Profitability and Big Data

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The Big Data promise is enhanced service for the customer, and enhanced profitability to the organization. It is crucial that an organization deploy the appropriate combination of big data and analytical tools to extract information that is beneficial to the organization, and to realize the most profit from its customers. This paper describes a mathematical model for big data profitability which will help solidify these concepts and provide means for assessing values for profitability. Most of the proposed variables can be estimated by any organization from their existing systems and the cost of the needed big data technology.

INTRODUCTION

Business purpose may be defined in a narrow and valid fashion as the creation of a customer (Drucker, 1954). In other words, businesses (and to large extent other types of organizations) exist to serve, and acquire customers for profitability or some similar measure of satisfaction. The Big Data promise is enhanced service for the customer, and enhanced profitability to the organization. These promises may be within reach of the organization if and when it achieves the promise of the old fashioned database technology. Only after then the organization can optimize its profitability and service using Big Data technologies.

Big data technology, unlike the old database systems, is characterized by having massive amounts of data that is generated in real time and stored for analysis. In addition, the data comes from varied sources such as text, messages, picture, and social media among others that are added as technology permits digitizing these new forms (Bendre, et. al. 2016). All these data from all these various sources are contained in a large depository and made available for analytics to extract information in real-time, or near real-time, so the organization can make decisions and gain competitive advantage (McAfee, et. al. 2012).

Benefitting from a Big Data program

In order to benefit from the Big Data technology, to optimize its service to and profitability from its customers, the organization must define its customers, their need, and their ability to provide profit for the organization.

1. When embarking on a Big Data program, an organization needs to answer the question: Who are our customers? The group of customers has needs the organization exist to provide. As the organization meets the needs of its customers it realizes profit. An organization might have several groups of

customers each with unique needs, none the less, the organization must treat these groups as distinct in a certain way but related in others.

2. If our customers are willing to profit us, what do they expect in return from us? In other words, what value does the organization bring to its customers? That is the reason the customers are willing to associate with the organization and pay for its services.

3. What makes our association with our customers profitable? How can the organization maintain this profitable association for the long run? Profitability implies that what the organization earns from its customers is larger than the cost it incur in providing for the service. This also implies that the customers see the value of the service the organization provides and willing to pay more than the cost the organization incur in providing the service. As such, the organization must establish and maintain a working relationship that endures and provide profit.

Using profit analytical tools, that are available with Big Data technologies, to assess customer profit we can answer some of the questions posed above. The tools can answer what profit came from what customer. These profit entities, for all customers, can be displayed in a Profit and Loss statement for the organization from its customers. Other analytical tools may be used to augment Profit and Loss statement with other customer information to answer a number of questions. For example:

Big data allows for personalization of customer's needs, wants, and contribution to the profit of the organization (McGuire, et. al. 2015). The Profit Loss statement may be ordered according to the value of profit. Such that customers who contribute the most profit to the organization appear toward the top of the list. While customers that the organization loses money on appear at the bottom of the list. This kind of list provides a snapshot of the relative contributions of customers to the organization. So management can decide on incentives for their best customers, vs terminating associations with their costly customers. (Wired.com, 2017), (Mukherjee, et. al. 2016), (Cokkalingam, et. al.).

The analytical tools can further place the customers into segments according to their contribution to the profitability to the organization. Considering these segments management can discerned which segment provides the most profitable customers to the organization and which segment does not.

Furthermore, the organization may be able to characterize the evolution of customer's profitability over time during which the customer and the organization have a business relationship. In addition, the analytical tools may be used to ascertain the buying habits and service demands that have the desired impact on customer profitability, and how such an impact has materialized.

