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1. Introduction

Transit Pay is a card-based payment system designed to modernize and simplify the payment process for public transportation in Nepal. This innovative system eliminates the need for cash transactions and minimizes the risk of theft and robbery associated with carrying Cash. The Transit Pay system uses a card that stores passengers' information, including their sign-up details, travel history, and payment details. It allows passengers and transportation operators to enjoy a hassle-free journey.

The Transit Pay system has several advantages over traditional cash-based systems. Eliminating the need for Cash reduces the risk of human error and improves accuracy in the payment process. Passengers benefit from faster, more convenient transactions and reduced exposure to cash-carrying risks. It uses radio frequency to transfer data between the system and the card. As a result, customers do not need to use a cash-in transaction. It calculates bus fares based on the distance customers cover in a bus and the fuel cost per kilometer, and it allows a bus operator to add fixed profit to the system.

The implementation of Transit Pay involves some risks and challenges, such as hardware availability and resistance to changing from traditional cash-based systems. However, contingency plans have been implemented to mitigate these risks, which are described below in more detail.

In our country where 97% of transactions in Nepal were still conducted using cash especially in rural areas according to September 2021. Implementing the Transit Pay system in vehicle can bring a lot of benefits in my view. However, according to a report published by the Nepal Rastra Bank, the central bank of Nepal, in fiscal year 2019/20 (mid-July 2019 to mid-July 2020), the number of card transactions in Nepal increased by around 27% compared to the previous fiscal year. The COVID-19 pandemic has also accelerated the adoption of digital payments in Nepal, as people are avoiding physical contact and looking for safer payment options.

2. Problem Scenario

There are several problem scenarios that the Transit Pay system aims to solve. Some of the significant problems are listed below: -

i.   Cash payment in public transportation can be time-consuming and inconvenient.
ii.   Carrying Cash in public transportation can increase the risk of robbery and thief.
iii.   Foreigners may not be familiar with the local currency and may have difficulty paying.
iv.   Current payment of the system may lead to human error, inaccurate calculation, and no record keeping of transactions.
v.   Payment demanded by the bus conductor becomes mandatory for the customer.
vi.   The conductor can charge for service based on race, gender, or appearance, which promotes discrimination in public.
vii.   Conductors can miss the bus fees from customers when collecting from many people.
viii.   Hand-to-hand cash payment systems may lead to dangerous communicable diseases like Covid- 19, Ebola, Chickenpox, and many more.

3. Project As a Solution

The Transit Pay system will work as a solution to the various problems related to payment on buses. Using a card-based payment system instead of hand-to-hand Cash is more convenient and cost-effective. It makes the payment process faster, more convenient, and more cost-effective. Besides eliminating the risk of human error, the digital payment system also improves accuracy. It prevents drivers from carrying Cash, which reduces the risk of robbery and theft.

The cost of bus fares will be calculated per kilometer and fuel price basis, which means that every customer will be charged according to the fuel price and the distance they covered on the Bus. It makes tourists understand how Transit Pay works in Nepal, encouraging them to spend more to travel on local transportation. There is a database that stores all records of passengers using transportation, which even helps reduce crime rates. When a criminal uses public transport, investigators can determine their location at

a particular point in travel history. A bus can usually run on 1 liter of diesel for 3 to 5 kilometers, depending on the number of passengers. So then, each fare is calculated by the system using a Formula and i.e.

Bus Fare per Person = ((Distance x Fuel Cost per Kilometer) + (Fixed Profit)) * Number of Passengers

Where,

Distance = Distance covered by customer in Bus

Fuel = Cost of Fuel per Kilometer

Profit = Amount of money that the bus operator wants to add

Passengers = No. of Passenger

Overall, Transit Pay is a card-based payment system that offers a reliable and efficient solution for payment in public transportation, making it more convenient for passengers and improving the safety and efficiency of the system.

4. Aims

Transit Pay aims to provide a more efficient and convenient payment process for transportation where every Bus trip's fare is accurately calculated by IoT system and users need to sign up and verify their credentials to use the system.

