

Customer Behavioral Segmentation at Banking System using Principal Components Analysis and Artificial Neural Network: The Quality Management

Md.Sarwar Kamal¹, Mohd. Kamal Uddin²

¹Lecturer, Computer Science and Engineering

¹sarwar.saubdcoxbazar@gmail.com.

²Assistant Professor, Faculty of Business Administration

^{1,2}BGC Trust University Bangladesh, Chittagong.

²mku_bgc@yahoo.com

Abstract

Banking system is very important and essential part our daily life. For bank and business purpose, customers are the key factors for prosperity and development. In that case the customer behavior trace is very useful for the progress of the bank. Customer behavior segmentation is a technique of dividing customers into separate, meaningful, and homogeneous subgroups based on various features and facts. Bank. This work emphasis on the improvement of the start-of -the -art in commercial practice through machine learning data mining. Proper technology to assess huge amounts of transaction data to count efficient Customer Behavior Segmentation (CBS) in an exact time is a fundamental problem. We analyze the date set by K-Medoids Algorithm (KMA) .Besides the KMA, we also imposed Fuzzy K-Means and Fuzzy K-modes algorithms. The Principal Component Analysis (PCA) is finally used to correlate the appropriate data set. We noticed that K-Medoids Algorithms is better only for the linear and Quantitative data set. On the contrary, Fuzzy K-Means is better when there are lots of mixed data sets, I mean both for Qualitative and Quantitative. We suggest both of the algorithms for separate environments and policies.

Keywords: Bank fraud detection, machine learning data mining, Principal Component Analysis (PCA), K-Medoids Algorithm (KMA), Fuzzy K-Means and Fuzzy K-modes algorithms.

1. Introduction

Financial sector of a country comprises with commercial banks, non-bank financial institutions, insurance companies etc. In the investment arena and financial system of the country Banks play significant role by mobilizing people's savings in the form of deposits. Banking business has been shaped as global business and the rest other business greatly depends on the strength of banking performance. Expansion of bank branches is also directed to increase the network of the banking system. In a sense, healthy banks and healthy economies seem to go together (Kashem & Ullah, 2005). A healthy banking system depends on the sound performance to satisfy the clients' need promptly in the appropriate manner. For bank and business purpose, customers are the key factors for prosperity and development. In that case the customer behavior trace is very useful for attaining the ultimate goal and progress of a bank. Benhabib and Spiegel (2000) argued that the economic growth is positively linked to financial development. Later on, it is observed that a country having a well-organized banking industry can achieve economic growth rapidly as a consequence of the financial development (Levine, 2005). Customer segmentation is one of the vital functions of the marketing management approach to marketing. This approach involves with the identification of the relevant market that the company is serving and the partitioning of the market into groups of customers (segments) with similar needs and/or characteristics who are likely to exhibit similar purchase behavior. The aim can range from a purely descriptive aim of creating better understanding of the situation in the customer base to a highly

normative aim of generating actions in order to influence the profitability of different segments of the customer base (Kaj Storbacka, 2009). Maintaining clients and performing cross sales play a determinative role in a bank's profitability, market segmentation and the examination of customer attitude and beliefs towards banking services. Customers today are demanding a more personalized service and look for an optimal customer experience. Direct in-person customer contact and customer advisory services in the branch provide opportunities for banks to enable a high-quality, differentiated customer experience supported by innovative technology, such as surface computing, interactive media, information/transaction terminals, and multifunctional ATMs (cash points), enhancing the customer value proposition.

