optimize fleet management, and promote safety. This Smart Transport Service System improves efficiency, passenger experience, and safety for public transportation by providing application to passengers, drivers, and stations with multiple convenience functions.

1.2 Industry

Sector	Industry Group	Industry	Sub-Industry
Industrials	Transportation	Transportation Infrastructure	Highways & Rail tracks

According to International Standard Industrial Classification of All Economic Activities (ISIC), the industry which the smart public transport service system services should be the transportation infrastructure (ILO Department of Statistics, n.d.).

1.3 Market Size

According to the report by Allied Market Research, the global intelligent transportation market size is keep increasing, the market worth is expected to grow from USD 23.35 billion in 2019 to USD 58.60 billion in 2027, CAGR (Compound Annual Growth Rate) is up to 12.7% from 2020 to 2027 (Ahrefs, n.d.).

1.4 Explanation of Disruption

The image recognition function using AI can accurately identify the number of people waiting at the station and analyse the current number of people waiting at the station and the number of passengers through the model to give reasonable scheduling suggestions, thereby helping the bus system to enhance scheduling capabilities and operating efficiency.

2 Introduction

2.1 Functionality

The public transportation service information system is a robust system that provides real-time information and services to passengers, drivers, and station managers. It includes three main sub-systems: the driver-side system, the passenger-side system, and the station-side system.

The driver-side system includes features such as display real-time monitoring passenger flow, communication with dispatch centre for orders or assistance. Driver-side system also provides driver health monitoring from the start of transport vehicles to the end of driving.

The passenger-side system includes features such as select preferred vehicle with time schedule, real time notifications about the preferred vehicles. Helping calculate fares based on the starting station would be one functionality in the service system. Passengers would receive notifications which would update about the current and next stations, as well as notification about any disruptions and delays in service.

The station-side system includes features which can monitor the passenger flow real-time, and each station would be the node in dispatch centre service network, display the real-time traffic information.

2.2 Description

2.2.1 Function Description

Real-time monitoring of passenger flow: The system uses cameras with computer vision technology to monitor the flow of passengers in real-time. The cameras are placed on vehicles and stations, these cameras would upload the image of passenger flow and the servers would use AI algorithm to calculate the number of passengers in station also the number of passengers entering the vehicles with dynamic changes. The data will be collected and transmitted to the centre server and provide information to drivers and passengers. This function would be a disruptive innovation with the usage of computer vision and combine the AI model with smart public transport service system.
Communication with dispatch centre: The system provides the access for drivers to communicate with dispatch centres and other drivers. The service with Voice over Internet Protocol (VoIP) were provided in driver-side system to make them share the traffic situations and receive orders from centres to assist drivers to make better decisions. This function would be helpful for drivers to keep conscious in the process of driving.
Driver health monitoring: This function would use wearable devices such as smartwatches or health monitors to catch the health situation of drivers in real-time. The wearable devices are equipped with sensors that can detect the changes in significant vital signs. The data collected by sensors would be transmitted to the centre would be supervised by dispatch staffs and alert the driver immediately if some signs with their situation is going wrong.
Real-time notifications to passengers: The system would use mobile applications to provide notifications to passengers about the station information and other relevant information like degree of congestion and whether passenger have arrived their destination, etc.

2.2.2 Problems it Solves

The problem it can solve would concentrate on aspects:

- **Transport Efficiency:** The Smart Public Transport Service System would improve the efficiency of public transport by providing accurate traffic information and passenger information and process them under the help of AI algorithm.
- **Transport Safety:** The system concentrates on providing all-day protection to drivers and passengers because that dispatch centre would collect data from station and drivers and make better decision on traffic dispatching.
- **Transport Satisfaction:** The system can make the public transport more effective and take care of passengers' feelings by receiving passengers' feedback and make the bus scheduling more orderly.

2.2.3 Contribution

The smart public transport service system contributes to the improvement of intelligent transport. Intelligent transport has been an important topic for government to research effective methods to achieve reasonable planning for urban traffic, effectively improve road utilization and reduce accident rates. This system provides a brand-new solution for future urban traffic, using the combination of AI and traffic management to actively collect data and make the most rational analysis strategy. This method not only helps to improve the operating efficiency of society, which also contributes to the happiness and safety of residents.

2.3 Users and Stakeholders

- **Passengers:** Passengers who use public transportation services are the users of the system. They use the service system to get real-time information of the transport information. They are concern about the bus schedule, fares, or delays, as well as to receive notifications about bus arrivals and station information. Passengers are also the stakeholders, they benefit from the system's ability to optimize vehicle schedules and routes, which can reduce passengers wait time and improve the transporting experience.
- **Drivers:** Drivers are users of this service system, they use the system to communicate with the dispatch centre in real-time, get information of passenger flow and follow the schedule, and receive alerts about potential disruptions. The drivers are also the stakeholders of the service system, which means drivers can keep them work in nice environment and guarantee their safety in the period of working.
- **Transportation Companies:** These companies are the stakeholders of the service system. With the help of smart public transport service system, they can cut the output of maintaining the transportation system. They can make the public transport more effective because the optimized scheduling strategy. Consequently, the satisfaction among users will increase and they can build their reputation.
- **Governments and Regulatory Agencies:** Governments are the stakeholders of the service system; they will benefit from the increased efficiency which the system contribute to the society. Better urban transportation helps build a city's word of mouth and reputation, which not only makes an outstanding contribution to the development of the city, but also contributes to the development of the city: attracting investment and attracting more talents to the city. The management pressure and cost of relevant urban management departments will also be reduced.

2.4 Objective of the Product

The primary objective of this smart public transport service system is to provide an efficient and more effective means of scheduling public transportation services. This system aims to improve passenger experience with real time information on bus schedule, passenger flow, fares, and other notifications. The system makes the process of receiving information more easily with the help of mobile application. At the same time, passengers can take the public transport with the time they want and avoid the delay situation.
In addition, the system will benefit for overall public transportation to be more effective. The high-level performance on public transport would reflect positive affect on the society improvement, governments will reduce their operation cost and make better allocation decision. Transportation companies can optimize their fleet management and use of resource.

