Bachelor of Science in Computer Science & Engineering

Development of an Intelligent System for Social Protection Service Beneficiary Selection using Machine Learning for the Bangladeshi People

by

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7. Introduction

One of the most common problem of a Developing Country like Bangladesh is poverty. To eradicate poverty almost every country in the world has some social services initiated by the government under the name of Social Safety Net Programs or Social Protection Programs. The Social Protection Programs help the residents of the society with cash flow or other helping methods. The Social Protection programs are designed to help people with physical or psychological disabilities, the elderly, and people living in situations at risk.

The Government of Bangladesh also has several Social Protection Programs to reduce the vulnerability of the people at risk and to decrease poverty. At present, there are 132 Social protection programs in Bangladesh. A few of them are given below:

- Old Age Allowance
- Allowances for the Widow, Deserted and Destitute Women
- Allowances for the Financially Insolvent Disabled
- Micro-credit for Women Self-employment
- Interest-Free Micro-Credit Program for RSS, RMC and Urban Centre
- Food For Work
- Work For Money
- Housing Support for Homeless People
- Financial support for Cancer, Kidney and Liver Cirrhosis and other patients, etc.[1]

Under these Social Protection Programs, the government of Bangladesh provides direct cash distributions to the beneficiaries. Such as, under the program Old age Allowance the beneficiaries get 500 Tk per month, Allowances for the Financially Insolvent Disabled programs beneficiaries get 750 Tk per month, Financial support for Cancer, Kidney, and Liver Cirrhosis, and other patients programs beneficiaries get 50,000 Tk for one time, Interest-Free Micro-Credit Program for RSS, RMC and Urban Centre programs beneficiaries get 5,000 Tk to 30,000 Tk loan, etc.[2]

The government of Bangladesh had a budget of a total of 5,38,982 crore Tk which is 3.10% of GDP for all the Social Protection Programs. For the Old allowance program with a budget of

2940 crore Tk they provided the facility to 49 lac people, Allowances for the Financially Insolvent Disabled with a budget of 1620 crore Tk they provided the facility to 18 lac people, Allowances for the Widow, Deserted and Destitute Women with a budget of 1230 crore Tk they provided the facility to 20.50 lac people, etc.[1].

According to these Statistics, We can see that the government of Bangladesh has taken necessary initiatives for social welfare and to eradicate poverty. But the problem is that the process of Selecting beneficiaries for a program and conducting the SSN programs is backdated. The process followed by the government to conduct these programs is are given below:

- Set up some criteria for being the beneficiary of a Social Protection Program
- Formed committees in every union, municipality, city corporation, Upazila, district, and national level to conduct the Social Protection Programs. The number of committees may vary for different programs.
- Have physical Information collection form for applying to the programs
- Candidates fill up the form and submit it to the Union, Municipality, or City Corporation office
- Then the local formed committee selects the candidates and sends the list of candidates to the Upazilla committee
- The Upazilla committee take initiative to distribute the granted money to the beneficiaries [3]

The problem with the current selection process is that there are corruption, nepotism, lack of knowledge about the selection criteria, supply and demand gap, the elite's participation at the local level, etc. This results in the wrong selection of 51% of beneficiaries or candidates.[4][5]

Solving this selection problem can help all candidates who need the help of the Social Protection Programs genuinely. That's why an Intelligent beneficiary selection system for social protection services is proposed here. This system will significantly improve the selection process.

This will be an intelligent system as this will be trained with existing candidates' application information and their selection data using Machine Learning and get an insight into the criteria

for candidates selection, it will be able to predict the right candidates with application information without any human interaction. Then there will be no need for human-based decisions like the current system as the intelligent system will predict the right candidate. That's how the proposed system will reduce the chance of corruption, nepotism, and the elite's participation at the local level and will solve other problems.

For the benefit of the applicants, a mobile application will be developed in the proposed system. Using that Mobile application anyone can easily apply for the service of social protection. They can also know about different Social Protection services through the mobile application. This mobile application will make the old and manual application process digital and anyone can apply for Social Protection Programs from anywhere in Bangladesh.

