

Project Format

1. Project Title: Predictive Maintenance of ATMs

2. Focus area of Research (highlight relevant area): Smart ATMs

3. Kind of Project: Process development

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5. Need for this project/research:

Predictive maintenance of ATM machines will help determine the condition of the ATMs and estimate when a maintenance service is required. This will help increase the availability of such ATM machines and reduce service-related downtime. Also, maintenance will only be done when needed thus reducing costs for banks in running these ATMs

6. Project Details: (~300 words)

- Problem Definition

The current scenario in the banking sector is showing a rapid decline in the number of bank branches with simultaneous increase in the number of ATM bases setup by each bank. However, inefficient maintenance of ATM bases by respective banks lead to longer downtimes thus causing customers to prefer a new bank. To reduce the loss of customers banks should opt for predictive maintenance of their ATMs. In today's world it is no longer enough to respond to outages when and after they occur, since this increases the down time of the ATMs and prevent customers from receiving services when needed. Predictive maintenance will enable proactively deciding when a maintenance visit is needed thus preventing unexpected ATM failures.

- Approach to the problem

Data on ATM logs, service history and environmental factors will be combined to form a model for predicting ATM outages. We will have to extract features from the log data to understand which thresholds and frequencies are reached for an outage to occur. The service data will show help us identify certain error combinations that result in outages or failure of the ATMs. After the feature selection an analytical model will be setup to predict outages and determine a pre-defined time interval right before the occurrence of a failure. The data required for creating such a model will depend on the availability of (possibly confidential) ATM data. **This data must be provided to the PI by BoB for completing this project.**

- Methodology

Data Collection: Data on failure and repair history, ATM logs and machine operating conditions will be collected from BoB. Some of the variables will be temporal in nature while others will be static. We will have to identify the predictor and response variables and the data types. Due to the massive data volume, mining techniques will have to be used.

As mentioned above, Bank of Baroda would provide available past data for sample ATM machines. In addition , we propose to install industrial temperature and humidity sensors

(connected to a Arduino microcontroller) inside a few sample ATM machines. It is proposed to combine these recorded data along with the other predictor variables in our proposed prediction algorithm.

Methods to be used: (1) Binary classification will be used to predict if the ATM will face a failure in future time period. (2) Regression model or a Cox proportional Hazards model will be fitted to investigate the association between the several log and service predictor variables and survival time of the ATMs. LASSO type penalty functions will be used for identifying only the relevant factors.

Validation Methods: Cross validation techniques will be used to validate the above suggested methods and ascertain their performances on new data.

Deployment: The validated algorithm can be deployed in a sample ATM machine **provided BoB grants us relevant access to the ATM OS and associated hardware**. If allowed, the deployed algorithm will monitor in real time past predictors and provide recurring forecasts as to the probability of future failures. This predictions can be monitored by maintenance personnel by directly accessing the ATM OS terminal during daily cash refilling. In the future (not part of this project), predictions about possible failure can also be transmitted over the internet to a central server directly accessible by BoB maintenance crew.

7. Present status of proposed process or product development:

This is a new proposal. We are now in the stage of literature review of predictive maintenance being used in ATMs worldwide.

Predictive maintenance techniques to help prepare for equipment failures and schedule advance corrective maintenance have been proposed recently by Wang et al. (2017).

They present a general classification-based failure prediction method and apply it to automated teller machines (ATMs). A data-driven approach based on multiple-instance learning for predicting equipment failures by mining equipment event logs have also been proposed by Sipos et al. (2014).

8. Deliverables:

- 1) A standard analytical model for predictive maintenance of ATMs
- 2) Performance measures for such predictive models
- 3) An R program to execute the model
- 4) Integration of off-the-shelf temperature and humidity sensors with a few sample ATMs
- 4) If granted access, a background executable version of the developed algorithm capable of running on the ATM operating system. This will provide real time predictions about future failures.