Cost Management for Developing Electronic Toll Collection (ETC): An Automated Toll Collection System

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The development of our automated toll collection system project entails the utilization of a variety of hardware and software components. In this regard, we have the flexibility to explore different options, such as acquiring both hardware and software or opting to lease the hardware while having our in-house development team create the software. Our objective is to identify the most cost-effective and advantageous approach for our project. To compare the financial viability of the two strategies, we can calculate the Net Present Value (NPV) and Return on Investment (ROI) for each strategy. We will make some assumptions along the way to perform these calculations.

Assumptions:

1. Discount rate is 10%.

2. Both strategies have the same initial investment, Tk. 9,00000/- (Marked with Gray Color in Financial Table).

3. Since the development and go-live times differ between the two strategies, we need to consider these timelines when calculating the NPV and ROI. Strategy 1 generates benefits half a year earlier than Strategy 2.

4. The cash flows are estimated over a 5-year period.

5. Cost and Benefits are estimated on choosing of each strategy, not for the whole project.

6. Assuming the specific financial data for both strategies has provided below:

Strategy 1: Buy Hardware, Vendor Maintenance, Vendor Software Development

Cost		Benefits	
Hardware Purchase: (Unit x Price)		Year 1	
• Toll Booth Equipment (4 x 25,000)	1,00000/-	• Saving Upgrade and Update Cost	2,50,000/-
• RFID Hardware (4 x 12,500)	50,000/-	• Saving Customization Cost (2 x 2 x 50,0000)	2,00,000/-
• Vehicle Detection Sensor (2 x 25,000)	50,000/-	Year 2	
• Central Control Server (2 x 75,000)	1,50,000/-	• Saving Upgrade and Update Cost	2,00,000/-
• Payment Processing Equipment (4 x 20,000)	80,000/-	• Saving Customization Cost (4 x 2 x 50,000)	4,00000/-
• Backup Power Supply (2 x 35,000)	70,000/-	Year 3	
		• Saving annual licensing Cost (55% off)	50,000/-
Total Hardware Cost	5,00000/-	• Saving Upgrade and Update Cost	2,00,000/-
Software Development (Unit x Package/License Cost):		• Saving Customization Cost (4.5 x 2 x 50,000)	4,50,000/-
• Toll Management Software (2 x 45,000)	90,000/-	Year 4	
• License Plate Recognizer (1 x 70,000)	70,000/-	• Saving Upgrade and Update Cost	1,50,000/-
• RFID Software (2 x 25,000)	50,000/-	• Saving Customization Cost (3 x 2 x 50,000)	3,00,000/-
• Networking Software	60,000/-	Year 5	
• Payment Processing Software (4 x 10,000)	40,000/-	• Saving annual licensing Cost (67% off)	60,000/-
Initial Licensing Cost	90,000/-	• Saving Upgrade and Update Cost	2,50,000/-
		• Saving Customization Cost (4 x 2 x 50,000)	4,00,000/-
Total S/W Development Cost	4,00000/-		
Total Cost	9,00000/-		
H/W Maintenance Cost (Recurring Every Year)	3,00000/-	Saving DevOps Team Cost (500 x 100 x 10)	5,00000/-

Strategy 2: Rent Hardware, No Maintenance Charge, In-House Software Development

Cost		Benefits	
Software Development (Unit x Development Cost):		Year 1 (Half Year)	
• Toll Management Software (2 x 50,000)	1,00000/-	• Saving Development Cost (2 x 75,000)	1,50,000/-
• License Plate Recognizer (1 x 80,000)	80,000/-	• Saving Upgrade and Update Cost	3,00000/-
• RFID Software (2 x 25,000)	50,000/-	Year 2	
• Networking Software	90,000/-	• Saving Development Cost (4 x 75,000)	3,00,000/-
• Payment Processing Software (4 x 15,000)	60,000/-	• Saving Upgrade and Update Cost	5,90,000/-
DevOps Team Cost (500 x 100 x 10)	5,00000/-		
Additional Cost	20,000/-	Year 3	
Total Cost	9,00000/-	• Saving Development Cost (4 x 75,000)	3,00,000/-
Hardware Rent (Unit x Cost Per Month):		• Saving Upgrade and Update Cost	6,10000/-
• Toll Booth Equipment (4 x 1000)	4000/-	• Saving Train/Test Cost (2 S/W x 1,25,000)	2,50,000/-
• RFID Hardware (4 x 625)	2500/-	Year 4	
• Vehicle Detection Sensor (2 x 750)	1500/-	• Saving Development Cost (3 x 75,000)	2,25,000/-
• Central Control Server (2 x 2500)	5000/-	• Saving Upgrade and Update Cost	5,95,000/-
• Payment Processing Equipment (4 x 750)	3000/-	• Saving Train/Test Cost (3 S/W x 1,00000)	3,00000/-
• Backup Power Supply (2 x 2000)	2000/-	Year 5	
		• Saving Development Cost (4 x 75,000)	3,00,000/-
H/W Rental Cost (Per Month)	17,000/-	• Saving Upgrade and Update Cost	5,80,000/-
Total Rent (Recurring Per Year)	2,04,000/-	• Saving Train/Test Cost (5 S/W x 64,000)	3,20,000/-
		Recurring Cost Reduction (3,00000 – 2,04,000)	96,000/-