8. Background and Present State of the Problem

Selecting the wrong candidates is a big obstacle in the implementation of Social Protection Programs. Developing a digital and intelligent system for selecting the right candidates can help to remove this obstacle to the successful implementation of Social Protection Programs. Some work has been done on finding the problems of Social Protection Programs and the causes and solutions of those problems. Some had also made digital systems for Social Safety Net programs or Social Protection Programs.

In the works of [4], the researchers have shown the effectiveness of the Social Safety Net Program in Bangladesh. They interviewed 101 people and find out various information. They analyzed the interview information and found out that social safety net programs have problems of no transparency, problems facing different kinds of harassment in the selection process, safety net services are not sufficient and efficient, etc. They have suggested some advice to solve those problems such that the government should ensure transparency and accountability, should take necessary steps to remove all kinds of harassment, should increase the amount of money and quality of services for Social Safety Net Programs, etc. The Limitations of their study is that they only analyzed the data and suggested some solution, they haven't take initiative to remove the problem. Our Proposed system will remove harassment in the selection process and will ensure transparency and quality of services.

In the works of [5], they interviewed 188 beneficiaries of the old age allowances programs and allowances for the widow, deserted and destitute women programs and found out that about 51% of the beneficiaries were wrongly selected through bypassing the selection criteria. While searching for the reasons behind the wrong selection of beneficiaries, researchers find that most of the problems related to beneficiary selection take place during the implementation phase. According to that research, the implementing authority was not well informed about the beneficiary selection process in some cases. Moreover, corruption and nepotism invited beneficiary selection through a non-participatory approach in some cases. The beneficiary selection committees were non-functional in some cases. Sometimes, an updated eligible candidate list was not available for selecting deserving beneficiaries. Information on eligibility criteria and deadlines was not disseminated properly in some other cases. They have done a good in finding out the problem but they didn't take any initiative to solve the problem. As our Proposed system will be automated and will have no human dependency in the selection process, it will be able to overcome the problem of lack of knowledge of authority, corruption, nepotism, etc. problems.

In the works of [6], issues and challenges of Social Safety Net Programs have been pointed out by the researcher. He mentioned that the management of safety net programs in Bangladesh has come under scrutiny because effective management of these programs is considered critical to their success. According to the researcher, the biggest challenges lie in implementing programs, such as establishing eligibility criteria in practice, lack of resources, supply and demand gap, the elite's participation at the local level, and corruption. Different problems and limitations in social safety net programs and their providing system mentioned in the paper are as follows:

1. Social safety net programs must be monitored by the highest level of government to ensure transparency and accountability.
2. Most recipients face different types of harassment in the selection process and in getting the service. Therefore, necessary steps should be taken to remove all types of mistreatment.

3. Many have objected that services are provided too late. Therefore, they cannot be used correctly and for the expected area. Therefore, assistance must be provided on time regularly.
4. Lack of coordination between the various implementing organizations, departments, and ministries. Therefore, it is necessary to ensure effective and regular coordination and interaction.
5. Due to unfair targeting processes in many social safety nets, many poor and very poor cannot access the plans they deserve and are deprived of their rights.

Our proposed system will ensure a fair selecting process so that poor people can access the plans they deserve.

In the works of [7], they have used a machine learning-based approach to divide the households into different categories so that these can be used for different Social Protection Programs. They have used the k-means clustering technique to cluster the households into categories. They have found different information about the households in 4 clusters such that the average household size, household income range, an average household member's daily expenditure, etc. But They haven't labeled the cluster, so they couldn't find out the accuracy of their model with test data. Another limitation of their research is that they haven't mentioned which kinds of social protection interventions are required for each cluster, and they haven't made any digital system by which people can apply for social protection and benefit from it and this research was done in the context of Pakistan. Our proposed system will train with the specific goal of selecting beneficiaries and the best-trained model will be chosen according to their performance and accuracy. Through our mobile application, people will be able to apply for Social Protection Program and benefit from it.