5. Objectives

The objectives of Transit Pay that must be achieved to complete the project are listed below: -

i.   To provide a modern payment system that makes it efficient and convenient for customers.

ii.   To accurately calculate fares to customers on each trip.

iii.   To provide a secure and reliable payment system to customers.

iv.   To build a web application that allows a customer to verify their details to use the card.

v.   To build a prototype using IoT, which regulates the system.

6. Expected Outcome and Deliverables

The completion of the Transit Pay system would make it possible to achieve the different tasks, some of which are listed below: -

i.   Improved payment process: The card-based payment system makes the payment process fast and convenient for passengers.

ii.   Cashless Transaction: Using a card will reduce the need for the conductor to handle Cash, which also helps to minimize the risk of robbery and theft.

- Scanning cards on the system will store the location and user details in the database, which the admin can see as a travel log.

iii. Accuracy: It helps to eliminate human errors and improve the accuracy of every customer's fare calculation.

iv.   Cost-effectiveness: Fare calculation based on fuel price and distance the customer covers lead to more cost-effectiveness for the passengers.

v.   Increase tourism: The introduction of Transit pay will make local transportation more attractive to tourists, which will help to increase revenue.

vi.   Prototype development: A prototype will be developed using IoT to demonstrate a modern payment system in transportation.

vii. Web – application: Transit Pay website will be developed where users must sign up and verify their credentials. Then a card will work on a prototype, and a customer can see the Transaction history.

7. Project Risks, Threats, and Contingency Plan

There are pros and cons to everything, and Transit Pay also has some risks and threats, and they are: -

i.   Transit systems may lead to technical challenges during a developing and implementing process, such as system failure, bugs, and many more.
ii.   Hackers could sell customer information if they find a vulnerable point to attacks.
iii.   Some customers may prefer using Cash for transactions which could limit the Transit Pay system.
iv.   A competitor may emerge with an advanced payment system, resulting in less use of Transit Pay.
v.   There may be challenges when repairing equipment or replacing the system.

Following are some of the contingency plans that can be implemented to prevent and minimize the above risks: -

i.   Backup hardware should be purchased for the smooth functioning of the system.
ii.   Regular system backups should be performed to prevent data loss and customer information and security measures will be implemented to protect our customers' sensitive information, including encryption, password protection, and firewalls.
iii.   Awareness and benefits about system will be done which promotes the system rather then a cash transaction.
iv.   Proper research should be done about the price of fuel to update the system for accurate bus fares different version will be released.
v.   Maintenance and checks should be performed on all system components to prevent unexpected system failures.

8. Methodology

The Rational Unified Process (RUP) is a software engineering process that provides a disciplined approach to assigning tasks and responsibilities within a development organization, with the goal of producing high-quality software that meets the needs of end-users within a predictable schedule and budget. RUP activities create and maintain models, rather than focusing on the production of large amounts of paper documents. In addition, it emphasizes the development and maintenance of semantically rich representations of the software system under development. (Kruchten, 1999) For the development of this project, I have decided to follow the Rational Unified Process (RUP) methodology. This methodology categorizes into four steps which are described below with figure (testbytes, 2019): -
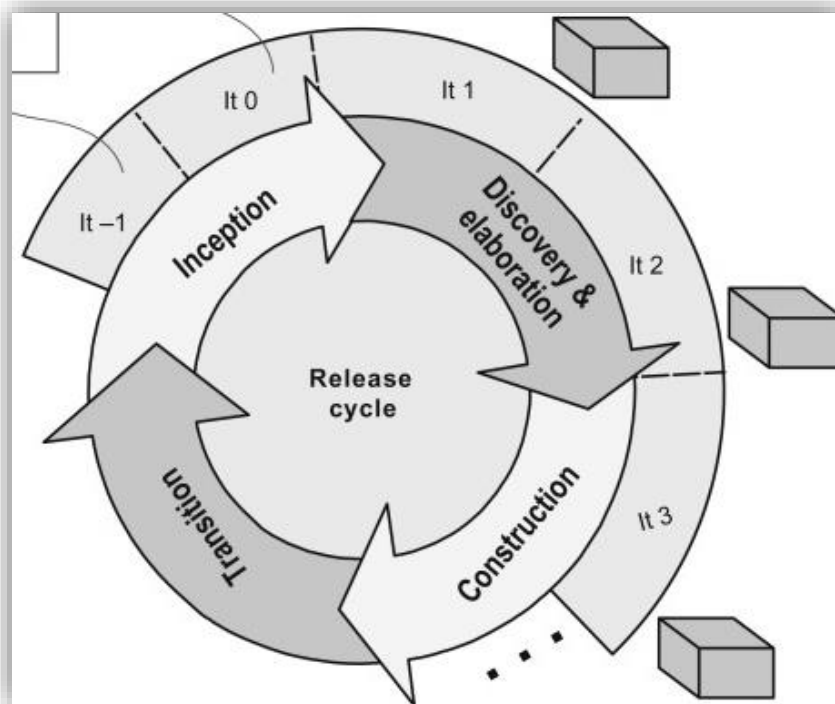