Measuring the profit contribution to the organization at the customer level assist the organization understanding of some customers' large contribution to the profitability of the organization. This understanding will lead to a number of data based decisions by management to improve the profitability of the organization. Some of these decisions are:

- Strategies and operational policies to achieve and/or enhance customers' loyalty and improve customers' retention.
- Strategies and operational policies to improve the return on investment of marketing initiatives.
- Strategies and operational policies to improve product design and services, pricing of products and services, and of positioning the organization in the market place with respect to its products and services.
- Strategies and operational policies to design customer service polices and processes to avoid losing valued customers because of poor service. It is highly probable that customers which produce great profitability to the organization will go somewhere else after an instance of bad service. The organization cannot afford such a mishap. The various segment of customers contribute to the profit of the organization in different magnitude. Therefore, service should be designed to accommodate the various segments of customers. For this reason big data with the appropriate analytical tools may provide for enhanced market segmentation.

The success of the organization is dependent on the accuracy of measurements of the revenues and costs of customers on their individual level. This process is prescribed by mathematically modeling the revenues and costs attributed to each individual customer. Big Data doesn't change the necessity of having accurate mathematical models. However, it does add more possibilities including speed of analysis

and granularity of measurements. This will lead to more accuracy of measuring customers' contribution to the revenue and costs of the organization. The granularity of measurements will assist the organization in basing its decisions on information obtained from customers' behavior while interacting with organization. These fact-based decision will lead to orient the organization toward more profitable decisions (McGuire, et. al., 2015).

Therefore, integrating accurate mathematical modelling that measure cost and revenue on the individual level with big data technology will lead to better decision on the part of the organization. This is the result of the organization's ability to predict customers' behavior and deploy strategies and operational polices to improve its profit. None the less, the organization needs to assess its return on investment of a big data program using mathematical modeling (Farah, 2017).

Possible Benefits from Big Data

In the following paragraphs we discuss some of the possibilities that big data can provide the organization when it comes to enhancing its profitability:

1. Customer profit may be used as a variable to predict the future of value of the relationship between the customer and the organization. Furthermore, profit may be used to evaluate certain operational policies that are put in practice to enhance the future profitability of customers. In other words, the organization can evaluate the return on investment of some of their customers' operational policies.

2. Marketing has been, for a longtime, dependent on customer segmentation. This segmentation has been related to variables such as geographic locations of customers, level of income, sex, and age. Big data offers many more variables to carry out a much more detailed analysis in higher dimension than what has been done recently (McGuire, et. al., 2015). Variables such as customer sentiment, motivation, behavior, and beliefs can be obtained from the massive data that is collected by organization from their own websites or from social media. A more elaborate customer profile, based on many variables, can be constructed using analytical tools paired with big data. What variables to use, and with what analytical tools, are dependent on the model constructed by the organization which is a reflection of its current needs and strategies?

3. Needless to say that the organization profitability is greatly impacted by customers' experience while dealing with the organization. The organization might be able to mitigate any bad experience only if it can identify it preferably before it takes place. One step in that direction is measuring customers' experience with the organization. Operationally that implies that measures of customers' experience need to be identified, and methodology to carry out these measurements need to be developed and implemented. Big data -- with all the possibilities of sensor data, text, and social data -- and appropriate analytical tools may provide customers' experience measurement with such a methodology. The complimentary part of this methodology is to relate customers' experience, as measured, to programs to reward customers' loyalty and profitability.

It is crucial that an organization deploy the appropriate combination of big data and analytical tools to extract information that is beneficial to the organization. This information provides the necessary insight to design strategies and operational processes to realize the most profit from its customers. An organization might benefit from the experience of others by sharing such strategic knowledge when available. Otherwise, such an exercise need to be carried out by its own staff.

A Mathematical Model for Big Data Profitability

A mathematical model for big data profitability will help solidify the above discussed concepts and provide means for assessing values for profitability. Most of the proposed variables can be estimated by any organization from their existing systems and the cost of the needed big data technology; the remainder of the variables will be assessed by a task force set by the organization to carry out this project.