In the works of [8], they made a decision support system to make selection criteria for social safety net programs using Machine Learning algorithms like Bayesian Network, Decision Tree, etc. They have done an excellent job in making a System that can evaluate if the selection criteria are efficient for the specific social safety net program. The Limitation of their study is that they have a lack of sample size (17 SSNP advocacy campaign strategies and 11 examples of past recipients/nonrecipients of the SSNP packages). That could have constrained the statistical

significance of the outcome, as the larger the training dataset, the more representative it would be of an SSNP database. They have also mentioned that they have a desktop and mobile application in their system architecture, But what was the functionality of these applications was not mentioned in the research paper. They have only focused on making a Decision support system that is used for evaluation of the criteria used for the Social Protection Programs and this research was done in the context of Nigeria. Our proposed system will be trained with sufficient data and we will be having a mobile application that has the functionality of applying for a Social Safety Net Program and seeing the application result without any hassle.

In comparison to these, the beneficiary selection system is being proposed in the context of Bangladesh to overcome all the problems and ensure the efficient beneficiary selection process for the Social Protection Programs of Bangladesh.

9. Objectives with Specific Aims and Possible Outcomes

The main objective of this project is to develop an intelligent system that can automatically check the eligibility of an applicant for Social Protection Programs. The key objectives and possible outcomes of this work are the following:

- Developing Machine learning models for different Social Protection programs like Interest-Free Microcredit programs, Old Age allowances, Allowances for the widow, deserted and destitute women, Allowances for insolvent Persons with Disabilities, Assistance for cancer, kidney, and liver cirrhosis patients, etc.
- Developing a mobile application through which people can easily apply for SSN programs and see the result of their application.
- Developing an administration dashboard that will be used by the government official to see the number of applicants, their information, and prediction results of the applicant's eligibility. That will make the implementation and monitoring of Social Protection programs very easy.
- Developing a Backend or API server that will connect the mobile application, administration dashboard, and predictive models, to the whole system.

10. Outline of Methodology

The process of developing the whole system is divided into three parts:

- Intelligent beneficiary selection predicting system using Machine Learning for Social Protection Programs in Bangladesh
- A mobile application for the user to apply for a Social Protection Program
- A backend or API server that will connect the mobile application with the prediction system

10.1 Intelligent beneficiary selection predicting system

There are total 132 Social Safety Net Programs in Bangladesh. We can't include every one of them at the same time, so I have selected 5 of them to work with. They are given below:

1. Interest-Free Microcredit programs,
2. Old Age allowances,
3. Allowances for the widow, deserted and destitute women,
4. Allowances for insolvent Persons with Disabilities,
5. Assistance for cancer, kidney, and liver cirrhosis patients.

We will build Machine Learning Model for every one of them. Every one of them will follow the same architecture for making predictions using the system. Figure 1 represents the Architecture of the Intelligent beneficiary selection predicting system. This system will Predict if an applicant for a Social Protection Program can be selected or not. To build the system the following steps will be used:

10.1.1 Data Collection, Data Cleaning, and Feature Extraction: As all of our selected Social Protection programs belong to the Ministry of Social Welfare, I will collect data from the Divisional Department of Social Welfare, Chattogram. They have previous data on the applicants for the Social Protection Program mentioned above. We will apply for data from them. After getting the data, I will create a dataset. Then I need to clean up the data to remove unnecessary information. We need to extract the exact features needed for Training the model. Like for the old allowance program feature that will be needed are given below:

- Have a National ID card / Birth certificate or not
- Age
- Average Annual Income
- Gender

- Government Service holder or pension receiver
- Received any other allowances or not
- Have physical illness/disability, mental illness, partial disability
- Amount of land owned

For the Interest-free microcredit program, the features are as follows:

