Classification Analysis of NPO Donators: A Case Study of a Taiwanese University

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---**ABSTRACT**--

To propose a practical alumni donor type analysis model, this study applied customer profitability analysis from relational marketing theory as a basis to investigate the sorting of alumni groups by donation profitability using data contained in a university database regarding a large number of university alumni. The ultimate purpose of this study was to provide a new direction for university planning and fundraising strategies. The subject of this case study was a private university in Taiwan, and its alumni database was used to construct an alumni donor type analysis model through the application of four data mining techniques (discriminant analysis, logistic regression, artificial neural network, and multivariate adaptive regression splines). This process distinguished four types of alumni groups: lost alumni without profitability, lost alumni with profitability, retained alumni without profitability, and retained alumni with profitability. A comparison of discriminative rates showed that the multivariate adaptive regression splines model had the highest overall correct classification rate, 82.6%, and thus is a tool worthy of recommendation.

Keywords—*NPO, donate behavior, customer profitability analysis, ANN, MARS*

I. INTRODUCTION

Unlike general revenue sources for businesses, the main financial sources for nonprofit organizations are government grants and private donations. Regarding universities, because governments worldwide generally consider institutions of higher education to be important units for knowledge development and the cultivation of employment talent, universities are often quite reliant on government educational funding in addition to tuition income. However, if the government's annual budget for higher education continually decreases, the operating burden on universities is bound to become heavier. To avoid financial problems, all universities must increase the proportion of revenue from private donations or even consider a shift toward market-oriented operations.[4][6][8] U.S. universities have engaged in fundraising efforts for many years and have achieved quite fruitful results. According to the U.S. Council for Aid to Education (CAE), 2014 data show that revenue from donations at 1,000 major U.S. universities amounted to approximately USD 38 billion, reflecting an increase of 10.8%, and that alumni donations amounted to USD 9.85 billion, accounting for more than 25% of the total[23][24][24]. These data indicate the importance that U.S. universities attach to fundraising efforts and demonstrate the significance of alumni donations to their alma maters. Gostomski (2004) noted that both the status of a university in terms of academic research and the extent to which alumni identify with their alma mater affect the willingness of alumni to donate generously[3]. A survey by CAE found that to target five to eight donors, universities must hire researchers to conduct fundraising target research with a focus on alumni donation behavior. University research staff analyze statistical data on alumni lifestyle, interests and donation behavior with the goal of determining the conditions under which alumni would give more easily. Sheridan (2004) argued that with the exception of spontaneous donations, donation behavior is stimulated primarily by institutional initiatives in external fundraising. Therefore, many universities have been hindered by their lack of follow-up contact for fundraising purposes (due to, e.g., changing email addresses), inadequate investment in fundraising activities, limited human resources, a lack of fundraising software, and the failure to cultivate on-line fundraising techniques among staff[18].

According to a Taiwanese survey on the current status of university fundraising, mediocre donations are believed to be caused by several factors, including the failure of universities to engage in targeted self-promotion, the incomplete construction of alumni databases, the inability to create an effective contact network, a lack of initiative to hold fundraising activities that prioritize alumni, and difficulty convincing alumni to give back to their schools. In addition, the lack of a dedicated fundraising unit and inadequate manpower and resources affect external fundraising results[4][13].

Chen (2010) maintained that due to the stability and diffusion effect generated by donors who have long identified with and actively invest in an organization's goals, continued interaction with these donors and adequate expressions of gratitude for their donations can create unexpected support for fundraising measures. Therefore, building long-term relationships with the most generous alumni donors is an important strategy in university fundraising[4].

The analysis and sorting of alumni groups that demonstrate the most profitable donation behavior out of the large number of university alumni in the university database and the maintenance of good relations with these alumni over the long run to increase the effectiveness of the university's fundraising efforts are important market research topics that could enhance university fundraising. Among data mining techniques, customer profitability analysis (CPA) provides the best selection criteria. CPA refers to the quantification of customer contributions to a business and is used to support customer profit management. Universities can view alumni as valuable customers. CPA will allow universities to thoroughly understand the values of donor alumni and to formulate different strategies to target alumni groups with different values. This enables the more efficient use of resources and will increase the overall value of alumni donations[16][22].

