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Department of Computer Science

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Spring 22 23

Digital payment system with QR code technology for public transportation in Dhaka

Software Requirement Engineering

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Project submitted

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1. PROBLEM DOMAIN

1.1 Background to the Problem

Dhaka is probably one of the very few megacities in the world without any proper design or guideline for the operation and expansion of its public transport system.There are 11,060 buses and 8,583 mini buses. Out of 160 bus routes 140 routes are operational of which 88% of the routes are being operated by 137 bus companies.Approximately 21 million people commute every day by different types of public transportations and the most used mode is the bus. 44.7 percent of the daily trips are mainly related to work while 17.7 percent are related to school by bus. We can imagine the total extra revenue from the number. So from the numbers we can assure that a huge number of people who uses Bus as their daily travel medium will be benefited by using a proper digital payment QR code system.

1.2 Solution to the Problem

The current payment system for buses in Dhaka, Bangladesh is based on cash, with passengers paying 2.15 taka per kilometer for long-haul buses and minibuses. However, due to the conductors' inability to provide change, passengers often end up paying more than the actual fare. This creates a significant problem for passengers and leads to extra expenses. To address this issue, implementing a digital payment system with QR code technology can provide a more convenient and efficient payment method for passengers. With QR code payments, passengers can easily pay their fares without worrying about carrying cash or finding exact change. This system will not only benefit passengers but also make operations more streamlined and efficient for bus operators. A digital payment system with QR code technology will significantly improve the overall transportation system in Dhaka and provide a better commuting experience for the 21 million people who use public transportation every day.

2. SOLUTION DESCRIPTION

2.1 System Features

1. QR Code Reader: The system will include a QR code reader that can read the QR codes generated by the passengers' payment apps or payment cards.
2. Payment Gateway: The system will have a payment gateway that will process the payments made by the passengers.
3. Mobile Application: Passengers can download the mobile application of the payment system to generate their QR codes or make payments.

4. Card Payment: The system will also support payment cards that are enabled with QR codes, providing an alternative payment option for passengers.
5. Fare Calculation: The system will calculate the fares based on the distance traveled by the passengers and the type of bus.
6. Real-time Tracking: The system will enable real-time tracking of buses, which can be viewed by passengers on their mobile application or web portal.
7. Bus Operator Dashboard: Bus operators will have access to a dashboard that will show them the payment transaction details, passenger volume, and other important data.
8. Payment Reports: The system will generate payment reports that can be used by bus operators and authorities for analysis and decision-making.
9. Data Security: The system will ensure the security of the passengers' payment data and prevent any unauthorized access.
10. Integration with other Systems: The system will be designed to integrate with other transportation systems, such as bus scheduling and route optimization software.

2.2 UML Diagrams

1. **Use Case Diagram:**

Actors	System
Passenger	Generate QR Code
	Scan QR Code
Bus Operator	View Transaction Details
Payment Gateway	Process Payment

2. **Activity Diagram:**

Activity	Action
Open Payment Application	Passenger opens the payment app
Select Bus Fare Payment	Passenger selects the bus fare payment option
Scan QR Code	Passenger scans the QR code displayed by the bus operator
Payment Accepted?	System checks if payment is accepted
Process Payment	If payment is accepted, the system processes the payment
Cancel Payment	If payment is not accepted, the system cancels the payment
Display Payment Confirmation	System displays payment confirmation to passenger

3. ER Diagram

Entity		Attributes	Relationships
Passenger		id:int name: string phoneNumber: string	Payment
Payment		id:int amount: float transactionDate: date	Passenger BusOperator PaymentGateway
BusOperator		id:int name: string busNumber: string	BusRoute Payment
BusRoute		id:int routeName: string	BusOperator Bus
Bus		id:int busNumber: string busType: string	BusRoute
PaymentGateway		id:int name: string url:string	Payment

3. Social Impact

Suppose if any person travels 4 kilometers in Dhaka by bus the person has to pay 8.8 taka as a fare. But unfortunately, that person has to pay more than that fare as the conductors most of the time unable to give back changes. So as a result, a vast number of people are paying extra money just for not having any appropriate payment system. This is not only an inconvenience for the passengers but also creates opportunities for dishonest conductors to take advantage of the situation. However, with the help of a digital payment method with QR code technology, we can easily solve this problem. The digital payment system will eliminate the need for cash transactions, and passengers can pay their fare using a mobile app linked to their bank account or mobile wallet. This will not only ensure that passengers pay the correct fare but also promote transparency and reduce the possibility of corruption. Moreover, the digital payment system will be more convenient for passengers who won't have to worry about carrying the exact change or being overcharged by dishonest conductors.Also Here are other few ways in which it can affect society:

1. Convenience: The current cash-based payment system for public transport can be inconvenient, especially when passengers don't have the exact change. A digital QR code payment system can eliminate this inconvenience, making it easier for passengers to pay their fare.