Budget Estimate and Financial Analysis:

In Strategy 1, we adopt a comprehensive approach, hiring the vendor to build the software as well as buy the required hardware. The financial table lists the expenses related to this strategy. It's crucial to remember that there are ongoing costs, such as Tk 3,00000 for yearly hardware maintenance. This strategy's main advantages come from the project's software component. For software to stay current and functional, major and minor updates and upgrades are frequently necessary. Since the vendor is in charge of hardware maintenance in this instance, there are major cost savings on upgrades, updates, and customization (two customizers at a set rate of Tk. 50,000 are needed to customize one module). Additionally, license fees may be flexible, particularly in the third and fifth years. We can benefit from special offers throughout certain years, such as a third-year Halloween discount of 55% and a fifth-year discount of 67%. Furthermore, we may save money on our internal DevOps team because the vendor's team develops and maintains the software. If we have 500 DevOps team members, each of them charging Tk. 10 per hour, we may save 500 hours in total, which is Tk. 5,00000 in savings.

Unlike Strategy 1, Strategy 2 focuses its first investment just on internal software development, including costs for testing, security, DevOps team expenses, and development tools. The DevOps costs are in line with what we covered in Strategy 1. In contrast, Tk. 2,04,00 is the yearly recurring cost for renting hardware. A first focus on developing limited features (savings per feature of Tk. 75,000), giving feature development priority, and setting up a self-contained development environment resulted in benefits that are measured annually and include savings in development, upgrade and update, and training/testing expenses. The cost reductions from upgrades and updates are usually greater for in-house produced software than for software purchased from outside providers. The in-house software development process's requirement for the train/test phase is anticipated to diminish over time as we transition to stable software versions. (In year three, we can save roughly Tk. 1,25,000 if we successfully test and deliver a stable version of at least five

software modules). Recurring costs are down Tk. 96,000 (Tk. 2,04,000 as opposed to Tk. 3,00000 in Strategy 1), and it is important to note that benefits are accounted for only half of the year.

Formula:

1. Discount Factor $= 1/(1 + r)^n$, where "r" is the discount rate and "n" is the number of periods.
2. Net present value (NPV) = The algebraic difference between discounted benefits and discounted costs as they occur over time.
3. ROI = (total discounted benefits – total discounted costs)/discounted costs

Calculating NPV and ROI for Strategy 1: The project will go-live on Year 0 and generate benefits on Year 1. The assuming discount rate is 10% and discounted factor is calculated by using the formula. The initial costs comprise the total hardware and software expenses, with recurring costs beginning from year 1. Benefits, on the other hand, are calculated by summing the annual savings, along with the cost savings related to the DevOps team.

Discount Rate = 10%							
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Cost	900000	300000	300000	300000	300000	300000	
Discounted Factor	1	0.909	0.826	0.751	0.683	0.621	
Discounted Cost	900000	272700	247800	225300	200000	186300	**2032100**
Benefits	0	950000	1100000	1200000	950000	1210000	
Discounted Factor	1	0.909	0.826	0.751	0.683	0.621	
Discounted Benefits	0	863550	908600	901200	648850	751410	**4073610**

Net Present Value (NPV) = 40,73,610 – 20,32,100

$$= 20,41,510$$

Return on Investment (ROI) $= \dfrac{2041510}{2032100} \times 100$

$$= 100\%$$

Calculating NPV and ROI for Strategy 2: The project will go-live on Year 1 and generate benefits after Year 1.5 years. The assuming discount rate is 10% and discounted factor is calculated by using the formula. The initial costs consist solely of the sum of software expenses, while starting from year 1, the ongoing costs are limited to the recurring hardware rental expense. Benefits are calculated by adding up the yearly savings and the reductions in recurring costs.

Discount Rate = 10%							
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Cost	900000	204000	204000	204000	204000	204000	
Discounted Factor	1	0.909	0.826	0.751	0.683	0.621	
Discounted Cost	900000	185436	168504	153204	139332	126684	**1673160**
Benefits	0	546000	966000	1256000	1216000	1256000	
Discounted Factor	1	0.909	0.826	0.751	0.683	0.621	
Discounted Benefits	0	496314	797916	943256	830528	779976	**3847990**

Net Present Value (NPV) = 38,47,990 – 16,73,160

$$= 21,74,830$$

Return on Investment (ROI) $= \dfrac{2174830}{1673160} \times 100$

$$= 129\%$$

Based on the information provided, Strategy 2 shows a slightly higher net present value (NPV) and higher return on investment (ROI) at 29% compared to Strategy 1. Though Strategy 2 becomes operational six months later than Strategy 1, It still appears to be the more advantageous choice due to its NPV and superior ROI.