Figure 1 Diagram of Rational Unified Process

8.1   Inception

This is the first stage of this methodology, where the project idea is initiated. It mainly focuses on defining the project's scope, estimating its schedule and cost, and evaluating its feasibility. Also, this phase aims to identify the critical use cases that will drive the system's functionality and help establish at least one candidate architecture. (Castilla, 2014) Some of the Inception phases for this project are listed below:

i.   By analyzing the market, technology, and resources, determine whether the project is feasible.

ii.   Discussion about development and documentation procedures with the supervisor/s.

iii.   Develop an estimate of the project's cost and schedule. Identify the risks and potential issues that may arise during the development process.

iv.   Determination of hardware and software requirements.

8.2   Elaboration

The Elaboration Phase is the second phase of the software development life cycle. Its main goal is to establish, validate, and baseline the architecture, address significant risks, and evolve the project plan. During this phase, it is crucial to understand the critical requirements to ensure that they have been covered in the architecture. (Castilla, 2014) Some of the Elaboration phases for this project are listed below:

i.   Hardware and software time and cost estimates should be reevaluated.

ii.   Finalizing the circuit diagrams for the transit pay of IoT components.

iii.   Design and develop essential diagrams for development, such as UML and ER diagrams.

iv.   Document the project proposal Identify potential risks during development.

8.3   Construction

The Construction Phase is the third phase of the software development life cycle. The main goal is to complete the requirements, expand the design, develop the rest of the components and features, test them, and integrate them with the rest of the application. (Castilla, 2014) Some of the Construction phases for this project are listed below:

i.   Creating an operational manual and a user manual for the system.

ii.   The results and progress of the project must be documented.

iii. The system should be tested and kept backup in case of any errors.

iv.   Ensure that the system is built according to the specifications and requirements.

8.4   Transition

The Transition Phase is the final phase of the software development life cycle, where the main goal is to deploy the software to the user community when the software has reached an acceptable level of quality. (Castilla, 2014) Some of the Transition phases for this project are listed below:

i.   Deploy the software to the user community when the software has reached an acceptable level of quality and user documentation has been prepared.

ii.   Carrying out beta testing to validate that the product meets users' expectations and making corrections and enhancements to ensure high performance and usability.

iii. Training users and maintenance people and evaluating the deployed version against the product's vision and acceptance criteria.

iv.   Addressing issues that may emerge during this phase may require future product evolutions.