Let **P** denote the total profit the organization will realize after the big data program is implemented. Let **PBD** denote the profit resulting from deploying a big data program. Let **PI** denote the initial profit without the big data program. Let **CBD** denote the cost of the big data program, and let $\mathbf{CBD_0}$ be the total investment costs (initial costs) in contemplating the deployment of big data program. This initial costs

represent the seed money that the organization commit to study the feasibility of a big data program. The feasibility study may, or may not, recommend to continue the development of such a program.

$$\mathbf{P = PBD + PI - CBD - CBD_0} \quad \mathbf{(1)}$$

PBG most likely is not known with certainty, therefore a probability distribution function of the likelihood of realizing such a profit need to be estimated. The probability distribution will allow the organization to compute an expected value of profit after the big data program is implemented. Let $\mathbf{P_i}$ denote the probability that the organization will realize $\mathbf{PBD_i}$**, for i = 1, 2, …, n**

$$\mathbf{PBD = \sum PBD_i * P_i \quad for\ i = 1, 2, \ldots, n} \quad \mathbf{(2)}$$

If the organization believe that their cost of implementing the big data follows the same distribution; the estimate of the expected value of the cost of the big data program is given in the following equation.

$$\mathbf{CBD = \sum CBD_i * P_i \quad for\ i = 1, 2, \ldots, n} \quad \mathbf{(3)}$$

Therefore, equation (1) may be rewritten as,

$$\mathbf{P = \sum PBD_i * P_i + PI - \sum CBD_i * Pi - CBD_0 \ \ for\ i = 1,2, , n} \quad \mathbf{(4)}$$

The decision to implement, or not, a big data program may depend on the following relation being true or not:

$$\mathbf{P \geq PI} \quad \mathbf{(5)}$$

If equation (5) is true then the organization might profit from the big data program. If not, then there is no monetary benefit from the big data program. Because of the estimates used in the above formulas, a sensitivity analysis might prove beneficial in solidifying the decision that the organization will be taking.

Special Cases

If the profit and cost of a big data program is known with certainty, then $\mathbf{P_i} = 0$ for all i except one where $\mathbf{P_i} = 1$. Equation (4) becomes:

$$\mathbf{P = PBD_i + PI - CBD_i - CBD_0 \quad for\ i \ \ where\ Pi = 1} \quad \mathbf{(6)}$$

If $\mathbf{P_i = 0}$ **for all i,** which implies that the proposed big data program does not contribute to the profitability of the organization, then equation (4) becomes:

$$\mathbf{P = PI} \quad \mathbf{(7)}$$

If $\mathbf{Pi = 1/n}$ where **n** is the possible number of values for i, which implies that all estimates of profit and cost of the big data program, will be realized with equal probability, then equation (4) becomes:

$$\mathbf{P = 1/n * \sum (PBD_i - CBD_i) + PI - CBD_0} \quad \mathbf{(8)}$$

The organization should be able to compute **ROI** on the big data program, and then compare it to other programs undertaken by the organization. Other financial performance measures may also be calculated and used in finalizing the decision about implementing a big data program.

$$\mathbf{ROI = 100 * [(\sum PBD_i - \sum CBD_i) - CBD_0] / [\sum CBD_i + CBD_0] for\ i = 1, 2, \ldots, n} \quad \mathbf{(9)}$$

Another financial metric the organization might use is the Rate of Return **RR**. The **RR** value is then compared to the RR acceptable to the organization.

$$\mathbf{RR = 100 * (P - PI)/PI} \quad \mathbf{(10)}$$

$$\mathbf{RR = 100 * (\sum PBD_i * P_i - \sum CBD_i * Pi - CBD_0) / PI \quad for\ i = 1,2, \ldots, n} \quad \mathbf{(11)}$$

This is the return over a single period of time, say one year. Where **P** is the final value of the profit, and **PI** is the initial value of the investment at the beginning of the year.

Yet another financial measure is the Internal Rate of Return **IRR**. Using the above given variables **IRR** is expressed in equation (9).

$$\mathbf{NPV = \sum[\sum(PBD_i - CBD_i)t / (1 + R) ** t] - CBD_0 \ for\ i = 1,2,\ldots,n\ ;\ t = 1, 2,\ldots, T} \quad \mathbf{(12)}$$

Where **NPV** is the Net Present Value of all cash flows from the deployment of big data project over T periods of time. $\mathbf{\sum(PBD_i - CBD_i)t}$ is the net cash flow during period **t**. **R** is the discount rate. And $\mathbf{CBD_0}$ represent the total investment costs in contemplating the deployment of big data program.