Based on the aforementioned, this study believes that the use of a simple, robust, and highly discriminating model on alumni donor types and the implementation of different fundraising strategies to target various alumni donor types are new strategies that university fundraising units should consider.

Unlike previous academic research on university fundraising, which focuses on the qualitative attributes of the donor and recipient units, and studies on increasing university fundraising results (for example, by setting up a dedicated mechanism, earmarking, establishing a school brand, and using donations properly and transparently to increase alumni loyalty and support), this study references CPA in relational marketing theory to focus on the development of a sorting model for the donation behavior of university alumni. By crisscrossing the two dimensions of "whether the alumnus was lost or retained" and "high or low donation profitability," four alumni groups were formed: lost alumni with low donation profitability, lost alumni with high donation profitability, retained alumni with low donation profitability, and retained alumni with high donation profitability. This model uses data mining techniques to process the large number of alumni contained in a database, identify alumni characteristics via related classification techniques, and divide alumni donation profitability into groups. This process allows building classification rules that predict alumni lifetime value characteristics, which in turn will provide a reference for operational decision making on alumni relations that will enhance the performance of university alumni fundraising.

This study is divided into five parts. The first part is the introduction, which explains the background and motive of the study and describes the research objective and process. The second part is a literature review, which includes topics such as university funding sources, fundraising work, and alumni donations to probe the significance of alumni donations. The third part focuses on research methodology, introducing the information processing theory referenced by this study and explaining how to build the model. The fourth part provides the results of the empirical analysis and compares the classification methods of the analysis models. Finally, the fifth part presents a discussion and the conclusion of this study.

II. LITERATURE REVIEW

1. Purpose of University Fundraising

There are five main reasons for a nonprofit organization to fundraise: maintaining the survival of the organization; expanding and developing the organization; fostering organizational autonomy; creating a valuable organization; and nurturing supporters and sponsors. The funding of universities in Taiwan has historically come from two main sources: tuition and miscellaneous fee income and government educational subsidies. The proportion of donations in the total income of Taiwanese universities' is very low compared with universities in Europe and the United States and is truly insufficient as an important revenue source[2][3][5].

The difference in donation income between universities in Taiwan and universities in Europe and the United States can be attributed to the more conservative attitude of relevant fundraising organizations in Taiwan compared with those in Europe and the United States; in addition, the Taiwanese public is generally passive in terms of donation behavior and has a low willingness to participate, often necessitating external stimulus or group influence to generate donation behavior. Because the tuition and miscellaneous fees at private universities are generally more than twice as high as those at national universities and government subsidies for private universities are lower those for national universities, a decrease in the number of students at private universities would immediately create pressure on school operations. Universities should thus consider means to increase cooperation between industry and academia, compete for research funding from private organizations or government entities, or increase non-business income (in addition to that derived from the provision of social services) by actively endeavoring to obtain approved financial aid from all areas. In this regard, donation income is particularly important[4][13].

A greater volume of donations would help universities to build more dormitories, purchase research equipment, develop additional research programs to elevate their academic status, and provide educational funding and financial aid for talent cultivation subsidies, all of which would enhance overall university development.

2. Significance of Alumni Donations

Because university fundraising in Taiwan has no clear target types, targets are generally divided into two categories: individual and business. Each university adopts a different, rather loose fundraising pattern, and there are no dedicated mechanisms. For the most part, fundraising units share manpower and other resources with related offices (for example, the office of public relations and the alumni association), and therefore, the effectiveness of fundraising is relatively limited[4].

