AN EMPIRICAL ANALYSIS OF MOBILE PHONE USERS FOR COMPETITIVE BUSINESS INTELLIGENCE

By

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ABSTRACT

With the current globalization drive, most firms rely on Competitive Intelligence to help position them strategically through effective decision-making based on Customer Relationship Management (CRM), marketing activities and competitors' vulnerability. It is of interest therefore to make decisions based on accurate inferences. Association rules have been widely used in data mining to find patterns in data that reveal combinations that occur at the same time which are called rules. The rules are sometimes too numerous to be used in decision making, hence, the interestingness of the rules are used to select the subset to act upon.

This paper aims at evaluating the interestingness of rules gotten from applying association rule mining algorithm to data received from questionnaires of mobiles phone users in Nigeria. A pattern is interesting if it is easily understood by humans, potentially useful and novel. The evaluation of the rule is done objectively using statistical independence and correlation analysis. This research has helped to reduce the uncertainty and inaccuracy of rules from which decisions are based towards the competitive advantage of an organization. Findings from the research revealed the areas of strength and weakness of mobile phone manufacturers and this understanding is used to provide competitive business decisions, which will in turn contribute to the profit of the organization.

Keywords: Competitive Intelligence, Association Rule Mining, Interestingness, Evaluation, Behaviour, Mobile Phones.

INTRODUCTION

No business is an island. For a business to succeed, it will need to deal with customers, suppliers, employees, and others. In almost all cases, there will also be other organizations that offer the same or similar products to similar customers. These organizations are known as the competitors.

Not so long ago, the mobile phone was an amazing invention, which revolutionized communication between humans. It has now become a piece of technology, which is deeply ingrained in modern life. In less than twenty years, mobile phones have gone from being rare and expensive pieces of equipment used by businesses to a pervasive low-cost personal item. In Nigeria today mobile phones outnumber land line telephones, with most adults and many children now owning mobile phones [Charles.K.Ayo etal (2007)]. Each new handset provides new exciting designs with MP3 players, cameras and other interactive goodies all of which fit into a pocket sized package, which with each evolution becomes lighter and thinner.

With all the focus on the technology and the desire to squeeze more and more exciting software on to mobile phones, the key function of the phone as a communication device seems to have been overlooked in some cases. The experiences of many mobile phone users are being overshadowed by the evolving technology, which in essence, might not be solving the problem of telephone industries, that is, the need to be bigger and brighter than the competitor. This study therefore aims to reveal which of these technologies help to improve the competitive advantage of the mobile phone industry. It also aims at revealing, if any, the weaknesses of various mobile phones in Nigeria.

Competitors in the mobile phone industry for more profit making can therefore capitalize upon this information.

Business Intelligence (BI) systems combine data gathering, data storage and knowledge management with analytical tools to present complex and competitive information to planners and decision makers [Solomon N. And Paul G. (2003)]. Strauss et al [Silverberg M. Etal (2000)] also defined business intelligence as the activity of gathering both secondary and primary information about competitors, markets, customers, and more. Business Intelligence is aimed at achieving the following goals: improving the timeless and quality of input to the decision process, and corporate performance management; optimizing customer relations; monitoring business activities and traditional decision support; packaging standalone BI applications for specific operations or strategies; providing actionable knowledge and delivering it at the right time [Bocker M. And Suwita A. (1999)]; offering better quality information; better observation of threats and opportunities and improving efficiency and information sharing among others [Mikah & P. Virpi (2002)].

Competitive intelligence (CI) which is an aspect of Business Intelligence involves analyzing the industry in which a firm operates by considering the input to the firm's strategic positioning, marketing activities as well as understanding competitor vulnerabilities for better decision making [Strauss J. et.al (2006)]. It is a specialized branch of Business Intelligence that involves a systematic and ethical program for gathering, analyzing and managing external information that can affect the organization's plans, decisions and operations [Strauss J. et.al (2006)].