2.5 Market or Industry it Belongs to

The smart public transport service system belongs to transportation industry, specifically to the public transportation sector. This industry includes various modes of transportation vehicles, such as buses, trains, metros and so on. The goal of this system would improve the market size of intelligent transport which aims to make the transport more effective and reduce the cost of the transport operation. At the same time, the intelligent is part of intelligent city which contributes to make the city with better liveability and smarter urban governance.

3 Market Research

3.1 Existing Applications of Public Transport in the Market

- **Mobile Applications**: Many applications are providing public transport service, which shows real-time information to users, such as TripView Lite, Transit and Moovit. Their service is to offer public transport timetables, transport routes and up-to-date information through real-time positioning and data collecting like traffic information(L,2021).
- **Intelligent Ticketing System**: These intelligent ticketing systems are used in the public transport service, which improves efficiency when people are commuting and travelling. For example, Cubic Transportation Systems' advanced ticketing technology which is installed for Sydney, Australia's first metro train system, which added mobile phones and credit cards to pay for travel and made more commuters pass ticketing gates quickly (Cubic Installs Advanced Ticketing Technology for Sydney Metro, n.d.).
- **Transit Signal Priority Systems:** This is a reliable technology, which gives priority to public transport vehicles at traffic signals. Therefore, vehicles can move through intersections more quickly and efficiently. In addition, TSP uses sensors and communication technology to communicate, which sends a signal to extend or reduce traffic signal lights to improve efficiency at traffic signals. For example, the transit signal priority system in Washington, D.C. In sum, it is helpful for people to use the TSP system as will improve overall public transport services (Active Transit Signal Priority | National Association of City Transportation Officials, 2016).
- **Dynamic Pricing Systems:** This system adjusts the pricing of public transport based on demand and supply. It is helpful for passengers to choose off-peak hours to travel. Passengers can save on the fee of transport. Meanwhile, this also improves the efficiency of transport use, such as the Opal system and London's Oyster card system (Saharan et al., 2020).
- **Transit Security Systems**: There are many security measures applied in public transport, such as bus camera surveillance, emergency response systems, access control systems and passenger alerts. It is important for passengers to protect their lives in public transportation services. Meanwhile, transit security systems can provide a safe environment and deal with emergencies in time. In addition, some crimes can be prevented by these transit security systems (Guo, Z., Xiao, Z., Alroobaea, R., Baqasah, A. M., Althobaiti, A., & Gill, H. S. 2022).

3.2 Market Demand and Market Gap

Australia's vast land area and low population density have made public transport a crucial aspect of the country's transportation infrastructure. According to the Bureau for Infrastructure, Transport and Regional Economics (BITRE), passenger numbers on public transport (excluding buses) in Australia increased from 1.1 billion in 2015-16 to 1.2 billion in 2018-19, with heavy rail passengers projected to reach 396 million in the metropolitan area in 2020-21 (Bureau, 2022b). As a key element of modern society's social infrastructure, public transportation offers substantial benefits, including reduced traffic congestion, lower energy consumption, and fewer environmental impacts, as well as promoting economic growth and improving people's travel efficiency (Sun, Pan, White, & Dubey, 2016; Kanthavel, Sangeetha, & Keerthana, 2021).

However, existing intelligent transport systems in Australia have certain limitations. For instance, the annual cost of urban traffic congestion in the country is estimated to be US$12.9 billion, and it may increase to US$20 billion if appropriate measures are not taken (Kanthavel, Sangeetha, & Keerthana, 2021). Furthermore, the unpredictability of public transportation, such as bus travel, may deter some individuals from using it for their daily commute, as it can often be delayed due to various reasons such as traffic jams, road construction, special events or bad weather (Holeywell, 2013), causing potential

passengers to seek alternative modes of transportation. The lack of real-time information about bus locations and delays makes it difficult for passengers to plan their journeys, which is particularly problematic for bus transportation. Tracking vehicle movements and providing passengers with accurate arrival time estimates is a challenging task due to several factors, including traffic congestion, operational delays, and varying passenger loading times at each station (Sun, Pan, White, & Dubey, 2016).

In addition to the issue of delays, public transportation safety is also a concern. In 2021, there were 1,123 road fatalities, a 2.6% increase from the previous year (Australian Government, 2022). Traffic accidents not only have tragic consequences for the families involved, but they also have significant socio-economic impacts. A 2009 study by BITRE estimated the cost of road crashes to be AUD 17.85 billion, which is approximately 1.7% of Australia's GDP in 2006 (Bureau, 2022a).

Fatigue is one of the leading causes of crashes, and drivers who are sleep-deprived cannot function properly. Professional drivers, who often work long hours and have an unhealthy lifestyle, are particularly vulnerable to fatigue-related crashes. Their sedentary work style, irregular hours, and lack of sleep can lead to drowsiness, irritability, confusion, impaired concentration, memory, reaction time, hand-eye coordination, and vigilance levels. Professional drivers have been identified as a high-risk group for various health conditions, including cardiovascular disease, obesity, diabetes, apnea, and high stress, based on surveys (Greenfield et al., 2016).

To address these challenges and meet market demands, we propose the development of an intelligent public transport management system that leverages real-time passenger density monitoring and traffic scheduling to provide passengers with timely information and improve their travel experience. Additionally, we plan to integrate driver health testing as a critical component of the system to detect and mitigate any potential safety risks. Our proposed system aims to enhance the efficiency and reliability of public transportation while ensuring the safety and well-being of drivers and passengers alike.