In equation (9) we set **NPV** to zero (the definition of **IRR**) and solve for **R**. The result is the **IRR** for investing in the big data program. So equation (9) becomes:

$$\mathbf{0 = \sum[\sum(PBD_i - CBD_i)t / (1 + R) ** t] - CBD_0 \ for\ i = 1,2,\ldots,n\ ;\ t = 1, 2,\ldots, T} \quad \mathbf{(13)}$$

Special Cases

For a single period of time; that is **T = 1**, and initial cost for developing the big data; equation (13) becomes:

$$\mathbf{0 = \sum(PBD_i - CBD_i) / (1 + R) - CBD_0, \quad for\ i = 1,2,\ldots,n} \quad \mathbf{(14)}$$

$$\mathbf{CBD_0 = \sum(PBD_i - CBD_i) / (1 + R), \quad for\ i = 1,2,\ldots,n} \quad \mathbf{(15)}$$

$$\mathbf{(1 + R) * CBD_0 = \sum(PBD_i - CBD_i), \quad for\ i = 1,2,\ldots,n} \quad \mathbf{(16)}$$

$$\mathbf{R = [\sum(PBD_i - CBD_i) - CBD_0] / CBD_0, \ for\ i = 1,2,\ldots,n} \quad \mathbf{(17)}$$

$$\mathbf{R = [\sum(PBD_i - CBD_i)] / CBD_0 - 1, \quad for\ i = 1,2,\ldots,n} \quad \mathbf{(18)}$$

Estimating the Values of PI, PBD, and CBD

The organization needs to estimate values for the variables **PI**, **PBD**, and **CBD**. The value of $\mathbf{CBD_0}$ is, most likely, known with certainty; that is seed money allocated to study the feasibility of a big data program. The more accurate the estimates are the closer to reality the decision of implementing, or not, the big data program will be.

PI may be calculated by using existing software that are available. A number of software, available in the market, allow the organization to calculate the cost and revenue on the customer level. However, estimating **PBD** and **CBD** with reasonable accuracy could be more challenging. Using the appropriate analytical tools and a comprehensive data collection program, the organization should be able to produce quality estimates of these variables. The value of these variables can also be updated by the emergence of new tools and more data. Therefore, over time the values of **PBD** and **CBD** become more accurate leading to a more predictive power of the above described model.

SUMMARY

The Big Data promise is enhanced service for the customer, and enhanced profitability to the organization. These promises may be within reach of the organization if and when it achieves the promise of the old fashioned database technology.

In order to benefit from the Big Data technology, to optimize its service to and profitability from its customers, the organization must define its customers, their need, and their ability to provide profit for the organization.

The success of the organization is dependent on the accuracy of measurements of the revenues and costs of customers on their individual level. This process is prescribed by mathematically modeling the revenues and costs attributed to each individual customer. Big Data doesn't change the necessity of having accurate mathematical models. However, it does add more possibilities including speed of analysis and granularity of measurements. This will lead to more accuracy of measuring customers' contribution to the revenue and costs of the organization. The granularity of measurements will assist the organization in basing its decisions on information obtained from customers' behavior while interacting with organization. These fact-based decision will lead to orient the organization toward more profitable decisions.

It is crucial that an organization deploy the appropriate combination of big data and analytical tools to extract information that is beneficial to the organization. This information provides the necessary insight to design strategies and operational processes to realize the most profit from its customers. An organization might benefit from the experience of others by sharing such strategic knowledge when available. Otherwise, such an exercise need to be carried out by its own staff.

This paper develops a mathematical model for big data profitability. The model will help solidify the above discussed concepts and provide means for assessing values for profitability. Most of the proposed variables of this mathematical model can be estimated by any organization from their existing systems and the cost of the needed big data technology; the remainder of the variables will be assessed by a task force set by the organization to carry out this project.

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