Competitive Intelligence is composed of the following stages:

1. Collecting the information.
2. Converting the information into intelligence, It involves three steps: CIA -Collate and catalogue it, Integrate it with other pieces of information and Analyze and interpret it.
3. Communicating the intelligence and countering any adverse competitor actions. Analyzing and interpreting data have been done using various techniques such as Analytic Hierarchy Process (AHP) and multiple linear regressions and so on [http://dspace.dial.pipex.com/town/square/ae034/competitor-analysis.html].

The rest of the paper is organized as follows.

Section1 presents a review of related work, section2 presents the objectives, selection3 describes the methodology of the system, the results obtained is presented in section 4 followed by the conclusion.

1. Literature Review

The previous works done in the area of mobile phone usability are listed here: It was reported in [Tomas Klockar et.al (2002)] that Tomas Klockar et al conducted usability test on mobile phones in order to find out how easy it is to use uncommon functions in Nokia and Siemens phones. They conducted a usability test to find how well users have learned their phone interfaces, in which 9 owners were asked to perform 26 tasks once. When performing the test, participants were seated with the phone in their hands and were videotaped with the camera focused on the phone. Their findings were presented in form of a Histogram. Similarly, in [Tomas Klockar et.al (2002)], it was reported that Böcker et al. evaluated two possible interfaces for the Siemens C10. They used a computer simulation to compare both an icon-based, and a text-based, hierarchical menu system to find out which had better performance. With a test of 80 users, it was found that users were more able to complete tasks with the text-based interface, but that they were more likely to buy a phone with the iconic interface [Grover D.L. et.al (1998)]. Silfverberg et al. in [Grover D.L. et.al (1998)] reported a theoretical evaluation of different methods of entering text into any phone. Finally, Young Sam Ryu et al [YoungSamRyV.et.al(2007)] did a comparative usability evaluation on mobiles phones using Mobile Phone Usability Questionnaire (MPUQ). Further, decision-making models using Analytic Hierarchy Process (AHP) and multiple linear regressions were developed and applied to the results from the questionnaires. Their study revealed

how mobile phone users make different decisions through different evaluation methods. Studies have also been carried out to attempt to inform the design of mobile phones. One such study focused on the ethnographic study of teenage mobile phone users to inform the design of third generation mobile phones. It highlighted that there is potential for future technology solutions to be compatible with and useful in people's everyday lives [Grover D.L. Et.al (1998)]. However, in our work we focus on evaluating customer satisfaction (through the usability issues of mobile phones) for exploiting competitive business intelligence in the mobile phone industry.

2. Objectives

The objectives of this paper include:

1. To gather data on customers' satisfaction data.
2. To apply association rules to generate rules from such data.
3. Evaluate the interestingness of such rules to reduce the uncertainty and inaccuracy of rules from which decisions are based towards the competitive advantage of an organization.

3. Methodology

Questionnaire was designed and administered to 310 respondents and all of them were returned valid. To handle analysis and interpretation stage in this research, the association rule technique was implemented to discover patterns that revealed possible combinations, which are called rules. The generated rules were further refined to evaluate their interestingness with a view to selecting the proper subset for decision making. Association rule mining and Correlation analysis in statistics were implemented using C# 2005 and SQL server 2005 as the database platform.

3.1 Questionnaire Description

The following are samples of the questions contained in the questionnaire:

What is your age range?

What is your profession?

What is your highest Academic qualification?

Are you a Nigerian?

What Brand (be specific with model) of mobile phone do you use?

What is the reason for changing your phone?

What is the general assessment of your mobile phone user friendliness?

Rate how easy it is to navigate through the services you have on your mobile phone.

Tick the Service(s) that has been most frustrating to use on your mobile phone.

How would you rate the availability of purchasing your mobile phone?

Why did you decide to purchase that particular brand of mobile phone?

What improvements would you like to see, if any on your mobile phone?

3.2 Association Rule Mining

Association Rule mining, one of the most important and well researched techniques of data mining is used to extract interesting correlations, frequent patterns, associations or casual structures among some sets of items in the transaction database or other data repositories.

Let $I=I_1,I_2,\ldots\ldots\ldots\ldots,I_m$ be a set of m distinct attributes.

T be transaction that contains a set of items such that $T \subseteq I$.

D be a database with different transaction records Ts.

