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Experimental Application of Machine Learning on Financial Inclusion Data for Governance in Eswatini

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Abstract: An objectives of good governance is to increase capital base of small scale businesses (SSB) in order to encourage more investments and hence increase employment rate. Embracing good financial inclusion (FI) schemes in a country helps to ensure that entrepreneurs of SSB have access to financial services and hence meet their needs. In this paper we studied FI scheme in Kingdom of Eswatini with the view to establish the extent to which SSB have access to funds in running their businesses such that they could satisfy the target population and meet their desired goals. We got FI dataset for Eswatini for 2018 from Finscope database. Finscope 2018 dataset contains 1385 attributes with 2928 records. This study extracted attributes based on payment channel, registered/unregistered business, usage of commercial banks/insurance/mobile money and source of income for households from the Finscope database. We identified lot of missing data and hence replaced them using Mode method of preprocessing module in WEKA. We split the datasets and carried out cross validation on it. Training data is 80% of the datasets and 20% was used for testing. We carefully classified FI for selected parameters for Hhohho, Manzini, Shiselweni and Lubombo regions of Eswatini using Logistic regression with 80% for training and 10 fold cross-validation. The best 10 fold cross-validation recall rate for Manzini region using support vector machine (SVM) is 69.4% and 63.4% using logistic regression. These results show that veracity of FI dataset is weak and this is due to large number of missing data.

Keywords: Financial Inclusion, Machine Learning, Governance, Small Scale Business, Low-Income Earner

1. Introduction

Business is about producing, selling and buying of goods and services with the view to making money. It is an organized effort(s) of an individual or group of individuals that team up to produce and sell goods and services [1]. The ultimate goal in business is making profit, however some businesses can be for non-profit and hence operate for charitable purposes. Every business organization, small scale, medium scale or large scale, needs valuable FI. Financial inclusion particularly for small scale businesses play very import role when it comes to business governance vis-à-vis meeting the needs of the target audience and customers [2]. Adequate understanding and proper representation of FI data paves way for good business analytics for proper decision making in business organizations [3].

Financial inclusion is the ability of business entrepreneurs to access financial products and services with the view to satisfy the need of their clients or customers [4]. It has to do with saving, making and receiving payments, transacting, receiving credit, and

insurance [5]. It is needed for all business organizations especially the small scale businesses in the developing nations. The inclusion helps the small scaled companies to access credits that could be invested in their businesses. It also helps in saving of cash such that future investments or response to unforeseeable risks can be carried out [6]. Financial inclusion improves the access to insurance products and services which are critical towards addressing vulnerabilities in businesses [7]. Therefore one of the elements of good governance in any country is to have adequate FI schemes for small scale businesses with view to (1) improve production of good and services; (2) increase employment rate and vis-à-vis the standard of living of the people.

The governance of a country relies so much on data aggregated from all private organizations, agencies and government parastatals. Decision making is based on these data [8]. Data grow geometrically in different forms in terms of structure, size, semantics, varieties etc. Therefore this increases the complexity of data and hence use of traditional database management system for data management becomes a challenge. Thus big data technology evolved to help organizations and government collect, organize, represent, process, and analyse data from many sources with the view to reducing cost and time; optimizing the use of resources and developing new products; and making smart decisions [9]. Financial inclusion dataset are big datasets and they are always needed by both private and public sectors. The datasets are diverse in terms of Volume, Velocity, Variety, Variability, Veracity, Visualization, and Value (i.e. 7 V's of Big Data) [10]. Thus, in this paper, we focus on the analysis of the financial inclusion dataset for Eswatini with the view to carefully classify FI data set based on selected parameters for Hhohho, Manzini, Shiselweni and Lubombo regions of Eswatini using Logistic regression (LR) and SVM. Machine learning technique has been identified to be very useful for analysis of government-based data and hence infer relevant hidden facts from them [11].

The paper is organized as follows: Section 2 present the general overview of the Kingdom of Eswatini vis-à-vis financial inclusion in the context of Eswatini. Review of related works is presented Section 3. Methodology is presented in Section 4 while result is presented in Section 5. Conclusion is presented in Section 6.

2. General Overview of Financial Inclusion in the Kingdom of Eswatini (formerly Swaziland)

Eswatini is a growing economy and it is a Southern African country with a current population of 1,154,514 which is equivalent to 0.01% of the total world population as of January 10, 2020, based on the United Nations estimates [12]. It is a landlocked country in Southern Africa with total land area of approximately 17,200 Km² (6,641 sq. miles) [12]. The Gross Domestic Product (GDP) per capital is 3,914.02 US dollars in 2017 and in the long-term, the Swaziland GDP per capita is projected to trend around 3,955.07 USD in 2020, according to World Bank econometric models. The ease of

doing business is ranked 112 as at 2017. The country is ranked as middle-income country and is committed to a free market economy and private ownership.