2. Objective of the Study

The banking sector in Bangladesh has achieved unprecedented expansion in terms of number and diversity of business keeping the view of individual and national perspectives. Most of the banks are using value based segmentation; renewing and detailing their segmentation schema in line with their business objectives that will help them realize untapped potential. However, having a look into the past literature, the present authors found a significant research gap invariably relevant to the issues presented in this paper. The paper tried to portray a fruitful combination between modern sophisticated programming tools (Computer Algorithm and Artificial Neural Network) and the ultimate goal and functions of the financial service providing organizations like banks of a country. The authors assume that the study will have a far reaching value in understanding the behavior of different types of customers linking to banks and delivering timely services ensuring smooth functioning through proper customer segmentation. Thus, the paper aims at application of proper technology to assess huge amounts of transaction data to count efficient Customer Behavior Segmentation (CBS) in an exact time to deliver prompt services which will be helpful in accelerating banks' smooth functioning system.

3. Literature Review

There are many references in international literature on customer segmentation and the factors that affect the purchasing behavior of financial product consumers. Apart from the use and reliability of psychological characteristics as segmentation criteria and the supremacy of ad hoc segmentation, Harrison [7] and [10] further dispute the adequacy of demographic characteristics for market segmentation. Beckett [3] presents a model that characterizes consumer behavior during the purchase of a financial service. By using as determinative factors of behavior the involvement in the service and the uncertainty of choice, they result in 4 types of consumers, depending on the combination of two characteristics. According to Arthur Meidan [12], the factors affecting the behavior of financial product consumers are divided in internal (psychological such as motivation, perceptions, and personal such as life cycle, age, profession, economic status, personality), external (cultural and social) and purchasing procedures. Bank customers are today more informed than ever before and have a high level of confidence in choosing products and service providers for themselves. Dr. Markus Hamprecht and Frédéric Brunier [5] in their study titled "Enhancing the banking customer value proposition through technology-led innovation", analyzed the new customer requirements towards banks. The study sheds light on the importance of technology for the banking customer and provides practical advice and tools for bank managers. Islam and Yang [8] observed that service quality satisfaction and informational trust had important mediating effects on the Balance score card performance process. These two mediating roles explain that, when an institution creates and raises the levels of service quality satisfaction and informational trust, the results lead to a favorable customer interaction relationship and thus could help the institution achieve higher levels for Balance score card performance measure. W. Boyd et al [4] focus on demographic characteristics, such as gender, age, marital status and records customer preferences in selecting their bank. Marla Royne Stafford [13] also highlights the importance of demographic characteristics stating that even though other types of segmentation are used (e.g. consumer behavior, psychological factors), a marketing expert

should know and understand demographic criteria in order to be able to estimate the size, the approach and the effectiveness of the market. Moreover, demographic criteria constitute an easier means of segmentation. The paper of G. McDougall et al. [11] is also based on psychological characteristics, aiming at examining the way quality of offered services is perceived by different client groups.

4. Technical Classification

Any organization in the world will run by the influences and utilization of users. The users may be mass people throughout the world. The contribution by the users will make any organization stable and permanent. In the context of business users are called as customers or consumers. The business prospects of industry cannot be succeeding without satisfaction of the customers who remain loyal and develop their relationship with the organization. On the eve of customer happiness the company always tried to design strategy of welfare and benefit. To achieve the goals the authority can follow any process like CRM (Customer Relationship Management) for building, managing, and strengthening loyal and long-lasting customer relationships. CRM should be a customer-centric approach based on customer insight. Its scope should be the “personalized” handling of customers as distinct entities through the identification and understanding of their differentiated needs, preferences, and behaviors. In order to make the CRM objectives and benefits clearer, let us consider the following real-life example of two clothing stores with different selling approaches. Employees of the first store try to sell everything to everyone. In the second store, employees try to identify each customer’s needs and wants and make appropriate suggestions. Which store will finally look more reliable in the eyes of customers? Certainly the second one seems more trustworthy for a long-term relationship, since it aims for customer satisfaction by taking into account the specific customer needs. CRM has two main objectives: 1. Customer retention through customer satisfaction. 2. Customer development through customer insight.