3.3 Opportunities for Growth in Public Smart Transport Services

- **Improvement of Technology:** Public transport service can improve its technology because current technology is not perfect and exists defects. For example, developing better sensors and having data analysis can improve the accuracy of arriving time and leaving time, which can offer more convenient services. In addition, integrating different technologies is a way to improve opportunities for growth in public transport service, which can improve the overall efficiency of the system, such as Artificial intelligence, and the Internet of Things (Molloy, 2023).
- **Improving User Experience**: It is important for users to have a better experience because it can improve growth potential if users feel very comfortable. For example, mobile apps for public smart transport services can be developed more user-friendly through simple interfaces, easier payment ways and overall information. This can attract more people to experience public transport services and enjoy the service. Therefore, users' experience is an opportunity to grow in the services (Grison, E., Gyselinck, V., & Burkhardt, J.-M. 2016).
- **Increasing The Services Coverage**: Although public smart transport services have covered many cities, some rural areas and small cities have not. This means it is significant to increase the service coverage. If there are opportunities to cover more areas, more people will experience convenient transportation. This is a potentially increasing opportunity to expand public smart transport services (McCallum, 2022).
- **Increasing Efficiency**: There are many cases occurring congestion at work, which is a long-term problem. However, improving the efficiency of public smart transport

services is helpful to reduce congestion. Customers would be more willing to take public transport and the services would be better. For example, achieving it can be through reasonable route arrangement and utilizing advanced technology (Atajanov, M., & Solayev, S. S. 2020).

- **Data analysis:** Using data analysis can provide some sensible advice when staff or systems decide. In addition, it can analyse some behaviours of passengers and drivers. Through analysis, administrative staff can make sure some aspects to modify or adjust public smart transport services to offer better services. For example, analysing drivers' behaviours to know whether drivers drive the vehicles safely and operate accurately and whether drivers are healthy. This would improve the security of public transport. Moreover, analysing passengers' behaviours can learn traffic flow through the number of passengers consequently improving public smart transport services (Topcu, A. E., Cibikdiken, A. O., Uçak, E., KaragümüÅ, E., & Åener, C. 2022).

4 Competitive Advantages

The smart public transport service system integrates multi-systems in information technology and systems to create a competitive advantage over other organizations and provide superior service for users.

4.1 How competitors are using ITS

1) Google Maps:

Google Maps is one of the most influential applications in the world. In Australia, google maps has coverage details such as, map tiles, geocoding, traffic layer, driving directions / snap to roads, biking directions, walking directions and speed limits in Australia.

In NSW Australia, Google Maps had already begun offering a feature early on that was applied to help consumers organize their daily commute by enabling them to plan, prepare for possible delays, and avoid delays altogether when feasible.

Since before 2012, users have been able to find out how to get to their destination by driving, walking or cycling on Google maps. Starting July 25, 2012(Transport for NSW, 2017), the NSW government and google maps partnered to create a new feature for Google maps - google transit - which allows NSW users to see a new option on google maps that provides This option provides real-time bus information for convenient public transport journeys to destinations, when to arrive, and an estimate of the total journey time, as well as updated time information when trains are running late(Transport for NSW, 2017).

Thanks to Google Maps' use of open data from Transport for NSW, commuters can now simply open the Google Maps app for real-time traffic information tailored to their specific journey. Transit riders in Sydney can now use Google Maps to find out where their bus is. Passengers will be able to see how far their bus is from them to avoid missing their trip.

2) Opal:

Opal is a smart card ticketing system used to pay for public transport in Sydney, Blue Mountains, Central Coast, Hunter Valley and Illawarra (Transport for NSW, 2023). Tourists can top up their opal card through retailers and the opal app before traveling. Users can register opal cards, activate new cards, check opal card balances, block lost or stolen Opal cards through opal.

In October 2020, the Opal travel app received additional capabilities to allow users to more quickly obtain essential information at designated stations and real-time information on all forthcoming departures. Simply defined, it is a method of transferring the information display screen that is only visible at the station, ferry terminal, and light rail station to the mobile phone client. Client-side access is available to users. • Vehicle location on a map

in real time, service line name, total number of stops, real-time or estimated arrival time Stop over, get on, get off labels (Transport for NSW, 2020).

3) Next There:

Beginning in May 2018, the New South Wales Transport Agency provided real-time seat availability information on Waratah trains to passengers through travel apps such as transportnsw.info trip planner and trip view and next there (Hendry, 2019).

When users use Next There, they can choose their own starting point and destination to get the optimal solution, which will provide users with easy-to-read transportation options, school bus information, and the degree of congestion on the bus. In addition, next there can also provide information on the length, facilities and accessibility of stations and terminals (Transport for NSW, 2018).

Passengers can check the real-time passenger flow in the car through next there, and the current congestion level of each car will be marked with different colours next to the information of each car. Green means there are plenty of seats, orange means passengers need to stand when boarding, and red means the car is crowded.

This feature is innovative because passengers are often not evenly distributed between train cars, so knowing which cars are full and which are empty improves occupancy. And if you have some flexibility when you need to get somewhere, you'll find that not all trains are as full as others. Choose your favorited car and have a seat to rest during your commute.

Next application which their footfall is calculated by extrapolating the number of people by weight measurement. There is an airbag with a barometer under each axle. When the door of the carriage is closed, the psi branches are converted into weight, and the weight of the carriage is subtracted. The total weight of passengers is deduced from the number of passengers through a special algorithm to calculate seat availability (NextThere, 2018).

4.2 Different Information technology and Systems

4.2.1 Real-Time Vehicle information system

Implement a real-time Vehicle information system (IRVI) that provides accurate and up-to-date information on vehicle arrival times, delays, and service disruptions. Utilize artificial neural networks (ANNs) to establish a model to predict transit arrival time that reduces passenger wait times (Chien, Ding, & Wei, 2002). Real-time Vehicle information system presents more precise real-time schedule about arrival time, delays, and service disruptions to passengers than competitors, empowering passengers to plan their journeys more effectively and enhancing users' experience.

4.2.2 Digital Platforms integrate Ticketing and Payment System

Develop a user-friendly digital platform that allows passengers to access optimal ticketing options, payment online, and real-time route information. Introduce an integrated tickets and payment system that enable passengers to use m-payment to buy tickets. Supporting m-payment streamlines the ticket purchasing process and reduces tap on/off time during heavy passenger traffic thus mobile payment offers more convenient and reliable service than competitors (Apanasevic, & Markendahl, 2018). Global Positioning System (GPS) technology identifies vehicle location and bus stop time accuracy which could represent precious real-time route information for passengers (Lin & Zeng, 1999).