- Have a National ID card / Birth certificate or not
- Annual Income
- Amount of land owned
- Received loan from any other institute
- Will buy any machinaries or not
- Will buy raw material or not

For the Allowances for the widow, deserted and destitute women program the features are given below:

- Have a National ID card / Birth certificate or not
- Have any disability or not
- Age
- Amount of land owned
- Widow/ husbend abandoned or not
- Deprived/landless or not
- Received any other allowances or not
- Government Service holder or pension receiver
- Maid/vagabond or not

The feature described here is the selection and rejection criteria for the Social Protection Program. In the preprocessing step, I will remove or replace all kinds of values that are incomplete, redundant and missing, etc. with null/zero values.

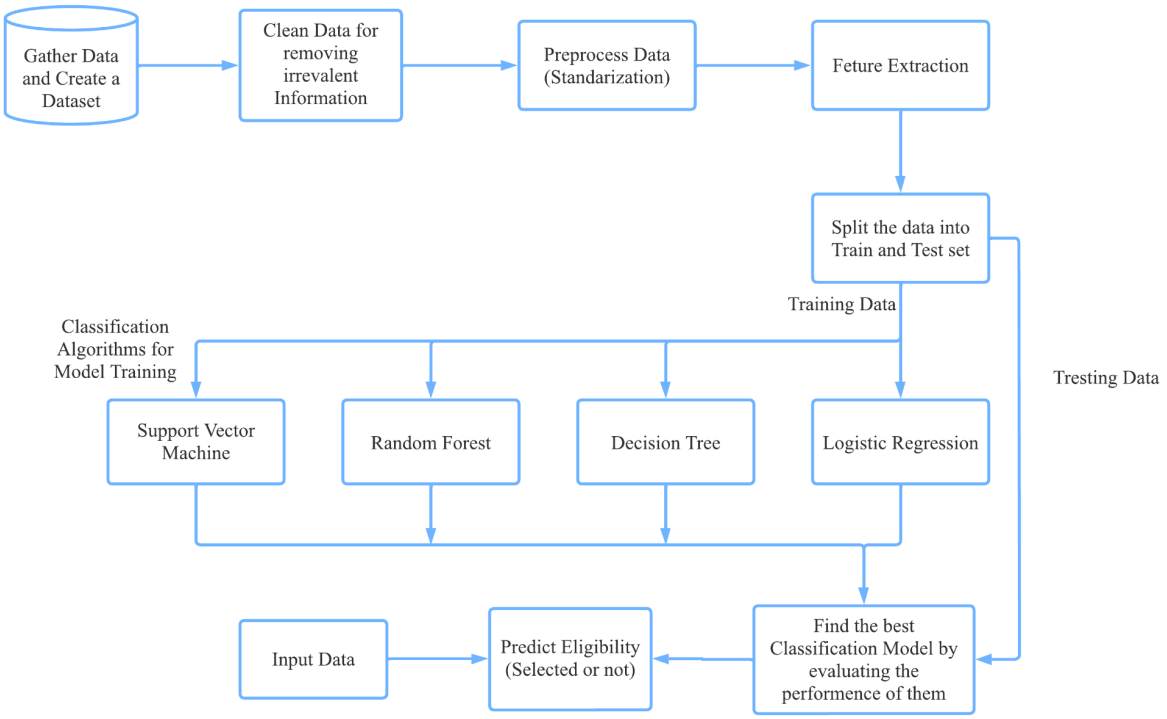

Figure 1: Architecture of Intelligent beneficiary selection predicting system

10.1.2 Splitting Data, Training the Model

The Prepared data will be split into Training data set and Testing data set. Then I will select a Machine Learning Algorithm. Our target is to get a binary result like selected for the Social Protection Program or not. So I will use a binary classification algorithm for prediction ability or intelligence. The Binary classification algorithm I will use for model training is given below:

Decision Tree Algorithm: It's a supervised learning algorithm, used for classification. It used the given data to make a tree-like structure where Nodes represent a feature, branches represent the decision and the leaf nodes refer to the classification result. As I will use labeled data and I need binary classification, that's why the decision tree algorithm is one of the best options for us to train the model.

