**Cost-Benefit Analysis of NTU Ride Pilot**

**1. Introduction**

As a Real-Time Bus ID Verification and Tracking System the NTU Ride Pilot functions to enhance NTU University’s transportation system effectiveness combined with improved security protocols and user accessibility. This Cost-Benefit Analysis (CBA) conducts financial evaluation by aligning development expenses with operational costs against future benefits.

**2. Cost Analysis**

**2.1 Development Costs**

**A. Hardware Costs (One-Time Costs for One Bus)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Cost (RS)** | **Quantity** | **Total Cost (RS)** |
| RFID Device | 1200 | 1 | 1200 |
| Student Cards | 40 | 50 | 2000 |
| Connector | 150 | 1 | 150 |
| **Total Hardware Cost** | 3350 |  | 3350 |

**B. Software Costs**

* **Mapbox (Live Tracking)** serves the company with free assistance under its Free Tier program.
* The free plan of Firebase Database Management operates currently at no expense.
* Future Cost Considerations:
  + The added number of buses at NTU could require purchasing paid plans from Mapbox and Firebase.

**2.2 Operational & Maintenance Costs (Recurring Costs)**

The project currently uses a free-tier structure but operational expenses alongside maintenance costs constitute the recurring expenses for the future. There are no ongoing expenses since the project development occurs under free-tier conditions. However, potential future costs include:

* **The project may require costs for Firebase Paid Plan data storage and database services.**
* **Future web-based expansion of the system by NTU will incur both domain and hosting fees.**
* **The project will require expenses for both system upgrades and security patches together with future enhancement and support costs.**

**3. Benefit Analysis**

**3.1 Tangible Benefits (Measurable & Quantifiable)**

1. **Reduction in Unauthorized Bus Access:**

RFID technology removes the possibility of unauthorized bus access.

1. **Enhanced Security:**

The current tracking system blocks unauthorized route changes and unauthorized stopovers.

1. **Time Efficiency:**

Automated card checker technology reduces the time needed for students to join the system.

1. **Real-time Location Tracking:**

Customers together with administrative staff can monitor buses online and minimize waiting at bus stops.

1. **Complaint Management Efficiency:**

The digital complaint platform diminishes the time needed for resolution while guaranteeing better customer service.

1. **Better Fleet Management:**

Through live monitoring admins gain better control over their bus routes which allows them to improve route scheduling according to current use levels.

1. **Scalability:**

The method extends to multiple buses through basic software upgrades.

**3.2 Intangible Benefits (Non-Measurable, but Valuable)**

1. **Improved Student Satisfaction:**

Real-time tracking combined with efficient student onboarding systems produce superior user satisfaction.

1. **Increased Trust in University Transport System:**

Students along with parents achieve better peace of mind when they have verified access to the bus system.

1. **Administrative Convenience:**

The implementation of digital systems provides two main benefits: it decreases physical documentation while ensuring precise information recording.

1. **Eco-Friendly:**

Efficient route management through the system helps reduce emissions and fuel consumption.

1. **Reputation & Branding:**

The institution stands ahead as a pioneer through its adoption of modern transportation systems.

**4. Cost-Benefit Comparison**

The investment of **RS. 3,350 per bus** together with expected future expenses for cloud services produces substantial advantages over expenditure levels.

**Comparison Table**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Cost Type | |  |  | | --- | --- | |  | Estimated Cost (RS) | | Benefit Value |
| **One-Time Hardware Cost** | 3350 | Long-term security & tracking improvements |
| **Software (Mapbox & Fir ebase)** | 0 (Free Tier) | Real-time location tracking, database management |
| **Potential Future Costs** | |  |  | | --- | --- | |  | Variable (depending on NTU’s expansion) | | Scalable and adaptable transport system |
| **Total Benefits** | |  |  | | --- | --- | |  | Significant reduction in unauthorized travel, time savings, improved safety | |

**Return on Investment (ROI) Calculation**

Since there are no ongoing major expenses in the project we can consider its ROI as exceptionally high. Better transportation management occurs because of enhanced efficiency along with increased security and service quality which creates the project's actual return.

**5. Conclusion & Recommendations**

**5.1 Summary**

The Ride Pilot system implemented by NTU University provides both financial value and extensive advantages for the institution’s transportation management system. A single initial hardware investment costs less than the future benefits which include enhanced security together with operational efficiency and student contentment.

**5.2 Feasibility Analysis**

* The implementation costs remain financially affordable because the applications use free-tier services from Mapbox and Firebase.
* NTU’s transport system can integrate this system without disturbing its everyday operations thanks to its practical implementation methods.
* The system can expand through manageable adjustments made to its cloud service plans.

**5.3 Future Recommendations for Cost Optimization**

1. **Monitor Cloud Usage** – If NTU expands, evaluate paid plans for Firebase and Mapbox only when necessary.
2. **Explore Alternative Hosting Solutions** – If a web-based system is implemented, consider cost-effective hosting providers.
3. **Leverage Bulk Purchases** – Reduce RFID costs by purchasing student cards in bulk.
4. **Optimize Bus Routes** – Use tracking data to optimize bus schedules, reducing fuel costs.

**1.** The decision to switch to Mapbox and Firebase paid plans should only occur when NTU expands to avoid unnecessary expenses.

**2.** A web-based system will require exploring cost-efficient hosting solutions with other providers for consideration.

**3.** Cut RFID expenses down by acquiring large student card quantities in bulk. 4. Data tracking enables the organization to optimize bus routes which cuts down fuel expenses.