Using AI and Machine Learning Algorithms to offer optimal ticket options and tailor service to meet passengers' needs and expectations, providing personalized travel

recommendations and notifications about route information, resulting in improved customer satisfaction and long-term loyalty than competitors.

4.2.3 Advanced Fleet Management

Utilizing an infrared sensor and a camera to calculate the number of passengers could be more accurate than the camera-only system and determine the number of passengers in a more robust manner (Erden, Alkar, & Çetin, 2015d). Smart public transport service system provides vehicle real-time information to passengers that enable passengers to click on a stop they prefer (Ferris, Watkins, & Borning, 2010). Public transport centre decides whether to add more vehicles to release heavy passenger traffic based on the number of passengers monitored and the bus stop station passenger preferred. Establishing models based on machine learning algorithms to make informed decisions on route planning, resource allocation, and service improvements. Analyse passenger data, travel patterns, and external factors to optimize routes, leading to a safer and more reliable service to customers and enhance over service quality.
To sum up, integrating these information technology systems into smart public transport service systems could create a competitive advantage over other organizations in the industry, ultimately driving growth and long-term success.

4.3 How ITS Will be Used by You

Based on deep learning algorithms, our smart public transport service system is specially developed for public transport systems. Inside the car, the on-board camera and on-board display screen use computer vision technology to identify and count the number of passengers in the car immediately after the door is closed and transmit the data to the dispatch centre. The number of passengers is accurately calculated and synchronized to the mobile phone client in real time, so that citizens can keep abreast of the latest developments and plan travel. The system also enhances the communication between the dispatch centre and the driver, because cv technology is not only used in the passenger compartment, but also used to monitor the driver's condition, together with smart watches or health monitors, not only responsible for the driver's personal safety, but also for the public traffic safety. At the same time, each station is equipped with a camera, which uploads a real-time image of the station every 3 minutes and uses cv technology to identify the number of people, thereby calculating the passenger flow level of the station, and then synchronizing the data to passengers, so that passengers can plan their own itineraries.
In addition, the system is not limited to the above functions. Based on the above technologies, it can also help public safety. Since cv technology can detect the real-time situation in the car in real time, if any suspected criminal behaviour is found, the video evidence can be uploaded to the command centre as soon as the confirmation is confirmed, and the police can be directly contacted after manual confirmation, and the real-time location of the vehicle can be provided, to Help resolve the crisis. At the same time, the stations are also equipped with cameras and safety detection functions, which are monitored 24 hours a day, so that every station can provide protection for the safety of citizens in the middle of the night.
Voice over Internet Protocol (VoIP) is another competitive advantage of our smart public transportation system. VoIP is a technology that allows voice conversations to be routed via the Internet or other Internet protocol (IP)-based networks (Chakraborty, 2018).
The reason why we use VoIP is that VoIP has advantages such as, easy to deploy, simplifies network transmission, reduces costs, provides more services, is not restricted by time and place, and is easier to upgrade (Chakraborty, 2018).

5 Unique Value Proposition

5.1 Customer Segments

- **Daily commuters:** They often need to arrange their daily routine in advance so that they can reduce unnecessary time waiting. The smart public transport services system provides real-time monitoring of passenger flow, which would help daily commuters acquire more real-time transport information and make a better plan daily.
- **Occasional Riders:** They hope that they can have more real-time traffic information. Thus, they can avoid some crowded roads to increase their safety. The smart public transport services system offers real-time notifications to passengers. Occasional riders can use mobile app to receive traffic information to change their riding routes and ensure their safety.
- **Tourists and Visitors:** The system is significant for tourists and visitors to have a clear and accessible transport information when they go abroad to travel. This makes them have a relaxing and efficient trip. The smart public transport services system offers real-time notifications to passengers. This function provides concise interface and traffic information to tourists and visitors through mobile app, which would help them plan their journey better.
- **Students:** They pay more attention to the time for school. Because they do not want to be late. Therefore, real-time monitoring of passenger flow is important for them. They can check passenger flow to decide what time they are leaving for school is suitable. Avoiding heavy passenger flow is good for them to go to school on time.
- **Elderly And Disabled Passengers:** They are worried about safety problem. Because their health and body are not young people. Thus, offering safe service is crucial and can make them reassured. The smart public transport services system provides driver health monitoring, which monitors drivers' situation and if they drive steadily. If there is a special situation, their equipment wearing will alert the driver. This would improve safety to some extent (ReportBuyer, 2018).

5.2 Minimum Viable Product

Often established in the early stages of a project, MVPs(Minimum Viable Product) not only have the role of soliciting investment and recruiting teams (Nguyen-Duc, Khalid, Shahid Bajwa, & Lønnestad, 2019) but also gain valuable market feedback by releasing a lite version of the product as a test, which can be used to improve the product and make it more attractive to customers.

As mentioned above, traffic congestion costs governments significant financial resources, passengers do not choose public transportation mainly because of its delays, and driver health, and more important factor in traffic safety is that overlooked. Based on the above information, our product aims to develop a smarter and more efficient public transportation management system, not only for passengers but also for public transportation drivers, who are our main target users.

Our team's key MVPs will focus on the following two points: real-time density monitoring of station passengers and driver heart rate testing and feedback. We will adjust the frequency of public transportation departures by detecting the real-time density of passengers at stations. This feature that designed to adjust the supply of public transportation according to the level of passenger demand, so that supply can exceed demand, thereby improving passenger efficiency and service satisfaction. We will also develop a basic driver wearable device to detect the driver's heart rate. The driver's heart rate will recorded anonymous to determine the driver's health in real-time. Ensuring the

driver's health is good will further ensure road safety and reduce the incidence of traffic accidents.
Based on the key MVPs, we will evaluate the product and use the test results and market feedback to further improve the system's functions, such as providing passengers with accurate schedules so that they can plan their travel time more rationally. For another example, in addition to monitoring the driver's heart rate to obtain their health status, further adding sensors on the steering wheel or dashboard to detect the alcohol level in the driver's body, etc.