2. Financial inclusion: Many people in Bangladesh do not have access to formal banking systems. A QR code payment system can be linked to a mobile wallet, allowing passengers to pay their fare digitally without needing a bank account. This can promote financial inclusion and help bring more people into the formal economy.

3. Transparency: A digital payment system can bring more transparency to the public transport sector. By recording all transactions digitally, it becomes easier to track revenue and reduce the possibility of corruption.

4. Improved safety: With fewer cash transactions taking place on buses, the risk of theft and robbery is reduced, making the public transport system safer for both passengers and drivers.

5. Environmental impact: By encouraging more people to use public transport, the digital payment system can have a positive impact on the environment by reducing the number of private vehicles on the road and decreasing air pollution.

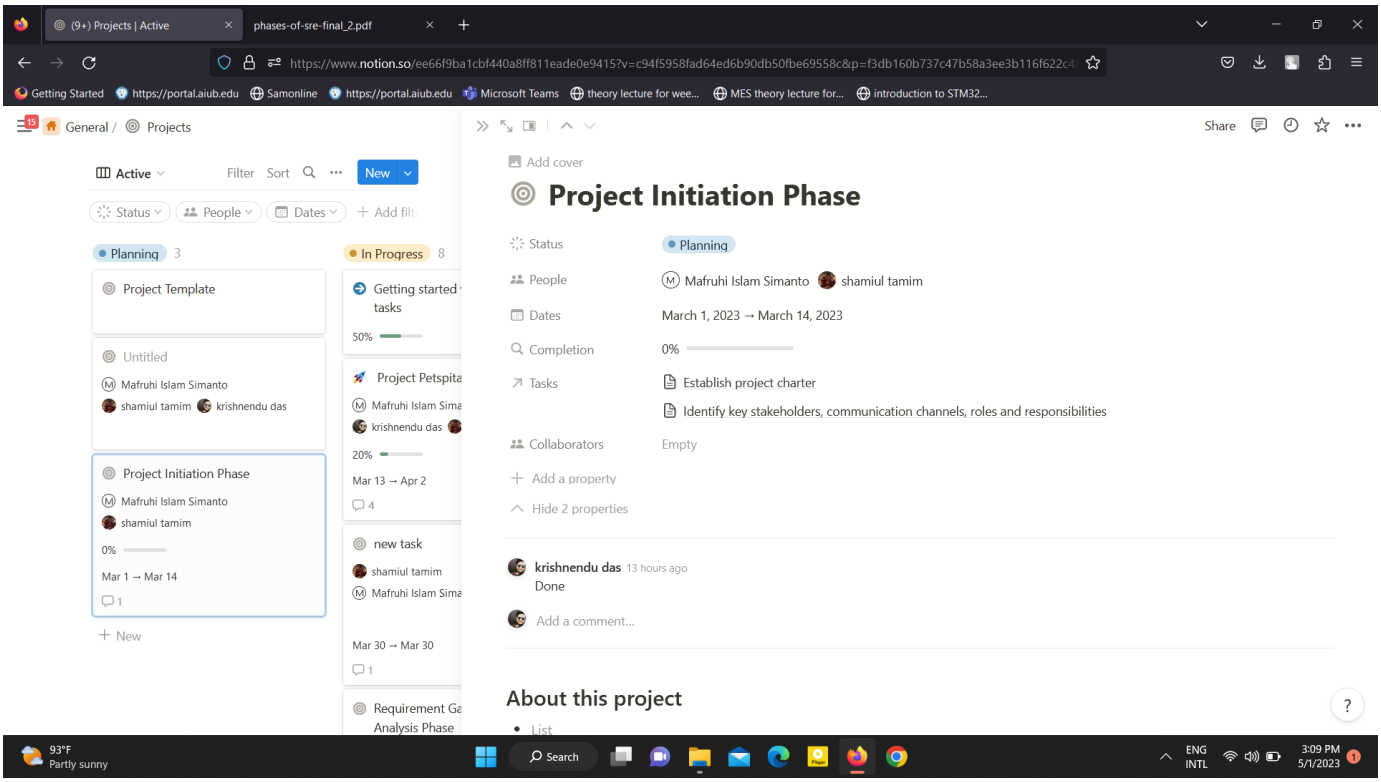
Overall, the proposed digital QR code payment system has the potential to make public transport in Dhaka more efficient, convenient, and accessible to a wider range of people. It can also bring greater transparency and safety to the sector, while also having a positive impact on the environment.