Random Forest Algorithm: In this method, multiple decision trees are used for classifying the data. It uses multiple decision trees and takes the result of the majority and uses that result for classification. This Algorithm can also serve our purpose. So, I will use it for our model training.

Logistic Regression: It's an algorithm that always results in binary classification. In Logistic regression, instead of fitting a regression line, it fits the data in an "S" shaped logistic function,

which predicts two maximum values (0 or 1). It can classify new data using continuous and discrete datasets. As I need binary classification, I will use Logistic Regression for Training the model.

Support Vector Machine Algorithm: It is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for Classification problems in Machine Learning. It chooses the extreme points/vectors that help in creating the hyperplane. The Hyperplane is the best decision boundary. It uses the hyperplane to classify data. So, I can use this algorithm for our model training phase.

10.1.3 Find the best Model, Predict Result

After Training the model, I will evaluate the performance of the trained model. We will find out the accuracy of the model and will find out different performance matrices like log loss, and confusion matrix. The lower log loss value represents the higher accuracy. After analyzing the performance I will select the best model according to accuracy. Then the selected model will be used for Predicting the eligibility of the candidate whether he is selected or not for the Social Protection Programs.

10.2 Mobile Application

To develop the mobile application, I will use Flutter. Flutter is a mobile application-making framework based on a programming language called Dart. It's an open-source platform. It's can be used for making android and ios based mobile applications at the same time, That why I have chosen this technology. I will also make an API server using Node JS, Express, and MongoDB. This API server will act as the Backend System and it will connect the trained Prediction Model with the mobile application.

The Flow chart of the mobile application shows us the features of the application and how to operate the application. The feature of the mobile application are given below:

10.2.1 Login, SignUp: Anyone can sign up to the application with his mobile number, national identity card number, and password. If he is a registered user, he can log in to the system with the national identity card and password. After logging in he will see the user profile, Available

Social Protection Program, Apply for a Social Protection Program, and Application's Status section.