University donors primarily comprise alumni. In addition to a lack of alumni identification with schools, the absence of an integrated fundraising unit with active external operations has created significant gaps in terms of strategy, activity and results when universities are compared with other nonprofit organizations that rely on donations for more than half of their operating funds. In terms of the most common means of fundraising in Taiwan, the methods employed by religious organizations are the most diverse and generate annual donations from believers that exceed 20% of their total funds, making religious organizations second only to social service groups in terms of the annual volume of donations received[5][8][12].

An analysis of the behavior of donors who sponsor nonprofit organizations shows that donors generally believe that they will receive non-economic benefits, such as self-satisfaction and a psychological sense of accomplishment, from their interactions with nonprofits. For example, donors will experience satisfying self-determined rewards or achieve their goal of helping others. This process and the relational interaction strategy suggest the application of the relational marketing theory.

Relational marketing theory emphasizes that the maintenance of relations between the organization and interested parties is central to the long-term survival of the organization. According to this principle, an organization should not only emphasize the achievement of goals and internal integration but also focus on contacts with external entities and plan ahead for long-term relations with such entities. In particular, relational marketing requires that nonprofit organizations recognize the need for long-term assistance from donors, acknowledge and trust relationships that generate donations of intangible products or services, develop vital interests to foster internal motivations to donate, transfer relational value, plan fundraising events, and emphasize mutually beneficial relationships between organizations and donors[1][2].

Therefore, this study believes that the implementation of relational marketing techniques through financial, social, and structural integration, the design of different relational marketing strategies and increased interactions with donors based on an understanding of donor behavioral patterns will greatly enhance the effectiveness of donor relationship management. This process is in line with active campaigning by universities for alumni donations, and meaningful investment by university fundraising units in relational marketing tools that target donor alumni could obtain substantial fundraising results.

3. Customer Profitability Analysis in Relational Marketing Theory

To effectively manage relational marketing efforts directed at donor alumni, this study references CPA, which is used by businesses to manage customer relations. The premise of CPA is the effective maintenance of customer relations using limited resources. Therefore, profitability analysis must be performed on each customer to determine the customer's future value to the business. Data mining techniques are used in CPA to sort customers effectively and establish valuable customer groups[9][21][22]. The tools used in this process include linear discriminant analysis, artificial neural network, multivariate adaptive regression splines, and support vector machines, among others. Note that these tools had different original applications and thus the analytical results differ as well. Therefore, many studies have selected an appropriate topic, used a variety of tools to analyze the model building, and made relevant comparisons to determine the best tools.

III. RESEARCH METHODOLOGY

This study focused on the single case of a university and used its alumni data to construct a model to classify donation behavior. The main purposes of the study were to sort the alumni and work with the university fundraising unit to gain an understanding of various related variables that may affect the donation behavior of university alumni based on a summary of the literature and an analysis of the database. Then, the focus shifted to ordering and filing the obtained independent variables that might affect alumni donation behavior, including data on demographics, donations, alumni, and related variables. Next, using the two dimensions of "whether the alumnus was lost or retained" and "high or low donation profitability," the donors in the database were divided into four alumni groups: lost alumni with low donation profitability, lost alumni with high donation profitability, retained alumni with low donation profitability, and retained alumni with high donation profitability. These groups were the dependent variables used in the study.