4. Development Plan with Project Schedule

For more efficiency we'll be using a PM tool name **Notion** .Here are the detailed development plan with a project schedule for implementing the digital payment system with QR code technology for public transportation in Dhaka:

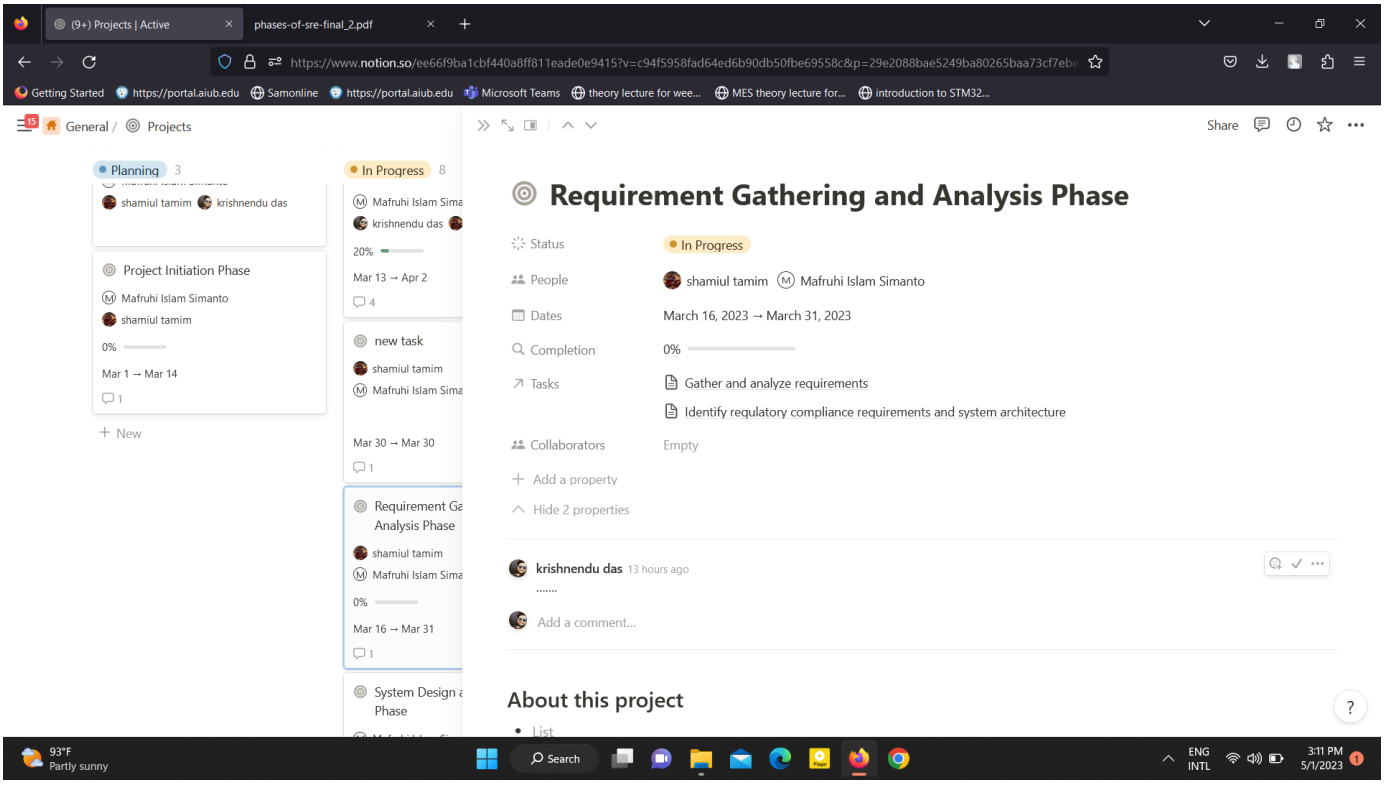
Phase 1: Project Initiation Phase (Week 1-2)

During this phase, the project team will initiate the project and establish the project charter, which will include the project goals, scope, objectives, deliverables, timelines, and budget. The team will also identify key stakeholders, establish communication channels, and define roles and responsibilities.