The governments in the African continent have realized the pivotal role that FI plays in combatting poverty and contributing to inclusive economic growth by positively impacting on the low income earners and small scale businesses. Hence reducing income inequality and expanding employment. Recent innovations in financial services for small scale business groups has made governments to know how FI could strengthen the resilience of vulnerable and marginalised populations [13]. Thus a number of countries on the African continent have begun to develop national FI strategies and spearhead key programs and initiatives to improve financial markets.

In the light of the above, the Ministry of Finance in Swaziland in 2017, published the FI strategy for the Government of Swaziland (GoS) [13]. This was based on the critical role that GoS attached for FI. The FI journey for GoS dated back to 2010 in which the government through the Ministry of Finance (MoF) established the Micro Finance Unit (MFU) to implement the International Fund for Agricultural Development (IFAD) supported Rural Finance and Enterprise Development Programme (RFEDP) with the view of facilitating access to financial services for the rural population and the micro and small scale businesses. In 2013, Ministry of Finance of GoS joined the Alliance for Financial Inclusion (AFI), which is a global movement on FI and this helps to impact directly on the welfare of people at microeconomic and household levels. It helps to reduce people's transaction costs and hence enabling them to efficiently manage risks, allocating capital for productive use and supporting the accumulation of wealth over time [13]. There are three dimensions of FI: Access, usage and quality. The comprehensive document of the GoS financial inclusion strategy is well presented in [13]. It is expected that the proposed strategy will lead to increase in reach, depth and quality of FI in Swaziland, and a sustainable financial sector that is able to increase citizen welfare, create economic growth, and hence meet national goals. It also presents the level of readiness of the government of Swaziland about financial inclusiveness. In this light few research works have been reported in the recent time on FI as it affect Swaziland.

The qualitative research reported in [14] was an exploratory study to investigate the competitive advantage and the critical success factors of Swaziland (Eswatini) financial cooperatives. Financial cooperatives are means of providing financial services to low-income earners and hence make them to be in the FI scheme of government. Financial services acquisition journey model in the context of Eswatini was proposed. The model offered an integrated representation whereby financial services are fully extended to low-income earners with the view to access funds and credit facilities and hence guarantees financial inclusiveness for them. Thus financial cooperatives are noted among the distribution channels for credit facilities. This aligns with the interest of United Nations (UN) and International Labour Organization (ILO) towards financial cooperatives as mechanism that should be utilized to promote FI within the low-income earners [15]. However the author in [15] noted the mixed views about the role of savings and credit cooperatives (SACCOs) to facilitate access to financial services for people

in Swaziland. Thus it was reported in the research that more knowledge is required about role of SACCOs and development of better scheme for quick access to loan and repayment of loan by their members which are mostly low-income earners.

The authors in [16] considered micro-insurance companies as another distribution channel that could make fund and credit accessible to low-income earners in Swaziland and this further helps to ensure wider coverage for FI. Hence they proposed a framework of micro-insurance distribution and implication based on the data collected in Swaziland. Similarly Mngadi noted in the research reported in [17] the role that microfinance institutions played on entrepreneurship in Swaziland. It was recommended that microfinance institutions should focus more on developmental finance for small scale businesses and low-income earner. In [18] crop insurance was identified as another FI scheme. Though it served as a means of protecting farmers against potential losses and hence minimize risk but it was noted in Swaziland that crop insurance is not well developed and implemented due to shallow knowledge of farmers about the preference for crop insurance. Similar study was carried out by Xolile in [19] focusing on livestock insurance. In [20], investment was also identified as one of the key instruments for equitable income distribution to ensure FI but this is also not well explored in low income countries and fragile environment.