9. Resource Requirements

➢ The basic resources which are needed to complete this project are as below: -

9.1   Hardware Requirement

❖ Arduino Uno

❖ RFID Module

❖ Jumper Wires

❖ Node MCU

❖ GPS Module

9.2   Software Requirement

❖ Text Editor: VS-Code

❖ Frontend: HTML, CSS, JavaScript OR ReactJS

❖ Backend: NodeJS

❖ Database: Postgres or MySQL

❖ Version Control: GitHub

❖ Circuit Design: Filecroco

10.   Project Gantt Chart

A Gantt chart, commonly used in project management, is one of the most popular and useful ways of showing activities (tasks or events) displayed against time. On the left of the chart is a list of activities and along the top is a suitable time scale. Each activity is represented by a bar; the position and length of the bar reflect the start date, duration, and end date of the activity. (Gantt, 2023) Gantt chart for the Transit Pay system is below:
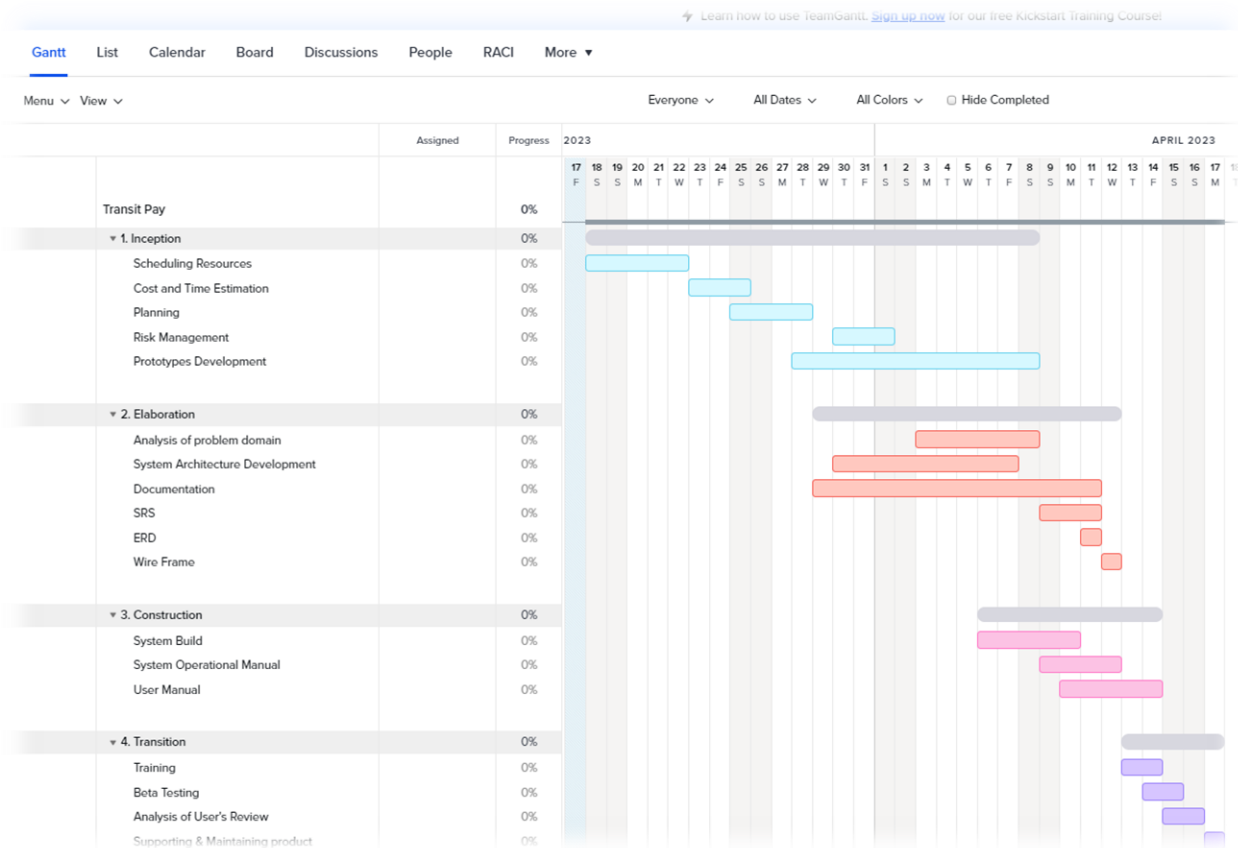

Figure 2 Figure of Gantt Chart

11.   Conclusion

The Transit Pay system is a smart alternative to traditional bus payment systems that will lead the country to an advanced payment system. It aims to provide an efficient and cost-effective payment system using a card-based system to eliminate the use of a hand-to-hand cash payment system.

It has become common for most countries to have a system like a Transit pay system. This system has many benefits, such as reducing the risk of theft and human error and increasing accuracy in fare calculation. A centralized database of passenger records provided by Transit Pay can assist in reducing crime rates and providing better transportation services. Contingency plans can minimize the risks and threats associated with this project. Overall, Transit Pay has the potential to revolutionize public transportation in Nepal, making it more accessible and convenient for passengers.

12.   References

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