5. Behavioral Segmentation

In behavioral segmentation the segments are identified with the application of appropriate clustering models on usage/behavioral data that usually reside in the organization’s data warehouse or data marts. Thus behavioral segmentation can be implemented with a high degree of confidence and relatively low cost. Attributes that can be used for behavioral segmentation include product ownership and utilization, volume/type/frequency of transactions, payment and revenue history, and so on.

Typical behavioral segments that can be found in banking include below:

Segmented Class	Functionalities
Depositors	Savings products – mostly deposit transactions using the network of branches.
Future investors	Insurance and investment products – few payment and deposit transactions.
Consuming borrowers	Consumer lending products (credit cards and consumer loans) – moderate to many transactions using all channels.
Frequent travelers	All kinds of products – many transactions through different channels and many international transactions.
Shoppers	Credit cards and other products – many transactions using mostly credit cards for purchases.
Needs borrowers	Mortgage loans and consumer loans – mostly payment transactions using the network of branches.
Classic users	Savings products and cards – moderate transactions mostly through branches and ATMs.
Transactioners	Payroll savings products with low balances – many transactions mostly for making small withdrawals for everyday needs.
Inactive	Unused savings accounts – no transactions. Typical behavioral segments that can be found in <i>mobile telephony</i> include
Roamers	Heavy users of all available services – the key differentiating factor is that they use their cell/mobile phones to make calls from abroad.
Superstars	Heavy users of all available services and all new cellular services (Internet, MMS, 3G, etc.).

Professional users	Heavy voice users – increased voice usage and a very high incoming community (the incoming community is the number of distinct callers that have called the specific
Classic users	Average voice and SMS usage.
Youth – SMS users	Heavy SMS users – they prefer using SMS to voice
Oldies – basic users	Voice usage only – very low incoming community.
Inactive	No outgoing usage for a significant time period. A detailed methodological approach for behavioral segmentation is presented in “A Guide for Behavioral Segmentation”.

Table 1: Over all Bank behavior of the existing system.

6. Data Collection

We have visited five private bank and two government bank in Patiya regions of Chittagong city. We also talked with the Branch manager as well as the senior employers of the Bank. Mr.Ifteler branch manager of Brack Bank told us that customers want the benefits from them in all sides especially when there are huge congestions. Some customers are very excited when they did not get quick responses. When customers are not getting their demands they become very much furious to the respective employers. Mr.Sumon, a senior officer of the EXIM bank told us that the female customers are more polite but they do not have any idea on banking transaction.

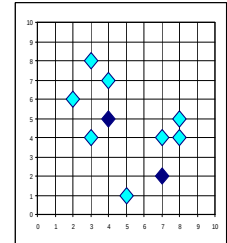
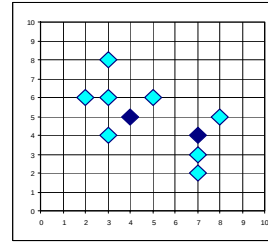
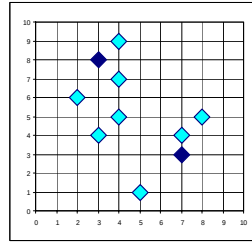
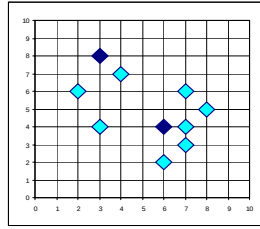
Bank Name	Customer Name	Loan ID	Loan Account	Location
Brack Bank	Tapos Bormon	4001	124782	Patiya
Brack Bank	Afjal Hossain	4012	783141	Do
Brack Bank	Abdul Aziz	4902	321574	Do
Brack Bank	Hira Das	4092	492345	Do
Brack Bank	Morjina Begum	4982	438921	Do
Dhaka Bank	Earsad Ullah	8723	234120	Do
Dhaka Bank	Emam Uddin	8701	234045	Do
Dhaka Bank	Abul Khair	8728	230912	Do
Dhaka Bank	Towhidul Islam	8723	234570	Do
Dhaka Bank	Karim Uddin	8703	249072	Do
UCBL Bank	Jahedul Islam	5423	764848	Do
UCBL Bank	Nishita Shaha	3452	658392	Do
UCBL Bank	Moktar Hossain	4563	652310	Do
UCBL Bank	Abutahar Mia	4567	680213	Do
UCBL Bank	Khursad Fazil	7832	602343	Do
Janata Bank	Asis Mia	0923	984536	Do
Janata Bank	Farhan Ali	0876	908765	Do
Sonali Bank	Tipu Sultan	3424	214567	Do
Sonali Bank	Korim Monshi	3214	213468	Do
Agrani Bank	Absar Mia	0123	987566	Do
Agrani Bank	Josim Uddin	0342	982342	Do