3. Related Works and Deductions

3.1 Related Works

Financial inclusion is a government scheme that is meant to enable citizens to make contribution towards the growth of a country and also make the citizen to make gain from the economic growth [21]. FI is considered as one of the significant indicator of inclusive growth in governance [22]. A number of research works have been done on financial inclusion across the continents. In [23], the authors criticized the unambitious approach that did not include FI as a sustainable goal in 2030 agenda for sustainable development in developing countries. The authors noted that FI was not included as a stand-alone goal among the several sustainable development goals (SDGs). The reasons identified for this are the: instrumentality argument, free market argument, and veil argument. The 2030 agenda was seen as a missed opportunity to focus on finding means to meeting the financial need of the global poor. This implies that in developing economies, the financial bridge between the rich and the poor keep widening as the government fail to extend good governance to the poor through the establishment of a strong financial structure that makes FI to be fully extended to the poor. Similarly in [24] positive influence of mobile micro-insurance on FI in developing countries was investigated and it was established that inclusive financing is more successful in countries that adopt and use mobile micro-insurance compared to countries where such services are not made available to the poor or low-income earners. It is inferred from this study that the use of low-cost mobile channels of micro-insurance would enable low-income earners and small scale businesses to have immediate access to micro-insurance and this contributes to financial inclusiveness. Thus governance should be

extended to low-cost or rural communities by erecting good infrastructural facilities and making good policies to support establishment of micro-insurance and low-cost mobile channels in these areas. Ozili in [25] reviewed digital finance (DF) vis-à-vis FI in the context of developing and emerging economies. It was noted that the mesh of DF and FI has lots of benefits to financial services users, DF providers, government and the economy in general. This corroborates with the study reported in [24]. Célerier and Matray in [26] did a study on the effects of FI on wealth accumulation in the context of USA. The authors studied the USA interstate branching deregulation policy between 1994 and 2005 and established that expansion of the bank branches across the states helped to increase access to funds the low-income earners, hence it increase the low-income household FI. These studies presented in [22, 27] looked at empowering women through financial inclusion. The authors noted that most of the Indian women that make up 46% of the India total population are denied opportunities and rights to financial access and this made them to be financially dependent. The authors affirmed that FI is needed for the women in order to pay for micro-insurance and obtain credit from financial institutions. This helps in national development by women improving access to markets and overall empowerment data.

3.2 Deductions from Literature Review

- a. We deduce from our review that a number of research works have been carried on financial inclusion with the following set of objectives: (1) Development of framework for FI implementation with view to reduce poverty; (2) Review of factors (e.g social, political, environmental etc) that could influence financial inclusiveness; (3) The involvement of adult in banking operations with view to having access to credit facilities; (4) Development of financial structure that make FI fully extended to the poor; (5) Government to focus more on encouraging the establishment of micro-insurance institutions.
- b. We further deduced that statistical technique was applied in the data analysis with the view to affirm the financial inclusiveness of households, low-income earners and small scale entrepreneurs.
- c. In addition, we found out that despite the wide range of research works done on FI across the continents, few were recorded for the Kingdom of Eswatini and these are mostly doctoral theses and masters dissertations reported in universities outside of Eswatini. These research works are mostly exploratory studies that focus mainly on the behaviour of the people (mostly low income earners and small scale entrepreneurs) towards micro-finance, micro-insurance, financial cooperatives and banks. Some also focused on the saving and investment attitude of low-income earners. None of the works access or make use of FI data set for Eswatini and no computational technique is applied in the course of data analysis.
- d. We noted that none of these research works relates FI with governance and neither did the authors make use of intelligent techniques such as machine learning techniques for mining the FI data set with the view to extracting more meaningful information that could impact on the governance of the country as per financial distribution, use and proper management. Also none of the works applied data mining or machine learning technique to process the FI data set with the view to understand the data pattern, ascertain the validity and accuracy of the data set.

In view of the above deduction, we choose in this research to apply machine learning technique for proper pre-processing of FI data set with the aim to clean, validate and classify the data and relate the required attributes of the data set to the governance of the country with regards to financial management (i.e. income distribution through credit facilities and government contribution and use of the income for personal and organizational gains)

4. Methodology

4.1 Dataset Description

The FinScope dataset is made up of 2928 data objects and 1352 attributes. Table 1 presents the description of the dataset and it shows the selected attributes from the FinScope database based on the objective of this study. The FinScope dataset are categorized based on four region (Hhohho, Manzini, Lubombo and Shiselweni). All data object used in this study has numeric attributes as shown in Table 1.

4.2 Data Pre- processing

The data collected was in Microsoft Excel in CSV (comma separated variable) format. After reading the data, the missing data that occurred in the payment channel attributes as displayed in Table 1 was replaced using the Mode method. In the mode method, all the missing attributes value in numeric form is replaced by the most frequent value of the known attribute.

5. Results

5.1 Experimental Results on Logistic Regression and Support Vector Machine

This section provides a comparison of the logistic regression and support vector machine (SVM) in terms of recall, precision and correctly classified instances.