An Association rule is an implication in the form of X Y, where X, Y $\subset$ I are sets of items called item sets, and X Y= . X is called antecedent while Y is called consequent, the rule means X implies. There are two important basic measures for association rules, support(s) and confidence(c) [Qiankun Zhao.et.al (2003)].

Support (s) of an association rule is defined as the percentage/fraction of records that contains X U Y to the total number of records in the database.

That is

$$Support(XY) \quad \frac{\text{support count of (XY)}}{\text{Total number of transactions}}$$

Confidence (c) of an association rule is defined as the percentage/fraction of the number of transactions that

contain X U Y to the total number of records that contain X, where if the percentage exceeds the threshold of confidence an interesting association rule X Y can be generated.

That is :

$$\text{Confidence}(X \mid Y) \quad \frac{\text{Support}\ (XY)}{\text{Support}\ (X)}$$

Evaluating the association rules gotten from the above formulae was done using correlation analysis to determine the degree of interestingness of each rule generated. The rules which are not positively correlated were eliminated from the list of generated rules. This therefore helps to reduce the number of rules from which decision is based upon, to the most interesting rules.

3.3 Correlation Analysis:

The occurrence of itemset A is independent of the occurrence of itemset B if P(AUB) = P(A)P(B); otherwise itemsets A and B are dependent and correlated as events. i.e

$$Corr(AB) \quad \frac{P(AUB)}{P(A)P(B)}$$

If the resulting value of the equation is less than 1, then the occurrence of A is negatively correlated with (or discourages) the occurrence of B. If the resulting value is greater than 1, then A and B are positively correlated, it means the occurrence of one determines the other. If the resulting value is equal to 1, then A and B are independent and there is no correlation between them [Jiawei el.al (2001)].

4. Results of the Study

Table 1. gives a brief statistics of phone brands and the number of users as received from the questionnaire.

From Table 1 it is obvious that Nokia phone products are the most widely used in Nigeria followed by Motorola. The reason for this is revealed in the implementation of association rule.

Figure1 gives a snapshot of the rules that were generated as a result of the application of association rule on the data. The support Threshold used is 13% (40 transactions) and the confidence is 70%. The support is chosen to be as low as 13% so as to have a fair representation of the important attributes (such as Difficulty in composing ringing tones) which might not be included in the rule generation due to number of questionnaire administered. Confidence was fixed at 70% so as to be able to reduce the number of rules generated.

Evaluation:

The result of the evaluation shows a 43% reduction in the number of rules generated. This therefore helped to reduce the rules upon which decisions are based to the most interesting ones. Rule such as:

Name of Phone Brand	Total Number of users
Nokia	197
LG	4
Panasonic	2
Samsung	18
Sagem	18
Motorola	24
Sony Ericson	17
VisaPhone	1
SENDO	2
DORADO	1
STARCOMS	6
VodaPhone	3
Empty	17

Table 1. Distribution of users by mobile phone brands

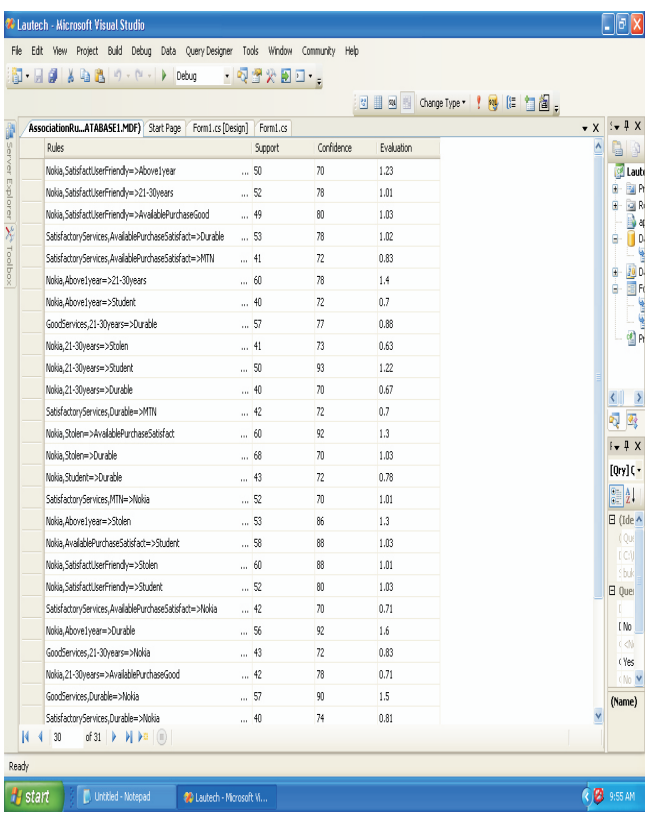

Figure 1. Part of the resultant association rules generated.