5.3 Value Provided to Stakeholders

Using Information Technology and Systems could bring countless benefits to stakeholders and provide unique product value.

- **Enhancing Passenger Experience and Reducing Commute Times**: Smart public transport service system provides accurate, real-time arrival and departure time to help passengers plan their trips more efficiently. And this system could analyze personal preferences and suggest optimal routes to improve the passenger travel experience. In addition to this, it can predict potential problems with vehicles or infrastructure, minimizing service disruptions and ensuring smooth vehicle operation and passenger safety. The smart public transport service system offers passengers dependable, timely, customized, safe, and comfortable public transportation.
- **Increasing Revenue and Making Better Decisions for Public Transportation Company**: A more efficient and reliable public transportation system can attract more customers to companies such as advertisers. It will also attract more passengers to choose public transportation to increase revenue for the company. The smart public transportation service system could optimize routes and schedules based on real-time traffic, passenger flow, and other factors, reducing fuel consumption and saving costs. Besides that, the smart public transportation service system can predict passenger trends, enabling administrators to allocate resources more efficiently and make better decisions for future demand.
- **Improving the Efficiency of Infrastructure Usage and Increasing Tax Revenue for Local Government:** The Smart public transportation service system could use limited infrastructure resources more efficiently to share the demand for private car trips, reduce road congestion and improve road transport efficiency. The smart public transportation service system can generate revenue for the government through fare revenue, advertising revenue, and other commercial partnerships. Furthermore, a smart public transportation service system helps to enhance the image of the city, attract tourists, and promote tourism.

5.4 Benefits and Advantages of the Product

- Real-time monitoring of driver circumstances allows for the prompt detection of risky behaviors such as driver weariness, distraction, and intoxicated driving, as well as reminders to drivers to alter their behavior to limit the occurrence of traffic accidents.
- Real-time traffic data collecting, and analysis can more correctly forecast traffic flow and congestion, allowing public transportation routes and timetables be rationally designed to increase the efficiency and convenience of passengers' journey.
- Passengers can more easily obtain crucial travel information, such as bus arrival times and the best transfer choices, thanks to real-time information and personalized trip planning, boosting their travel experience and satisfaction.
- By monitoring and analyzing real-time traffic conditions, the traffic dispatch center can make timely adjustments to trips, such as increasing and decreasing frequency,

changing routes, and so on. To avoid public transportation vehicles becoming stuck in traffic, reducing traffic congestion, and reducing the environmental impact of exhaust emissions.

- An intelligent traffic management system can not only enhance and optimize for existing traffic problems, but also deal with future traffic increases and technology advancements.

6 Revenue Streams

6.1 Sources of Revenue

- **Fare-collection:** Passengers can pay for their rides through the app or by tapping their contactless payment card. The app is user-friendly and securely linked to their credit card, allowing them to track their usage history. The system also offers partnership opportunities with local businesses, which can sell tickets or top up cards on their premises.
- **Subscription:** Frequent riders can purchase monthly or annual passes for unlimited access to all services provided by the information system (Danaher, 2002). The passes include unlimited ride passes, discounted passes for students, elderly, and low-income citizens, and partnership passes with local businesses to encourage commuting with public transportation.
- **Advertising:** The AI-powered public transport information system provides various advertising opportunities through in-app and station advertising. In-app advertising targets users based on their travel preferences and locations, while station screens display digital posters. The system also attracts local companies to sponsor content or promotions within the app, generating advertising revenue.
- **Customization and Integration Services**: The system processes anonymized data that can be sold to third parties for urban design, academic research purposes, and traffic management. This data can be used to optimize infrastructure and public transport services and shared with businesses to help them understand their customers better. The system also collaborates with academic research institutions to conduct studies on intelligent transport, environmental protection, and transport behaviours, which generate additional revenue.
- **Licensing and Franchising:** The AI technology and platform can be licensed to other public transport agencies or corporations, allowing them to implement the system with their own company's environment. The system also invites new plugins and generates revenue through licensing fees and technical support services (Sherman, 1991). Research partnerships are also established to integrate the system into other solutions, expanding its reach and generating additional revenue.

6.2 Revenue Model

- **Per-transition Payments**: Passengers pay a fixed fare, or a fare based on the distance travelled for each ride. When they use this information system, they should be prepaid with the transport fee each ride. Dynamic pricing based on peak and off-peak hours.
- **Subscriptions**: Offer the unlimited function and services which conclude in the information system to the customers only if they subscribe the whole system monthly, weekly or annually.
- **Advertising:** Advertising could be an effective revenue model for the AI based smart public transport system which could generate the revenue through in-app advertising, station advertising.

- **Tiered Pricing**: The tiered pricing could be divided into 3 tiers: basic tier, premium tier and enterprise tier (Schoengold & Zilberman, 2014). Basic Tier can have the essential features and functionality, update to premium could have advanced features like customized functions and analytics. As for enterprise tier they would be charged for information system which integrated into the organization with full suite of features.
- **Licensing**: License the information system to other city's public transport agencies or departments. Generating revenue through licensing fees which paid by other companies for technical support service and royalties.

6.3 Cost of Alternatives

- **Traditional Public Transport Information Systems**: The traditional information system which is used for public transport is normally inefficient, which means this system would be operated with manual processes. Traditional system would have limited real-time information and communication which could lead to the less satisfaction of passengers. It's more likely to have higher operational costs due to the suboptimal resource allocation with lower effective information system.
- **Private Transportation Information System**: The private transportation information system which implies that people should increase personal vehicle ownership costs. Private transport could also lead to high possibility on the congestion with higher pollution levels. Due to the demand change, it's crucial that the private transportation information system is less adaptive.
- **Ridesharing Services Information System**: This kind of information system would cost more than public transport system and have the limited capacity to serve large number of passengers. In this way, the passenger would have to wait extremely long time to wait for the ridesharing vehicle. Also, the ridesharing information system would face the challenge or regulatory and restrictions which focus on the Insurance requirements, labour and employment regulations, etc.