In this experiment, SPSS and WEKA (Waikato environment for knowledge Analysis) were used. SPSS was used to determine the number of missing data in the selected attributes as display in Table 1 and WEKA was employed for the machine learning techniques (logistic regression and SVM) to determine the classification accuracy. The results of the comparison are given in Table 2, 3, 4 and 5.

From the matrix in Table 2, the correctly classified financial inclusion from the selected parameters for Hhohho region is 269, 337 is incorrectly classified in Manzini, 83 incorrectly classified in Shiselweni and 87 incorrectly classified in Lubombo. The correctly classified financial inclusion from the selected parameters for Manzini region is 563, 104 is incorrectly classified in Hhohho, 87 incorrectly classified in Shiselweni and 134 incorrectly classified in Lubombo. The correctly classified financial inclusion from the selected parameters for Shiselweni region is 137, 80 is incorrectly classified in Hhohho, 250 incorrectly classified in Manzini and 121 incorrectly classified in Lubombo. The correctly classified financial inclusion from the selected parameters for Lubombo region is 148, 86 is incorrectly classified in Hhohho, 301 incorrectly classified in Manzini and 101 incorrectly classified in Shiselweni.

From the matrix in Table 4, the correctly classified financial inclusion from the selected parameters for Hhohho region is 289, 417 is incorrectly classified in Manzini, 52 incorrectly classified in Shiselweni and 58 incorrectly classified in Lubombo.

Table 1. Description of Dataset

Variable Name	Data Type	Description
C13B_1	Numeric	C13b. Payment channel - Food and drink and other groceries
C13B_2	Numeric	C13b. Payment channel - Water / Electricity, paraffin, gas and other fuel
C13B_3	Numeric	C13b. Payment channel - Education (school fees, university or college fees, uniform, transport, stationery)
C13B_4	Numeric	C13b. Payment channel - Transport expenses (taxi fare, bus fare, train fare, petrol for car)
C13B_5	Numeric	C13b. Payment channel - Bond or home loan, credit card, car financing
C13B_6	Numeric	C13b. Payment channel - Communication, e.g., Airtime, cell phone contract, EPTC telephone line payments, internet payments, data
C13B_7	Numeric	C13b. Payment channel - Medical, health expenses, doctors fees, pharmacy/chemist medicines
C13B_8	Numeric	C13b. Payment channel - Rental payments and rates, levies
C13B_9	Numeric	C13b. Payment channel - Other debt repayments (e.g. clothing store accounts, hire purchase)
C13B_10	Numeric	C13b. Payment channel - Savings, investments and retirement
C13B_11	Numeric	C13b. Payment channel - Insurance and Funeral premium payments (e.g., life insurance, burial society.)
C13B_12	Numeric	C13b. Payment channel - Household furnishings, equipment and routine household maintenance
C13B_13	Numeric	C13b. Payment channel - Personal spending e.g. haircuts, gym, lotto, cigarettes, alcohol, clothes,
C13B_14	Numeric	C13b. Payment channel - Leisure, entertainment and miscellaneous goods and services
C13B_15	Numeric	C13b. Payment channel - Farming inputs e.g. seeds, fertiliser, equipment, chemical
C13B_16	Numeric	C13b. Payment channel - Business inputs e.g. stock, machinery or equipment
A18	Numeric	A18. Main source of income – for Head of Household
Region	Numeric	Region
E1_1	Numeric	E1. Ever used - Commercial bank
E1_2	Numeric	E1. Ever used - Mobile money operator
E1_3	Numeric	E1. Ever used - Cooperative Society
E1_4	Numeric	E1. Ever used - Insurance provider
E1_5	Numeric	E1. Ever used - Pension fund administrator
E1_6	Numeric	E1. Ever used - Microfinance institution

Table 2. Matrix on Cross-Validation based on Logistic Regression

	A=Hhohho	B=Manzini	C= Shiselweni	D=Lubombo
A=Hhohho	269	377	83	87
B=Manzini	104	563	87	134
C= Shiselweni	80	250	137	121
D=Lubombo	86	301	101	148

Table 3. Matrix on Cross-Validation based on SVM

	A=Hhohho	B=Manzi	C= Shiselweni	D=Lubombo
A=Hhohho	289	417	52	58
B=Manzini	116	616	74	82
C= Shiselweni	98	295	114	81
D=Lubombo	104	361	75	96

Table 4. Recall on Logistic and SVM

Region	logistic	SVM
HhoHho	0.33	0.354
Manzini	0.634	0.694
Shiselweni	0.233	0.194
Lubombo	0.233	0.151

The correctly classified financial inclusion from the selected parameters for Manzini region is 616, 116 is incorrectly classified in Hhohho, 74 incorrectly classified in Shiselweni and 82 incorrectly classified in Lubombo. The correctly classified financial inclusion from the selected parameters for Shiselweni region is 114, 98 is incorrectly classified in Hhohho, 295 incorrectly classified in Manzini and 81 incorrectly classified in Lubombo. The correctly classified financial inclusion from the selected parameters for Lubombo region is 96, 104 is incorrectly classified in Hhohho, 361 incorrectly classified in Manzini and 75 incorrectly classified in Shiselweni.