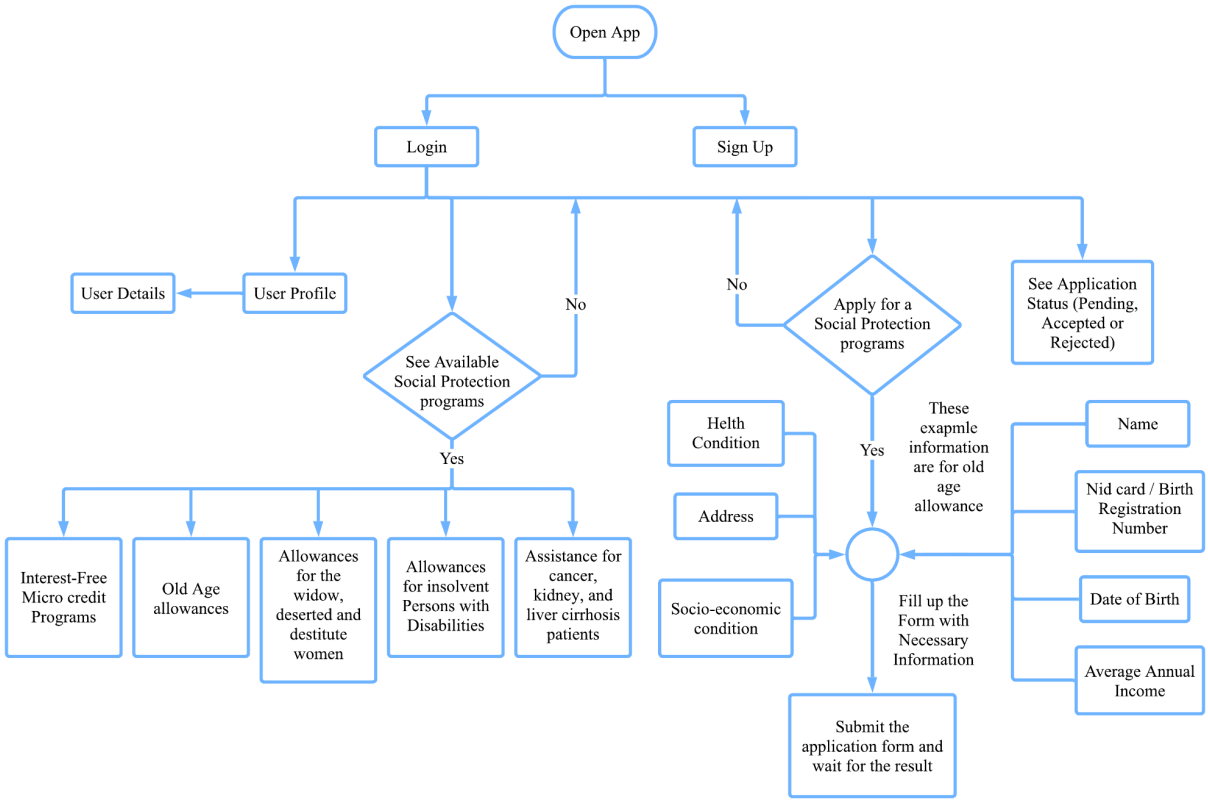

Figure 4: Flow chart of the mobile application

10.2.2 User Profile: In this section, user can see their personal information according to their national identity card and will be able to change the password.

10.2.3 Available Social Protection Program: Here the user will be able to see what kind of Social Protection Services are available to apply through this mobile application. They will also know about the information of the application process, selection criteria, and rejection criteria. This information will help them to decide if they can apply for the program or not.

10.2.4 Apply for a Social Protection Program: Through this section, anyone can apply for being a beneficiary of the Social Protection Programs. The User of the mobile application also can apply for other poor or computer illiterate persons with that person's information, and

permission. This will enable the opportunity of applying to a Social Protection Program for people who can't use a smartphone. Necessary information like for the old age allowance program, the user needs to fill up the form with name, Nid card/Birth Registration number, age, date of birth, average annual income, address, health condition (choose from the option physically ill, disable, mentally ill, partially disable, none), economic condition (choose from the option deprived, destitute, landless, none), social condition (choose from the option widow, divorced, widower, separated from family, none). After filling out the form user will be able to submit the application and will have to wait for the result.

10.2.5 Application Status: In this section, the user will see the application and application information he has submitted. Initially, the application status will be pending. After the result comes from the intelligent prediction system, the user will be able to see if his application is accepted or not. If the application is accepted then the user will get the guideline on how he will be able to get the money as a beneficiary.

11. Required Resources

Tools required to implement the system are given below:

Hardware requirements:

- A personal computer
- A smartphone
- Internet Connectivity

Software tools:

- Visual Studio Code
- Android Studio
- Node JS, Express, MongoDB
- React JS
- Flutter
- Jupyter Notebook, Scikit learn, Tensorflow and Keras, etc.
- Programming Language: Python, Dart and Javascript

12. Cost Estimation

The costs that will occur to implement our proposed system are given below:

Cost of Materials:	
A Personal Computer	Tk. 50,000
A Personal Smartphone	Tk. 20,000
Data Collection	Tk. 10,000
Paper	Tk. 500
Total	**Tk. 80,500**
Typing, Drafting, Binding:	
Internet Browsing & Typing	Tk. 2,000
Drafting	Tk. 500
Binding	Tk. 500
Total	**Tk. 3,000**
Grand Total	**Tk. 83,500**

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14. CSE Undergraduate Studies (CUGS) Committee reference

Meeting No. : **Resolution No. :** **Date:**

15. Number of Under-Graduate Student(s) working with the Supervisor at Present: 09

Signature of the Student

Signature of the Supervisor

Signature of the Head of Department