6.4 Reasons for Customers Paying for Your Product

- **For Passengers**: This product enhances the transportation experience by providing accurate and real-time information, allowing passengers to save time and adjust their schedules accordingly. Advanced booking features also allow passengers to plan their trips and calculate costs. Additionally, the system ensures passenger safety by monitoring anonymized health data of drivers and providing communication systems for emergency assistance.
- **For Public Transportation Agencies**：The system helps agencies allocate resources more efficiently by analysing passenger flow data and adjusting vehicle schedules accordingly. As a result, agencies can save costs and improve efficiency by optimizing scheduling and route planning. The reduction in operational and repair costs allows agencies to focus more on serving passengers and improving customer satisfaction. The system also significantly increases safety and security.
- **For Business Partnerships**: The system offers licensing opportunities for businesses to enhance their own services and efficiency with advanced technologies. Customization and integration of the system in existing infrastructure is possible, helping companies maintain their brand identity and competitive advantage. Data analytics tools provide valuable insights into passenger behaviours, route optimization, and performance evaluation, informing business strategies and decision-making processes. The flexible and scalable design of the system allows companies to expand their transportation services to meet changing or increasing demand.

7 Privacy and Trust

7.1 Protecting Consumers' Privacy

Privacy and cybersecurity gain significantly high priority in our Smart Public Transport Service System, and our team has seriously assessed potential issues and is committed to safeguarding customers' privacy against unauthorized surveillance, interception, and both intentional and unintentional disclosures. We will implement multiple approaches to ensure the highest level of data protection for our users.

7.1.1 Data anonymization and encryption

To ensure the confidentiality of users' data, it is crucial to introduce encryption and anonymization techniques for data in transit and in databases.

To ensure secure data transmission, the widely used RSA algorithm is employed for encryption, which relies on public key cryptography to prevent attacks such as eavesdropping, man-in-the-middle attacks, replay attacks, and spoofing. For data stored in databases, sensitive information such as users' Personal Identification Information (PII), account details, personal profiles, and financial information, if any, are encrypted using up-to-date and strong algorithms to prevent decryption and leakage in the event of a data breach. We understand the sensitivity of location information and the potential risks associated with its exposure. Therefore, we pledge to collect geographic location information solely for the purpose of calculating routes and solutions without recording or storing users' travel itinerary or geographic location information on our servers.

As the Smart Public Transport Service System needs many IoT devices to monitor and process transportation conditions and environmental data. This process involves generating, transmitting, and storing information, may including a growing volume of private information (e.g., PII) or sensitive content. In this context, data anonymisation techniques are widely used to prevent the inappropriate usage of the sensitive which help reduce the risk of re-identification and can be implemented to protect our consumers' privacy (Ni, Cang, Gope, & Min, 2022). The Figure 1 illustrates a basic IoT anonymisation evaluation framework.

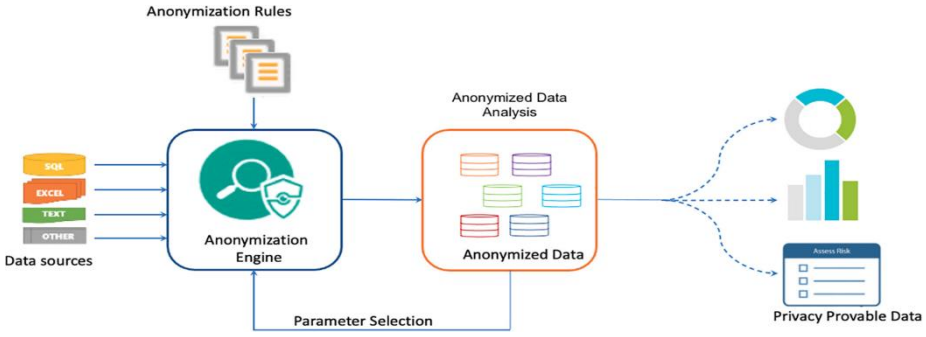

Figure 1 Data anonymisation framework (Ni, Cang, Gope, & Min, 2022).

Technically, according to research by Prasser, Eicher, Spengler, Bild, & Kuhn (2020), a combination of multiple transformation methods can be used to implement data anonymisation. These methods include sampling, aggregation, suppression, masking, categorisation, and generalisation. By utilising these approaches, the data in transit and in process can be effectively anonymised to ensure user privacy.

Figure 2 presented an example of anonymising a possible data model with random data in our system using a combination of transformation methods.

Bus No.	License plate number	Bus Max Load	Bus Current Load	Geographic Location	Speed (km/h)	Vehicle Identification Number (VIN)
1	XJ7-2M8	60	0	[-33.872428, 151.203774]	61	1GHJU23D45W678901
2	3TQ-D47	80	10	[-33.808197, 151.240688]	60	3ABYK49H68R512346
3	89B-KW6	60	4	[-33.912542, 151.176123]	0	2CJKL67R92T153084
4	YR5-1GH	50	2	[-33.863952, 151.278411]	30	9MVXZ81U45L706529
5	4FD-3PV	55	30	[-33.895524, 151.229318]	23	8QGHW47E33F958017
6	L2N-9J1	60	50	[-33.841660, 151.210982]	35	6PNKD39X12Y574830
7	S8C-6QE	65	0	[-33.887391, 151.198956]	40	4ERTY15U67V203951
8	0RZ-G52	70	12	[-33.825615, 151.267149]	5	7OLMJ28H95A169482
9	M15-XT3	65	21	[-33.919728, 151.224413]	15	5BVGZ42C83K048716
10	H9W-7D4	60	23	[-33.853317, 151.250854]	20	1ASDF76G58Q937205

Sampling Masking Categorization Categorization Generalisation Categorization Suppression

Bus No.	License plate number	Bus Max Load	Bus Current Load	Geographic Location	Speed (km/h)	Vehicle Identification Number (VIN)
1	***-2M8	[60, 70)	[0, 5)	[-33.87, 151.20]	[60, 80)	-
3	***-KW6	[60, 70)	[0, 5)	[-33.91, 151.18]	[0, 20)	-
5	***-3PV	[50, 60)	[30, ∞)	[-33.90, 151.22]	[20, 40)	-
7	***-6QE	[60, 70)	[0, 5)	[-33.89, 151.20]	[40, 60)	-
9	***-XT3	[60, 70)	[20, 30)	[-33.92, 151.22]	[0, 20)	-

Figure 2 Data Transformation Example.