Table 2: Customer information from different banks.

7. The K-Medoids Clustering Method

- Determine k data set arbitrarily
- For each pair of non-identified data set h and determined data set i , calculate the total swapping cost TC_{ih}
- For each pair of i and h ,
 - If $TC_{ih} < 0$, i is changed by h
 - Then assign each non-determined data set to the most similar data set.
- repeat steps 2-3 until there is no change

Total swapping cost



$$C_{jih} = d(j, h) - d(j, i) \quad C_{iih} = 0 \quad C_{jih} = d(j, t) - d(j, i) \quad C_{ih} = d(j, h) - d(j, i)$$

Figure 1: The K-medoids clustering for various customer segmented mentioned at table 1.

8. THE K-MEANS CLUSTERING

Given m , the m -Means algorithm is implemented in 4 steps:

- Partition objects into m nonempty subsets
- Calculate pivotal points as the centroids of the clusters of the new orientation. The
- Partitioned each object to the cluster with the nearest pivotal point.
- Go back to Step 2, stop when no more new assignment.

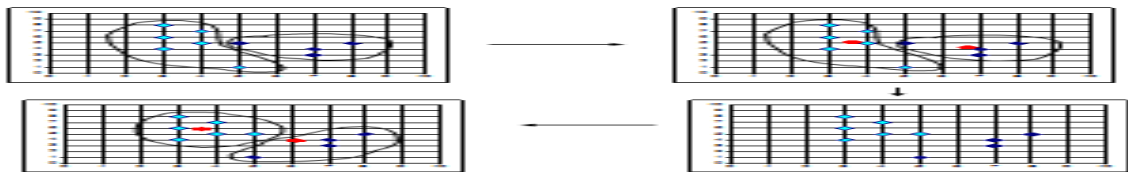


Figure 2: K-Means Clustering Algorithm.

9. Principal Component Analysis

From k original variables: $x_1, x_2, \dots, x_k$:

Produce k new variables: $y_1, y_2, \dots, y_k$:

$$y_1 = a_{11}x_1 + a_{12}x_2 + \dots + a_{1k}x_k$$

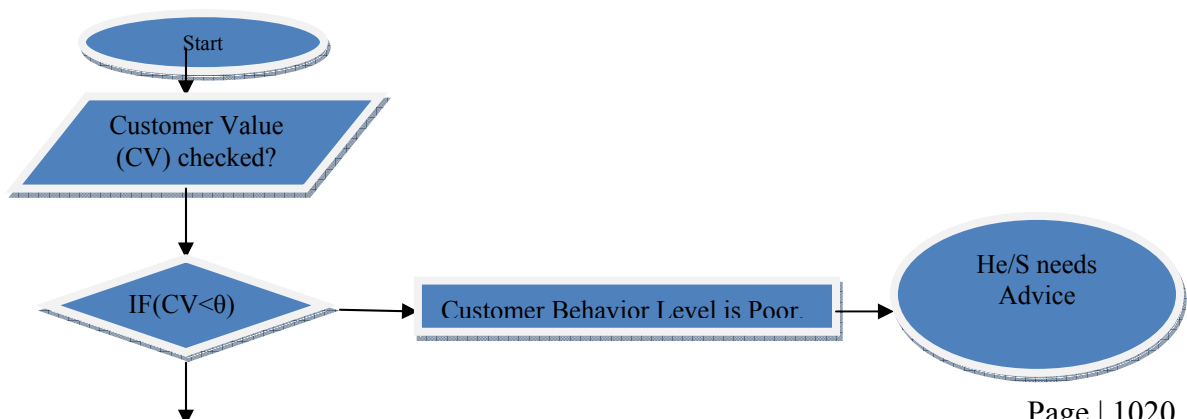
$$y_2 = a_{21}x_1 + a_{22}x_2 + \dots + a_{2k}x_k$$