1. Research framework

To verify the applicability of the discrimination model, this study constructed the model using a two-stage mode that comprised a model training phase and a model testing phase, as shown in Figure 1. First, the alumni data from the case study university was randomly divided into training samples and testing samples according to an 80:20 ratio. In the first phase, model training, four alumni donation behavioral rating models were established according to the four classification techniques used on the training samples. In the second stage, model testing, the sample reserved for testing was used to assess the model's applicability and the test results were employed to predict the model's level of accuracy in discriminating among various alumni groups.
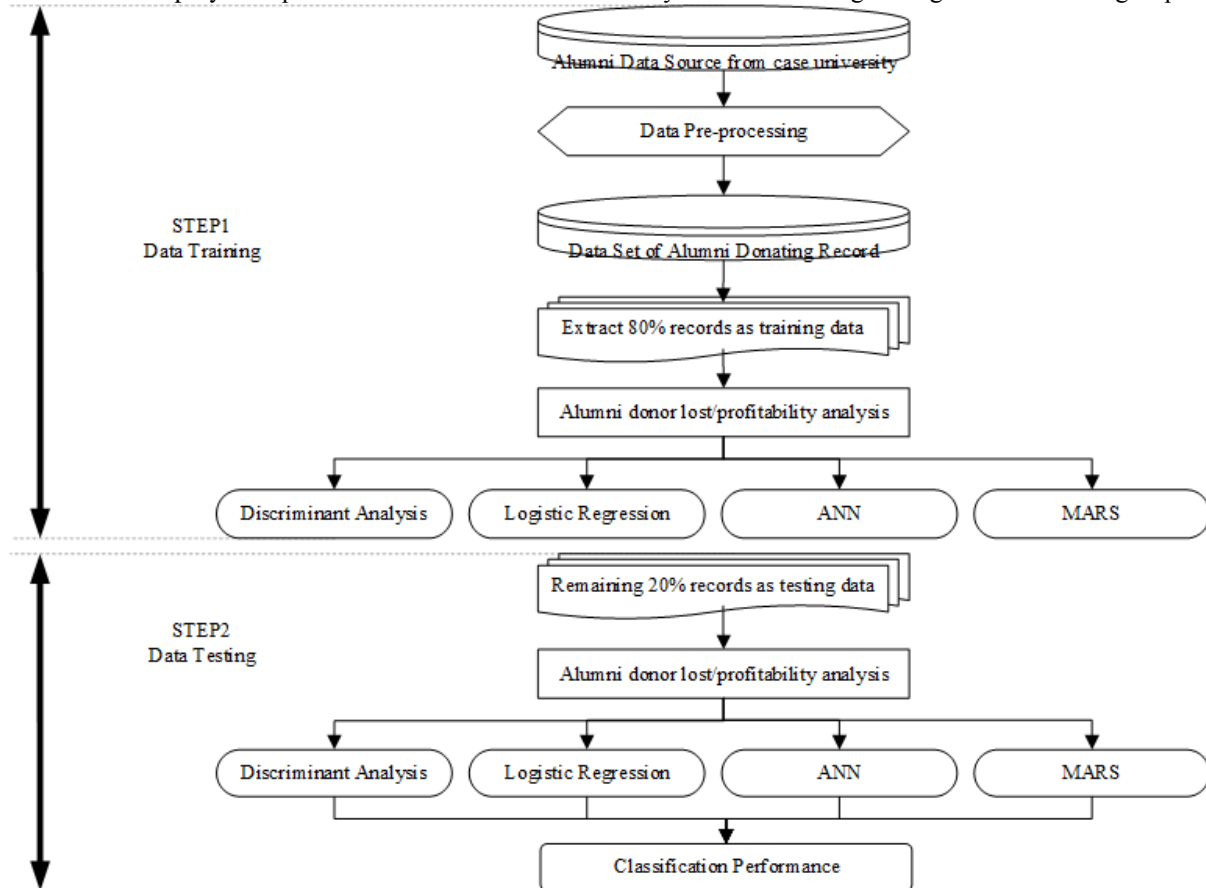

Fig.1: The Research Framework

2. Research Methods

The researchers entered into discussions with the management of the fundraising unit of the case study university in November 2014, providing detailed explanations of the study's research motive, purpose, methodology, and expected results in an effort to obtain university assistance in this endeavor. With the agreement of the fundraising unit, university alumni donation data were acquired and underwent pre-processing, including data extraction, data aggregation, and data filtering. To enhance the multi-category characteristic discrimination results of the medium (small) samples of empirical data, this study employed separate tools including discriminant analysis, logistic regression analysis, artificial neural network, and multivariate adaptive regression splines as sorting techniques to identify alumni donation behavior. This process allowed us to construct, compare, and select the most suitable donor alumni type scoring model.