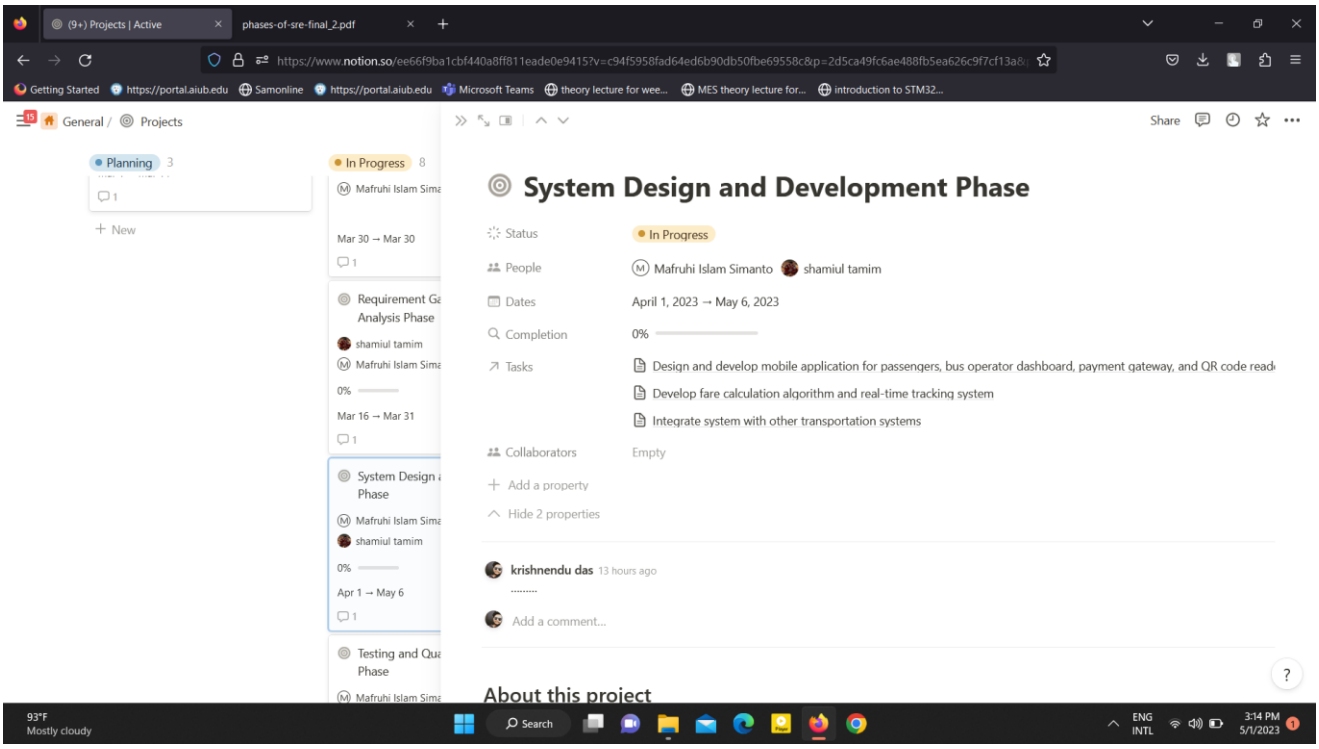
Phase 2: Requirement Gathering and Analysis Phase (Week 3-4)

In this phase, the team will gather and analyze the requirements for the digital payment system. The team will identify the different stakeholders and their requirements, including passengers, bus operators, and regulatory authorities. The team will also identify any regulatory compliance requirements and define the system architecture, including hardware and software requirements.



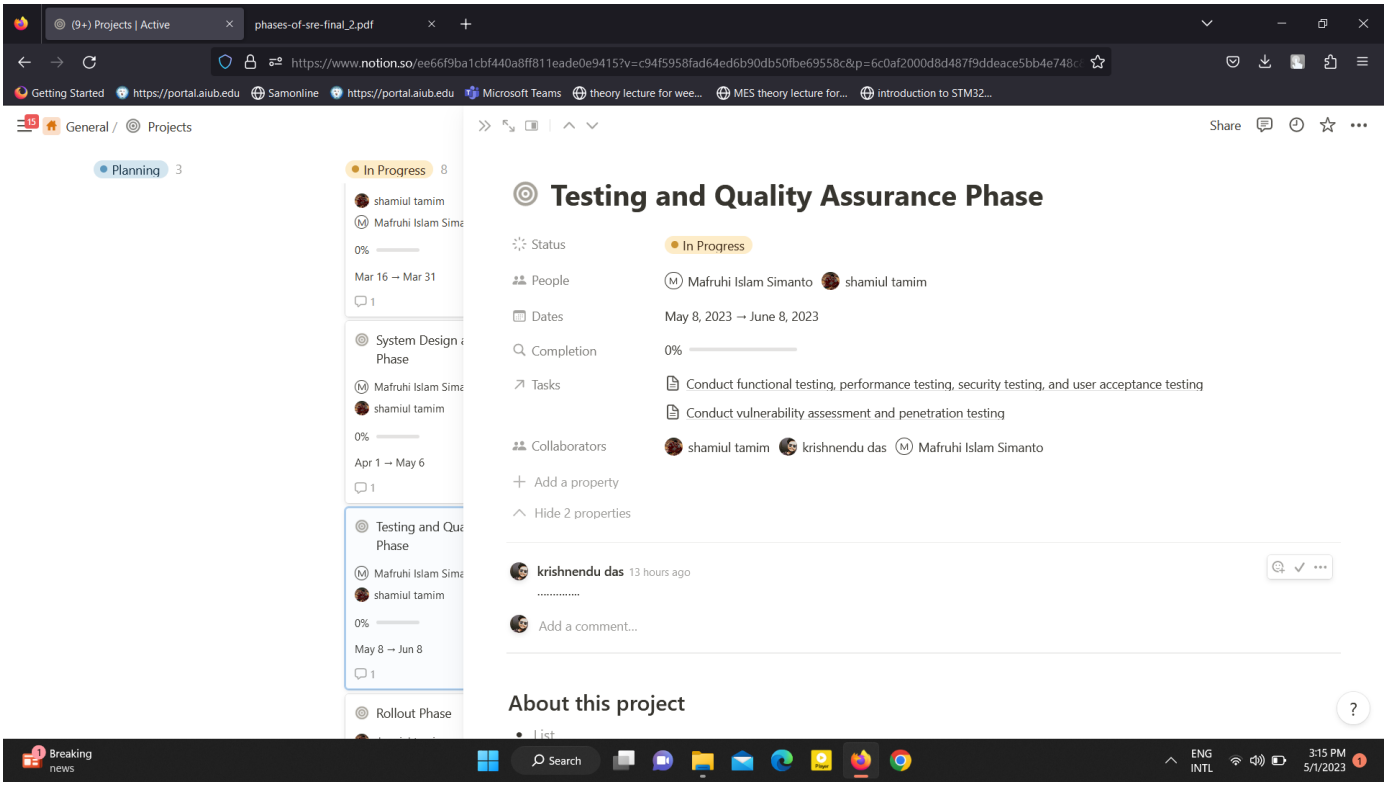
Phase 3: System Design and Development Phase (Week 5-12)