...

$$y_k = a_{k1}x_1 + a_{k2}x_2 + \dots + a_{kk}x_k \quad \text{From } k \text{ original variables: } x_1, x_2, \dots, x_k:$$

10. Implementation

Here we have segmented the three categories of the customers based on their attitudes, gestures, patients, movements, demands, body languages, communication skills and literacy. According to the algorithms of K-Means and K-Medoids Clustering, we have noticed that K-Medoids perform very well and finally the Principle Component Analysis (PCA) correlates all the classifications results. We define a threshold value of standard behavior after talking with Branch managers of five banks including two governmental Banks. Based on their opinion we then check this parameter with the K-Medoids Algorithm threshold value. Then we finalized the value is $\theta=0.24$. The flow chart of the process is given below.



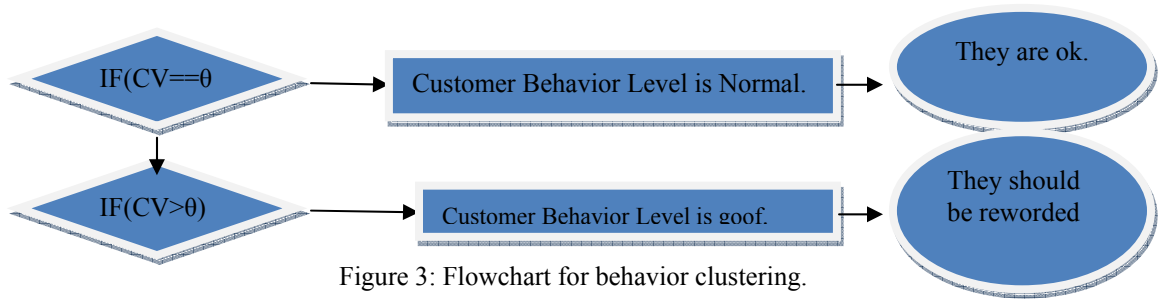


Figure 3: Flowchart for behavior clustering.

11. Result

Bank Name	Customer Name	Loan ID	Loan Account	Location	Segmented
Brack Bank	Tapos Bormon	4001	124782	Patiya	Good
Brack Bank	Afjal Hossain	4012	783141	Do	Poor
Brack Bank	Abdul Aziz	4902	321574	Do	Ok
Brack Bank	Hira Das	4092	492345	Do	Ok
Brack Bank	Morjina Begum	4982	438921	Do	Poor
Dhaka Bank	Earsad Ullah	8723	234120	Do	Poor
Dhaka Bank	Emam Uddin	8701	234045	Do	Poor
Dhaka Bank	Abul Khair	8728	230912	Do	Poor
Dhaka Bank	Towhidul Islam	8723	234570	Do	Poor
Dhaka Bank	Karim Uddin	8703	249072	Do	Poor
UCBL Bank	Jahedul Islam	5423	764848	Do	Poor
UCBL Bank	Nishita Shaha	3452	658392	Do	Poor
UCBL Bank	Moktar Hossain	4563	652310	Do	Good
UCBL Bank	Abutahar Mia	4567	680213	Do	Ok
UCBL Bank	Khursad Fazil	7832	602343	Do	Poor
Janata Bank	Asis Mia	0923	984536	Do	Poor
Janata Bank	Farhan Ali	0876	908765	Do	Good
Sonali Bank	Tipu Sultan	3424	214567	Do	Good
Sonali Bank	Korim Monshi	3214	213468	Do	Ok
Agrani Bank	Absar Mia	0123	987566	Do	Ok
Agrani Bank	Josim Uddin	0342	982342	Do	Ok

Table 4: The resultant part of the experiment.