3. Empirical Study

A classification analysis of donor alumni was conducted based on the fundraising and alumni databases provided by the case study university. The fundraising database had basic data on all donors (including alumni, non-alumni, business groups, and teaching staff) and yielded 38,687 pieces of data; the alumni database included basic data on all alumni and yielded 173,377 pieces of data. The data were from August 1, 1970 to November 30, 2014.

After the two databases underwent preliminary consolidation, purification, and conversion, a total of 6,165 pieces of data on donor alumni were obtained. The data fields included five variables: gender, total donation amount, number of donations, number of years since graduation, and the date of the most recent donation.

Experts discussed this study and considered donor behavior, donation characteristics, and duration before donating again. If the date of the most recent donation was more than 18 months before November 30, 2014 (548 days), the donor alumnus was considered lost. Then, RMF analysis was employed using three indices—the number of days since the most recent donation (recentness), donation frequency (frequency), and donation amount (monetary value)—to measure the level of contribution from each donor alumnus to the university. The methodology is described below:

1. Arrange the donors in a time sequence based on the date of their most recent donation;
2. Divide the donors evenly into ten grades;
3. Number the first 20% of donors who donated in the most recent period as 1, and accordingly derive the numbering 2, 3, 4, 5, …, 10, where the donors numbered as 10 were donors whose most recent donation dates were the furthest from the current time;
4. Arrange the donors by number of donations, and repeat the above steps to sort and number the donors; and
5. Include the donors' total donation amounts in the investigation and sort and number them. Use the SPSS 17 to run RFM analysis (R, recently: 1-10; F, frequency: 1-10; and M, monetary value: 1-10) to produce R, F, M numbers from 1 to 1000. This study classified those who scored 1-100 as having a high level of contribution, and those who scored 101-1000 as having a low level of contribution.

Finally, the donors were divided into four groups according to each donor's lost status (retained status) and level of contribution, namely, "lost alumni with low level of contribution," "lost alumni with high level of contribution," "retained alumni with low level of contribution," and "retained alumni with high level of contribution." The variables obtained in this study after data processing are as follows:

1. Gender: Category variable, 0: Male, 1: Female.
2. Total donation amount: Numerical variable.
3. Total donation counts: Numerical variable.
4. Number of years since graduation: Numerical variable.
5. Day of most recent donation: Numerical variable.
6. Lost or not lost: Category variable, 0: Lost, 1: Retained (Not lost).
7. Level of contribution: Category variable, 0: Low level of contribution, 1: Highlevel of contribution.
8. Donor type: 1: Lost alumni with low level of contribution, 2: Lost alumni with high level of contribution, 3: Retained alumni with low level of contribution, 4: Retained alumni with high level of contribution.

IV. DATA ANALYSIS

1. Data Descriptive Statistics

The gender distribution among alumni was fairly evenly split between men and women, with men accounting for 56.4% and women accounting for 43.6%. Descriptive statistics regarding the total donation amount, number of donations, number of years since graduation, and the number of days between the date of the most recent donation and November 30, 2014 are shown in Table 1. Regarding sample characteristics, men were the most numerous; total donation amount averaged approximately TWD 80,000; total number of donations averaged approximately three; number of years since graduation averaged approximately 25; and number of days between the date of the most recent donation and November 30, 2014, averaged approximately 2,600.

Table1: Descriptive Statistics of Alumni Donors

Variables	N	Percent	MIN	MAX	AVE	SD
Gender	6165	100%				
Male	3480	56.4%				
Female	2685	43.6%				
Total donation amount	6165		20	54695660	78058	1.1144E6
Total donation counts	6165		1	195	3.08	7.87
Day of most recent donation(2014/11/30)	6165		0	8545	2616.94	2187.18

In addition, statistical data on level of contribution, and whether the alumni were lost or retained are as shown in Table 2. The university's rate of lost donor alumni was as high as 78.7%. Given that the estimated customer attrition rate in business in general is 10-30%, there is significant room for improvement in the university's alumni fundraising strategy. Statistical data on donor typeis as shown in Table 3.