In this phase, the team will design and develop the digital payment system. This will include developing the mobile application for passengers, the bus operator dashboard, the payment gateway, and the QR code reader. The team will also develop the fare calculation algorithm and the real-time tracking system. The system will be designed to integrate with other transportation systems, such as bus scheduling and route optimization software.



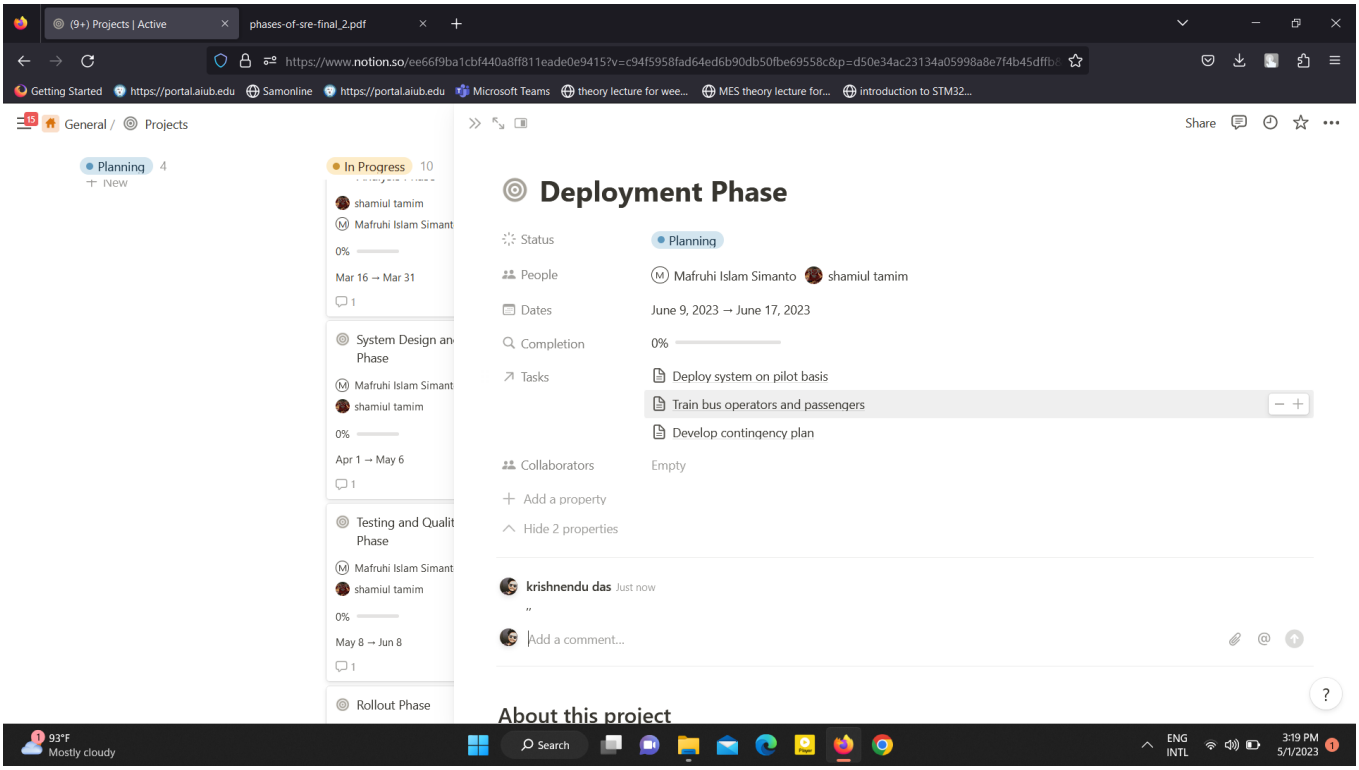
Phase 4: Testing and Quality Assurance Phase (Week 13-16)

During this phase, the team will test the digital payment system to ensure that it meets the requirements and works as intended. The testing will include functional testing, performance testing, security testing, and user acceptance testing. The team will also conduct a vulnerability assessment and penetration testing to ensure the security of the system.