12. Conclusion

Developing effective strategies across a range of behavior segmentation disciplines requires broad insights into customer value, potential value, behaviors and needs. By implementing Customer Relationship Management (CRM.) and creating client databases, it is possible for financial institutions to analyze and perform effective and profitable market segmentation. This is possible through assessing information collected in order to determine common preferences and ways of behavior, depending on common characteristics of the various customer groups, such as demographic, geographical, psychological, etc. Managing different banking relationships and comparing products and services between different providers is becoming easier for customers through direct channels, Internet blogs, and forums, and social networks. The present paper stimulates the future researchers in this field opening a new dimension in the existing literature regarding the issues of banking customer behavior segmentation using Principal Components Analysis and Artificial Neural Network in order to accelerate the modern banking system.

13. References

- [1].A. F. Kashem, M. Abul, S. M Ullah: "Performance Dynamics of Banking Industry in Bangladesh" IBS Business Review, *Journal of Bangladesh Institute of Development Studies*, Volume: III (2005).
- [2].Benhabib, J. & Spiegel, M. M. (2000) *The Role of Financial Development in Growth and Investment*, Journal of Economic Growth, 5, 341-360.
- [3].Beckett A., Hewer P., Howcroft B., (2000), "An exposition of consumer behavior in the financial services industry", International Journal of Bank Marketing, Vol. 18, No 1, pp. 15-26.
- [4].Boyd L.W., Leonard M., White C., (1994), "Customer preferences for financial services: an analysis", International Journal of Bank Marketing, Vol. 12, No 1, pp. 9-15.
- [5].Dr. Markus Hamprecht and Frédéric Brunier (June 2011), Enhancing the banking customer value proposition through technology-led innovation Accenture's research, www.accenture.at , Accenture GmbH Campus Kronberg 1 D-61476 Kronberg in Taunus.

- [6].Levine, R. (2005). Finance and Growth: Theory and Evidence. In P. Aghion & S. Durlauf (Ed.), *Handbook of Economic Growth* (pp. 865-934). Netherlands: Elsevier B. V.
- [7].Harrison S.T., (1994), “*Mapping customer segments for personal financial services*” International Journal of Bank Marketing, Vol. 12, No 8, pp. 17-25.
- [8].Islam, Majidul and Yang,Yi-feng(2009). “Service Satisfaction, Information trust and e-CRM. Performance in BSV model in the Empirics of Financial Institutions”,*Journal of Business & Policy Research*,Vol.4,No.1,July.
- [9].Kaj Storbacka (2009). *Segmentation Based on Customer Profitability – Retrospective Analysis of Retail Bank Customer Bases*. CERS - Center for Relationship Marketing and Service Management, Swedish School of Economics and Business Administration, Finland.
- [10].Machauer A., Morgner S., (2001), “ *Segmentation of bank customers by expected benefits and attitudes*”, International Journal of Bank Marketing, Vol. 19, No 1, pp. 6-17.
- [11].McDougall H.G.G., Levesque J.T., (1994), “Benefit segmentation using service quality dimensions: an investigation in retail banking”, International Journal of Bank Marketing, Vol. 12, No 2, pp. 15-23.
- [12].Meidan A., (1996), *Marketing Financial Services*, Macmillan Press Ltd, London.
- [13].Royne Stafford M (1996) “Demographic discriminators of service quality in the banking industry”, The Journal of Services Marketing, Vol. 10, N. 4, pp 6-22.