7.1.2 Privacy-preserving data sharing techniques

The Smart Transportation Service System needs to handle large amounts of sensitive data including personal details, travel patterns, and location information. To protect the privacy of individuals' data while allowing for data analysis and sharing, we will apply some techniques.

7.1.3 Differential Privacy in Real-Time Monitoring of Passenger Flow

According to some research (LIU & LIU, 2021), differential privacy can be used to protect users' privacy when real-time passenger flow data is being collected by IoT cameras using computer vision technology. By adding controlled noise to generate aggregated results, our system can process and calculate passenger density without exposing individuals' details. For example, our system can use categorisation transformation technique mentioned above to share passenger density categories with city planning institutions instead of real passengers' identities or travel patterns.

7.1.4 Homomorphic Encryption in Real-Time Notifications to Passengers

According to the research (Lauter, Dai, & Laine, 2022), homomorphic encryption allows performing computation directly on encrypted data, which makes it possible to share and analyse data with privacy being maintained. In the context of our system, homomorphic encryption can analyse encrypted location information to determine whether a passenger has arrived at the destination or not. Once arrive, passengers will receive a notification without exposing sensitive location information throughout the entire process.

7.1.5 Clear privacy policies and user consent

Clear and comprehensive privacy policies are essential for privacy protection, as they not only fulfill legal compliance (e.g., General Data Protection Regulation (GDPR)), but also meet the ethical need to keep users well-informed about a system's data practice.
To create a clear and comprehensive privacy policy, many aspects of our system have been taken into consideration. **Table 1** outlines the details of these aspects.

Aspect	Explanation
Data Collection	Types of data collected, including anonymised personal information, anonymised location data, passenger flow data using differential privacy, and anonymised driver health data.
Data Usage	How data will be used, including improving our system's services, improving transportation services, providing real-time notifications, and conducting analysis and research using anonymised data.
Data Sharing	Circumstances where data may be shared with third party, including transportation providers, city planners, dispatch centres, and research institutions.
Data Retention	The Smart Transportation Service System is committed to retaining user data for necessary duration to meet the purposes mentioned above depending on types of data. PII: Retained for the duration of the user's account and deleted with 30 days of account deactivation. Location data: anonymised and aggregated data is stored for up to 30 days. Passenger flow data: anonymised and aggregated data is stored for up to 12 months. Driver health data: anonymised data is stored for up to 3 months.
User Rights	The rights users have related to their data, including access, rectify, delete, restrict processing data.

Table 1 Privacy Policy Aspects

By carefully considering these aspects and presenting them in a transparent manner, we can create a privacy policy that effectively communicates our system's data practices and achieve trust among users.

7.2 Achieving Consumers' Trust

7.2.1 Transparent AI algorithms and decision-making

We believe maintaining transparency in AI algorithm and decision-making process within a system is crucial for building users' trust. To fulfill the requirement for AI transparency, the following two aspects are important.

- **Openness and Being Explainable:** Our system which employs AI for various tasks, such as real-time monitoring of passenger flow, route optimization, driver health monitoring, and dispatch optimization. To ensure transparency, we provide documentation that clearly outlines the functionalities, accuracy, limitations, and potential biases of the models and algorithms used. When making decisions, such as in route optimization, users are informed of the factors considered in the AI decision-making process, such as congestion levels and travel estimates. We strive to maintain openness and explain ability to foster trust and confidence among users.
- **Ethical Guidance for AI**: We are committed to fair and responsible operation of AI models. For instance, in the case of real-time monitoring of driver health, we conduct regular audits of the AI algorithm to identify and mitigate any potential issues that could affect accuracy. By adhering to ethical guidelines in AI implementation, we believe we can build trust with users and uphold our responsibility to operate in a fair and ethical manner.

7.2.2 User-friendly interfaces and interactions

A system cannot be easily accessed and utilized if it does not provide user-friendly interfaces and interactions, even though it employs many up-to-date technologies. In Smart Transportation Service System, we employ many approaches to provide users with user-friendly interfaces and interactions.

- Quick Navigation: Our system's user interface is designed with the focus on ease to use, allowing users to quickly access the specific service they need. We design a clean and straightforward layout, with a clean menu structure that enable users to easily find services such as route planner and current passenger flow condition.
- Data Visualisation: It is important to present complex data into digestible format for users. For instance, when displaying passenger flow data, we use visualisation such as heat map and graphs to present levels of passenger density in a station or on a bus. In this way, user experience will be enhanced.
- Adaptive Design: The application of our system, such as mobile client and PC client, should be compatible with different devices and various screen size because there are still so many people are using devices produces several years ago and our system is created for providing services for all citizens in this state or entire country. Therefore, to win trust from consumers via user-friendly interfaces, our applications should provide users with an optimal viewing experience regardless of the device they are using.

7.2.3 Ethical Consideration

When development and implementing our system, such ethical consideration is essential for ensuring the system is fair, responsible, and respectful of consumers' rights. To addressing this concern, we divided it into three subsections: Accuracy, Property, and Accessibility (Tavani, 2016).

7.2.4 Accuracy

To provide reliable services, it is essential to ensure the accuracy of the AI model and algorithm to achieve customers' trust in our system. First, we ensure that high quality dataset was provided to train our AI model after adequate validation and verification to ensure the source is accurate and reliable. Then, map and traffic data are regularly

reviewed and updated to ensure the accuracy of the functionalities of route optimisation and real-time notification. In addition, to achieve customers' trust, just as mentioned in previous section, we keep our AI model and algorithm transparent and being improved based on the users' feedback and ourselves' evaluations.