From the results on Table 5, it is the Manzini region that has a pass mark for the financial inclusion using the logistic regression and the SVM model. The SVM model outperforms the logistic regression model in terms of the recall while the logistic regression model outperforms the SVM model in term of the correctly classified instances as display in Table 5.

Table 5. Precision on Logistic and SVM

Region	logistic	SVM
HhoHho	0.499	0.476
Manzini	0.378	0.365
Shiselweni	0.336	0.362
Lubombo	0.302	0.303

From the results on Table 5, it is the HhoHho region that has the highest precision for the financial inclusion using the logistic regression and the SVM.

Table 6. Classification Accuracy

	Logistic Regression	SVM
Correctly classified	38.1489	38.0806

From the classification accuracy result show on Table 6 it is discovered that after the pre-processing of the replaced missing data in the financial inclusion dataset of 2018 the result is affected negatively due to large missing data in the original dataset. This is the main reason why the accuracy in the two model considered are below 40%. The classification algorithms will only be able to make an informed decision on the dataset if the accuracy is 80% and above.

5.2 Inferences

The following are our inferences based on the study carried out in this research as far as financial inclusion in the kingdom of Eswatini is concern vis-à-vis governance:

- Statistically, after the pre-processing, it was discovered that over 80% payment was made by cash while less than 1% was through the bank. On bank usage, it was discovered that only 47.5% has used commercial bank, 66.4% used mobile money, 7.2% used cooperative society, 10% used insurance, 4.9% used pension fund and 0.9% used microfinance. Most households in local communities does not have bank account so government need to come up with a policy to encourage cashless society that will also give room for credit accessibility and use of financial institution.
- From the classification algorithm in machine learning, the recall result in Table 3 is an indication that the government of Eswatini need to pay more attention to enhance financial inclusion in the these three regions (HhoHho, Shiselweni and Lubombo) with more attention on Lubombo.
- It was discovered in this study that 66.7% of the household in low-income earning communities make use of mobile money for making payment then the government need to consider mobile money as part of the key indicator for financial inclusion.
- The government also need to encourage head of household on the importance of business registration since only 3.8% registered their businesses.
- Research in this area is few in Swaziland and this is attested to by Zikalala in [15] and Kanyangale [16].
- Low-income earners and small scale enterprenuers should be encouraged to bank in order to have access to credit facilities with the view to expand FI and thus have all the low-income earners included. Similar recommendation was made in [19].
- Financial empowerment programmes are recommended to train people in various households on investment vis-à-vis financial management. Such programmes open up the credit opportunities in financial institutions (i.e. Banks, Microfinance, Micro-insurance, Financial cooperatives etc) and how they can be accessible to low-income earners. This is similar to the recommendations stated in [28, 29].

6. Conclusion

Presently in Africa there is so much interest to promote financial inclusion based on the commitment of so many countries to financial inclusion action plan to reduce poverty and grow their economy [26, 30]. But Africa as a continent is lagging behind other continents in financial inclusion because inclusive development is left out [5, 31]. Our findings in this study show that there is still need to revamp the financial inclusion datasets on the demand-side using machine learning methods for exploring different pre-processing algorithms to eliminate the remaining outliers in the dataset to improve the classification accuracy which is yet to be looked into critically due to lack of data quality. A better classification can only be achieved when there is good quality of data. The Confusion matrix was discussed in this paper using logistic regression and SVM to classify the actual and observations (true positive, true negative, false negative and false positive) from the payment channel, registered/unregistered/licensed business, usage of commercial banks, mobile money, insurance, microfinance, cooperative society and source of income for head of household. The results show that the veracity of the financial inclusion dataset is weak and this is due to the fact that the precision and recall rate is less than 50% and 70% respectively. Therefore, it is expedient to separate the demand-side data from the supply side data from the entire dataset and also to employ different pre-processing approaches or data transformation techniques to improve the quality of the data which will automatically improve the classification accuracy. The misclassification of the features misrepresents the causes underlying financial inclusion due to the precision rate against the recall rate.

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