Table2: Descriptive Statistics of Donor Lost / Contribution

Variables	N		Percent	
Lost or not lost	6165		100%	
	Lost	4852		78.7%
	Retained	1313		21.3%
Level of contribution	6165		100%	
	Low level of contribution	1473		23.9%

Highlevel of contribution	4692	76.1%

Table3: Descriptive Statistics of Donor Type

Variables	N	Percent
Lost alumni with low level of contribution	4841	78.5%
Lost alumni with high level of contribution	11	0.2%
Retained alumni with low level of contribution	1201	19.5%
Retained alumni with high level of contribution	112	1.8%
Total	6165	100%

V. RESULTS

This study was conducted by discrimination analysis, logistic regression, artificial neural network, and MARS (multivariate adaptive regression splines) using SPSS 17, Salford Predictive Modeler, and Weka software.The Independent variables were donor's gender, total donation amount, total donation counts, number of years since graduation, and other demographic variables. And dependent variablewas donor type.The overall correct classification rates of the four donor type discrimination models employed, namely, linear discriminant analysis, logistic regression analysis, artificial neural network analysis, and multivariate adaptive regression splines analysis, were 74.5%, 74.8%, 81.3%, and 82.6%, respectively, indicating that the model employing multivariate adaptive regression splines analysis generated the best results.

VI. DISCUSSION AND CONCLUSION

Due to continuous advancements in science and technology, collecting large amounts of information is no longer difficult. Nonetheless, future data analysis should not be limited to preliminary descriptive statistics. The use of emerging data mining techniques to thoroughly mine information hidden in data, including unknown valid information or valid information beyond human imagination, should be considered by university fundraising organizations with large amounts of alumni data. Such techniques could enable the discovery of relevant and valuable data characteristics that will help to solve the real problem of stimulating donations.

In summary, this study focused on alumni data provided by the case study university. Based on two dimensions, namely, "whether the alumnus was lost or retained" and "high or low donation profitability," data mining techniques were employed to build four donor alumni groups: lost alumni with low donation profitability, lost alumni with high donation profitability, retained alumni with low donation profitability, and retained alumni with high donation profitability.

The use of the results to determine the best classification tool and enhance the understanding of the significant characteristics of each group is expected to enable the development of methods to retain potentially lost alumni with profitability and to guide the university in its efforts to maintain loyal alumni with profitability, ultimately resulting in the maximization of revenue generated by university fundraising. Empirical results indicate that out of the four discrimination models used in this study, the multivariate adaptive regression splines analysis model yielded the best classification results and thus is a tool worthy of recommendation.

As described above, the donor alumni type classification analysis model of this study was designed solely for the subject university in this case study. Although the discrimination results can only provide a basis for this university to assess the characteristics of its alumni and to formulate fundraising policies, other organizations can reference the concept of this study and use a similar research process to build their own exclusive donor alumni type analysis model, which in turn will allow such organizations to implement an alumni relations management plan and strengthen their respective competitive advantages.

Regarding suggestions for future research, the subject of research in this study was the alumni database of a private university in Taiwan that included limited demographics and donation behavior as variables. Consequently, the overall research results were limited by the unique nature of the data, and thus, there remains room for improvement. To investigate possible means of obtaining better classification results, it is suggested that future studies collect other valid variables, such as alumni academic performance records, attendance at school functions, whether alumni join the alumni association, current occupation, annual income, etc. Such data should enable improvements in the model's discrimination rate or the extraction of important variables more relevant to alumni donation behavior, which may provide a reference for businesses. In addition, future studies might attempt to integrate an artificial neural network with classification tools that are outside the scope of this study—for example, classification and regression trees and fuzzy discriminant analysis—to see if additional research could further improve the discrimination rate. The aforementioned issues could be investigated in-depth in follow-up research.

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