7.2.5 Property

We have recognised the importance of the property rights of users, stakeholders, and third parties and we do take it into consideration. First, we respect users' ownership of their data and offer them controls over their information and we have clear privacy policies and user consent just as we mentioned above. Secondly, we recognise and respect the intellectual property rights of our partners, stakeholders, and open-source intelligence, and we guarantee that we have appropriate licenses and permission of the copyrighted sources in our system.

7.2.6 Accessibility

We will try out best to ensure our system can be fairly accessed by all users, regardless of their abilities, nationalities, background, and status. We provide as many languages as we can to support people using different languages to help them utilize our services. Additionally, we provide accessibility features for the disabled, such as screen reader, speak-text input, adjustable font-size, and high contrast colour themes.

7.2.7 Reflection from individuals

Individual	Reflection	Recommendation
A	In our current proposal, I believe we have made considerable efforts to address privacy and trust concerns related to the use of Information Technology and systems. However, as technology continues to advance, new challenges and risks will inevitably emerge. As a group member, I think it's crucial for us to stay updated with the latest developments in data protection and privacy-preserving technologies, as well as any relevant legal or regulatory changes. We should also consider implementing regular audits and assessments to identify potential vulnerabilities or areas for improvement in our proposal, which will help us maintain a high level of trust and privacy protection for our users. Additionally, I think it's essential to prioritize user education and engagement, as a well-informed user base will be more likely to trust our system and its privacy measures. By investing in user education and maintaining an open dialogue with our user base, we can ensure that our proposal remains responsive to their needs and concerns, ultimately fostering a more	Regular privacy audits and assessments are crucial for identifying vulnerabilities in the information system, addressing weaknesses, and enhancing user trust and confidence by continually improving privacy and security measures.

	trusting and secure environment for all parties involved.	
B	As someone who values privacy and transparency, I think our proposal does a commendable job of addressing these concerns in relation to Information Technology and systems. However, I believe there is always room for improvement. For instance, we could provide more information about the AI algorithms and decision-making processes in our system, which would help users better understand how their data is used and build trust. We could also explore integrating additional privacy-preserving technologies, such as differential privacy or homomorphic encryption, to further enhance the security of our users' data. Furthermore, we should continue to involve various stakeholders, including privacy advocates and legal experts, to ensure that our proposal remains up-to-date and compliant with the latest privacy regulations and best practices. In doing so, we can foster a more trusting relationship between users and our system, while maintaining a strong commitment to privacy and security.	Educate users on privacy and security best practices by providing resources and guidelines that outline safe information system usage, alerting them about potential risks and threats. Increased user awareness and responsible behaviour foster trust and maintain a high level of privacy.
C	Data encryption is one of the most essential sections of privacy and trust set by our team. This is a very common way to protect information security, but its importance should not be underestimated. As a smart public transportation system, control of real-time passenger location information is a must. Not only do we need to use passenger location data to monitor station passenger density, but we also need to use passenger location data to give passengers a more user-friendly ride schedule service. If passengers' location information is leaked and used by unscrupulous elements, the consequences may even threaten passengers' personal safety. So, we must pay attention to this point and protect passengers' information data. And let us give passengers more control over their data so that they can cancel sharing data at any time so that we can gain more trust from our users. We can also help passengers address their trust and privacy concerns and ultimately create a more secure and user-centric system.	Giving users more control and autonomy over their information data, users have the right to know what information is going to be accessed by the system and what it will be used for. Users can choose to unshared their information data at any time.

D	While our proposal addresses privacy and trust concerns significantly, we must remember that maintaining the integrity of these aspects is an ongoing process. We need to be proactive in assessing the security of our system and updating our privacy policies to reflect the latest developments in technology and regulations. To accomplish this, we should consider implementing periodic reviews of our security measures, staying informed of regulatory changes, and collaborating with other experts in the field. Furthermore, as our system evolves, we should strive to maintain transparency in our decision-making processes, ensuring that users understand how their data is being used and protected. By continually assessing and refining our privacy and trust measures, we can ensure that our system remains secure and maintains the confidence of its users.	Establish a clear, transparent incident response plan outlining steps for security risks or data breaches, including impact mitigation and user support. Transparency instils user confidence in the system's ability to protect data and respond effectively to threats.
E	In our current proposal, we have made significant strides in addressing privacy and trust concerns. However, we must remember that user expectations, technology, and legal requirements are continually evolving. Considering this, we should consider incorporating more advanced privacy-preserving techniques such as differential privacy and federated learning into our system. Additionally, we should invest in user education to help our users understand the importance of privacy and trust in Information Technology systems. By providing resources and guidance on privacy best practices, we can empower users to make informed decisions about their data and bolster their trust in our system. Furthermore, we should maintain open lines of communication with our users and welcome their feedback, ensuring that we continue to address their concerns and expectations regarding privacy and trust.	Collaborate with external privacy and security experts to enhance the information security plan with advanced tools and independent audits. This expands the range of expertise and perspectives, ultimately improving the system's ability to protect user data and maintain trust.
F	In our information system, we have a real-time health monitoring program for all the bus drivers, which is a smart wearable device that monitors the health of drivers who are on duty 24/7. Improving the safety of bus company operations by reducing accidents caused by the physical condition of drivers. But this monitoring program involves personal information and privacy of drivers, and it	Respect the privacy principle when collecting data, handle drivers' personal information properly, and take privacy protection measures. Obtain legal authorization for data sharing, which must be explicitly authorized by the driver and in compliance with relevant laws and

	could be difficult to get all drivers' permission for this health monitoring. Drivers may have questions about the health information stewardship program, and that's all we're going to face. We need to invest time in introducing drivers to the reasons for health information collection and privacy protection. It is our duty to protect drivers' personal health information, they are also the users of this information system, we need to win their trust. Also, we need to invest money in smart wearable devices, we could cooperate with companies who already have these devices, but it might need us to share the data with them, which could also cause a data breach.	regulations, to share the driver's health information with other organizations.

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