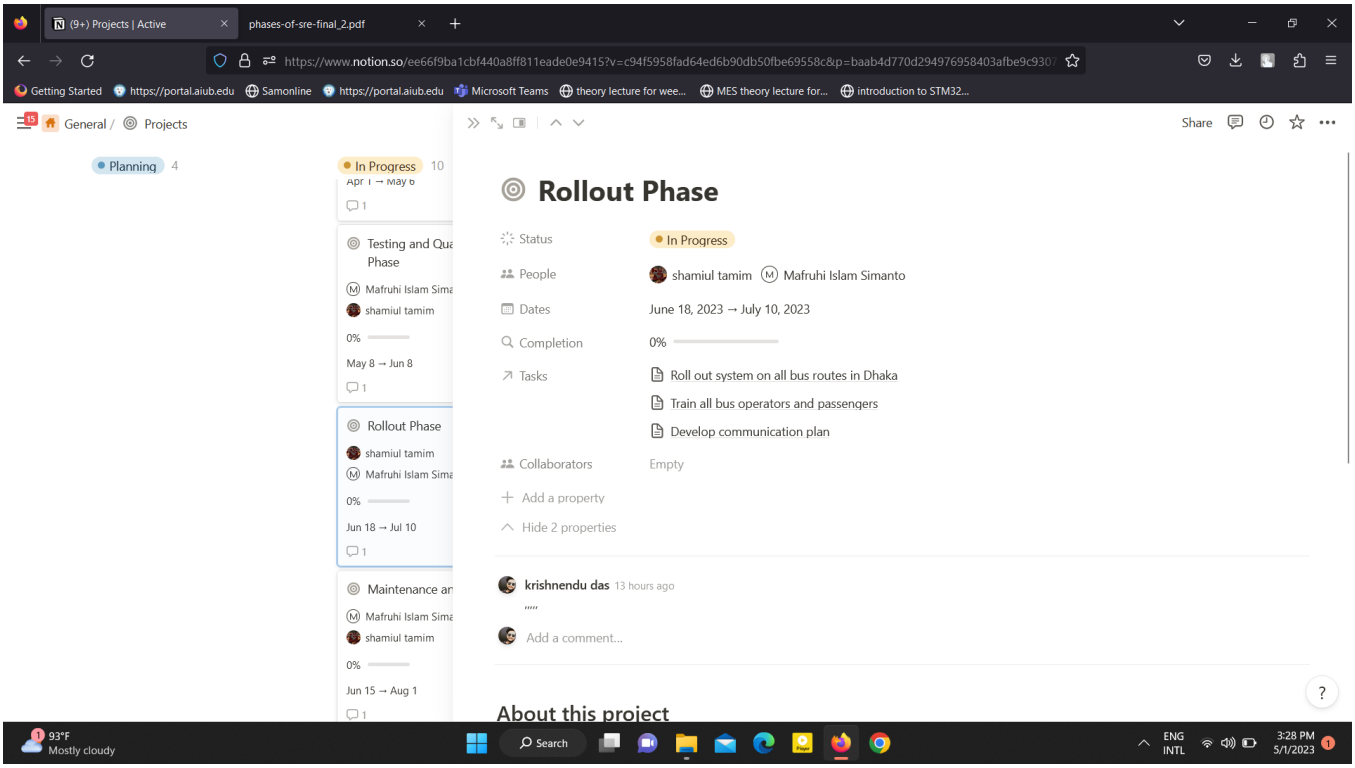
Phase 5: Deployment Phase (Week 17-18)

In this phase, the team will deploy the digital payment system on a pilot basis on selected bus routes. The team will train the bus operators and passengers on how to use the system, and the team will monitor the system's performance during the pilot phase. The team will also develop a contingency plan to address any issues that may arise during the pilot phase.