GoodServices,21-30years=>Durable

Nokia,Stolen=>Student

can be disregarded due to the result of the evaluation which reveals that they have evaluation values of 0.88 and 0.63 respectively. The implication of these evaluation according to correlation analysis is that any rule with correlation value <1 is negatively correlated.

Interpretation of the extracted rules:

Some of the association rules that describe the relations between attributes in the database are presented in Table 2. The rules give information on some interesting patterns that can be used for competitive business intelligence in the Nigerian mobile phone industry. The first column represents rules generated, the second column represents the support count, the third column represents the confidence and the last column represents the evaluation results.

Samples of the generated rules are interpreted for competitive intelligence as follows:

The rule *Nokia,SatisfactUserFriendly=>Above1year:* gives a clear inference that the users of Nokia products find it to user friendly and most of them have for this reason been using it for over one year and are therefore not disposed to change their phone often. Companies that produce other brands such as Samsung and Panasonic should therefore improve on their user friendliness.

The rule *Nokia,SatisfactUserFriendly=>21-30 years:* reveals a high population of Nigerian between the age of 21 and 30 who use Nokia phones because they find it to be user friendly. Therefore marketing could be targeted towards this sector of the population.

Rules	Support	Confidence	Evaluation
Nokia,SatisfactUserFriendly =>Above1year	50	70	1.23
Nokia,SatisfactUserFriendly =>21 - 30years	52	78	1.01
Nokia,SatisfactUserFriendly => AvailablePurchaseGood	49	80	1.03
Nokia,Stolen =>Durable	68	70	1.03
GoodServices,Durable =>Nokia	57	90	1.5
DifficultComposeRingTone, SatisfactUserFriendly =>Nokia	58	88	1.33

Table 2. Samples of extracted association rules

The rule *Nokia, SatisfactUserFriendly=>Available Purchase Good:* reveals that Nokia phones are easily and readily available to purchase.

The rule *Nokia,Stolen=>Durable:* reveals that even though Nokia phones are durable, they are often changed by the user because they are stolen very often. Nokia company can therefore look for means of improving on security features. Also, because of the fascinating features(radio, TV etc) it is the target of most customers and thieves alike.

The rule *GoodServices,Durable=>Nokia* implies that Nokia phone users were interested in buying it because they find it durable and easy to navigate through the services that are present on the phone.

The rule *DifficultComposeRingTone,Satisfact UserFriendly=>Nokia* reveals that even though users of Nokia phones are satisfied with its user friendliness, they however have difficulty in a particular service that it offers which is "Composing ringing tones". Both the Nokia company and other companies competing with it such as Sony Ericson and so on, can therefore improve on this servie so as to be able to win more customers.

Conclusion

In conclusion, identifying user requirements and understanding the user is a major part of contributing to the profit of the organization and this can be achieved through competitive intelligence.

This research has helped to reduce the uncertainty and inaccuracy of rules from which decisions are based towards the competitive advantage of an organization.

In this research, we have implemented Association rule technique of data mining, which has been widely used to find patterns in data that reveal combinations occurring at the same time, which are called rules. The rules are sometimes too numerous to be used in decision-making; hence, we have further refined these rules by evaluating the interestingness of the rules in order to select the subset to act upon. Also the implementation of association rules as opposed to the traditional statistical analysis has helped to reveal unique interesting relationships among

items in the data received from the questionnaire.

The evaluation of the generated rules gave pointers to the various attributes of the manufacturers considered, particularly the areas of strengths and weakness for the purpose of competitive business intelligence.

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