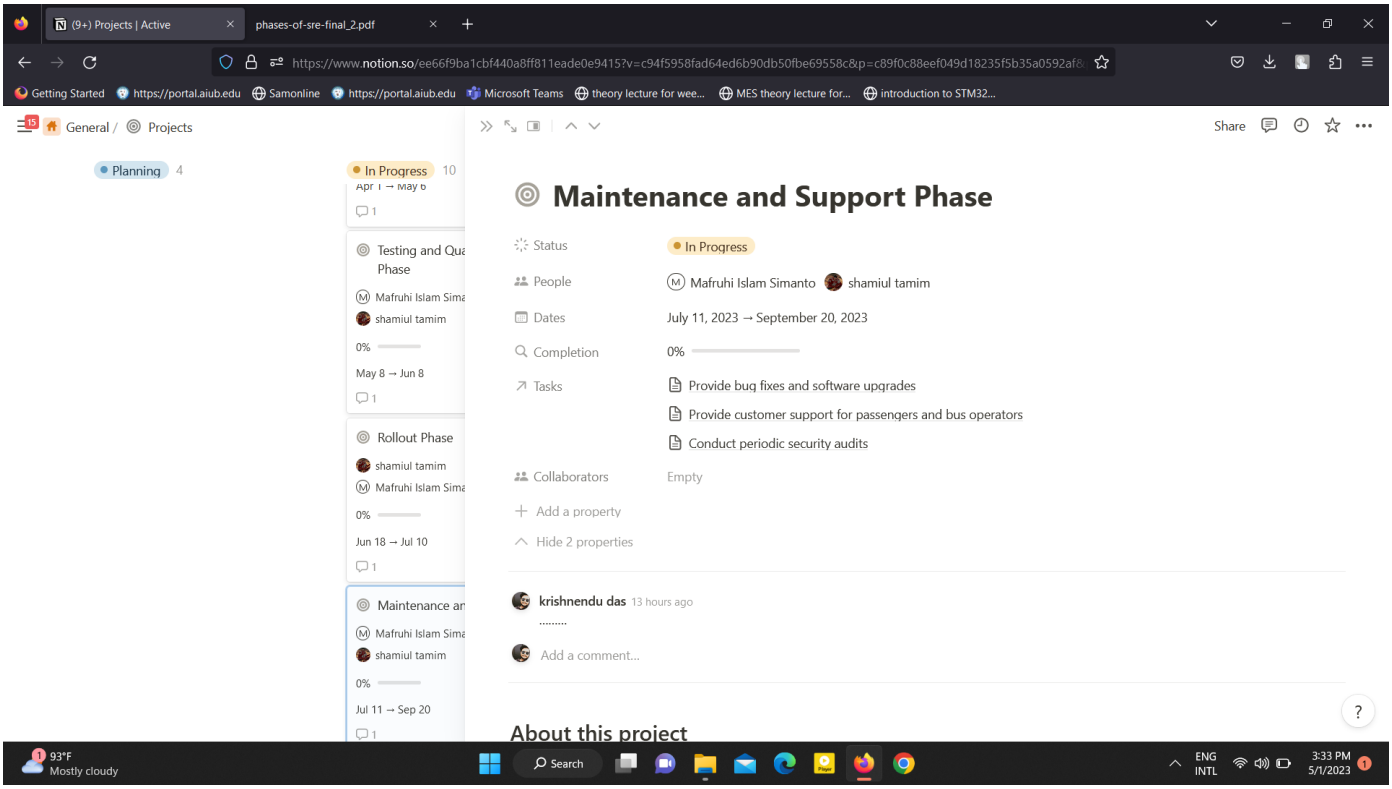
Phase 6: Rollout Phase (Week 19-24)

After successful completion of the pilot phase, the team will roll out the digital payment system on all bus routes in Dhaka. The team will train all bus operators and passengers on how to use the system, and the team will monitor the system's performance during the rollout phase. The team will also develop a communication plan to inform all stakeholders about the new payment system.



Phase 7: Maintenance and Support Phase (Week 25-52)

During this phase, the team will provide maintenance and support for the digital payment system. This will include bug fixes, software upgrades, and customer support for passengers and bus operators. The team will also conduct periodic security audits to ensure the security of the system.



Overall, the project is expected to take approximately 52 weeks to complete, with the bulk of the development work taking place in the System Design and Development Phase. The project will require a dedicated team of developers, testers, project managers, and other stakeholders to ensure its success.

5. Marketing Plan

Short-term Plan (1-3 Months):

1. Social Media Marketing: We will create social media pages on Facebook, Instagram, and Twitter to create awareness about the digital payment QR code system for bus fares in Dhaka, Bangladesh. We will run paid ads on these platforms to reach out to a wider audience.

2. Local Newspaper Advertisement: We will advertise in local newspapers to target people who are not active on social media. The ad will include a brief explanation of the system and how it can benefit the passengers.

3. Public Awareness Campaign: We will launch a public awareness campaign to educate people about the benefits of using the digital payment system. We will distribute pamphlets and hold small events at bus stations to demonstrate how the system works.

Long-term Plan (6-12 Months):

1. Collaborate with Transport Companies: We will collaborate with transport companies to integrate the digital payment system into their buses. This will help in increasing the usage of the system and make it more accessible to the passengers.

2. Tie-up with Banks and Payment Gateways: We will tie-up with banks and payment gateways to make the payment process more secure and convenient for the passengers. This will also help in increasing the credibility of the system.

3. Loyalty Programs: We will introduce loyalty programs to encourage passengers to use the system more frequently. This will include discounts, cashback, and other rewards.

Continuous Plan:

1. Customer Support: We will provide 24/7 customer support to address any queries or issues faced by the passengers while using the system. This will help in building trust and loyalty among the users.

2. Continuous Improvement: We will continuously gather feedback from the users and make improvements to the system to enhance the user experience.

3. Partnership with NGOs: We will partner with NGOs working in the transportation sector to create awareness about the system among marginalized communities. This will help in promoting financial inclusion and reducing the dependency on cash transactions.

6. Cost and Profit Analysis

To analyse cost and profit, we used COCOMO model

From the development plan and project scheduling, we can estimate Kilo Lines of Code (KLOC) for each task:

Phase 1: Project Initiation Phase
Task 1: Establish project charter (1 week) - 1 KLOC
Task 2: Identify key stakeholders, communication channels, roles and responsibilities (1 week) - 2 KLOC
Total KLOC for Phase 1: 3 KLOC

Phase 2: Requirement Gathering and Analysis Phase
Task 1: Gather and analyze requirements (2 weeks) - 5 KLOC
Task 2: Identify regulatory compliance requirements and system architecture (2 weeks) - 3 KLOC
Total KLOC for Phase 2: 8 KLOC

Phase 3: System Design and Development Phase
Task 1: Design and develop mobile application for passengers, bus operator dashboard, payment gateway, and QR code reader (4 weeks) - 40 KLOC
Task 2: Develop fare calculation algorithm and real-time tracking system (4 weeks) - 30 KLOC
Task 3: Integrate system with other transportation systems (4 weeks) - 20 KLOC
Total KLOC for Phase 3: 90 KLOC

Phase 4: Testing and Quality Assurance Phase
Task 1: Conduct functional testing, performance testing, security testing, and user acceptance testing (4 weeks) - 10 KLOC
Task 2: Conduct vulnerability assessment and penetration testing (2 weeks) - 5 KLOC
Total KLOC for Phase 4: 15 KLOC

Phase 5: Deployment Phase
Task 1: Deploy system on pilot basis (2 weeks) - 3 KLOC

Task 2: Train bus operators and passengers (1 week) - 2 KLOC
Task 3: Develop contingency plan (1 week) - 3 KLOC
Total KLOC for Phase 5: 8 KLOC

Phase 6: Rollout Phase
Task 1: Roll out system on all bus routes in Dhaka (6 weeks) - 100 KLOC
Task 2: Train all bus operators and passengers (2 weeks) - 5 KLOC
Task 3: Develop communication plan (2 weeks) - 3 KLOC
Total KLOC for Phase 6: 108 KLOC

Phase 7: Maintenance and Support Phase
Task 1: Provide bug fixes and software upgrades (ongoing throughout phase) - 100 KLOC
Task 2: Provide customer support for passengers and bus operators (ongoing throughout phase) - 20 KLOC
Task 3: Conduct periodic security audits (every 3 months) - 3 KLOC
Total KLOC for Phase 7: 123 KLOC
Total KLOC for the project = 3 + 8 + 90 + 15 + 8 + 108 + 123 = 355 KLOC

Using the given Total KLOC of 355 and COCOMO parameters, we can calculate the effort and cost required for the project as follows:

E = a(KLOC)^b
Taking a = 2.4, b = 1.05 (for the Organic mode), we have:
E = 2.4(355)^1.05 = 298 person-months (PM)
Now, let's assume an average salary and other incentives of 50,000 BDT per PM, then the Labor cost of the project would be:
Labor cost = Effort * Average Salary
= 298 * 50,000
= 14,900,000 BDT

System and maintainance cost = 9000*100 = 900,000 BDT

Now for revenue,
Assuming that the system is deployed on 100 buses in Dhaka, the revenue can be calculated as follows:
According to a report published by the Bangladesh Road Transport Authority (BRTA) in 2019, the average route length for buses in Dhaka was around 20 kilometers.

So Fare per trip would be (20 *2.15) = 43 BDT per person

For each buses have 45 seats,
Revenue = Number of trips per day * Fare per trip * Number of days per month
Number of trips per day = 100 * 4= 400
Revenue = 400 * 45 * 43 * 30
BDTRevenue = 23,220,000 BDT
Finally, we can calculate the profit as:
Profit = Revenue - Total cost
Profit = 23,220,000 – (14,900,000+900,000)
Profit = 7,420,000 BDT
So, the estiated profit of our project would be 7,420,000 BDT per month.

7. Reference

Public-Bus-Fare-of-Dhaka-Metro - বাংলাদেশ সড়ক পরিবহন কর্তৃপক্ষ-গণপ্রজাতন্ত্রী বাংলাদেশ সরকার (brta.gov.bd)

Bus fare reduced by 5 paisa per km | The Daily Star

BANGLADESH Bangladesh government launches 'digital bus' service with free 'Wi-Fi' for all (asianews.it)