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Karen Vizecky
Dakota State University, kjvizecky@pluto.dsu.edu

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Data Mining meets Decision Making: a Case Study Perspective

Karen Vizecky
Dakota State University, Fortune 500 Retailer
kjvizecky@pluto.dsu.edu

ABSTRACT

Data Mining (DM) technologies have been employed within the specialized domains of customer relationship and risk management for over a decade. However, it has been only recently that DM techniques have begun to enter the main stream of optimization activities often spurred on by recent external influences such as the challenging economic climate. While increased use of DM offers many benefits to organizations, communicating the value of DM requires an approach beyond over simplistic Return on Investment (ROI) calculations. The study described in this paper aimed to determine if Value Analysis (VA) as outlined by Keen (Keen 1981) may serve as an appropriate approach to evaluating DM and gaining executive alignment. A case study methodology will be employed to illustrate how a fresh perspective of this theory may address the challenges in communicating DM value.

Keywords (Required)
Data Mining, Return on Investment, Value Analysis

1.0 INTRODUCTION

The advances in computing power, the declining cost of data storage and improved software to process large organizational data sets has enabled greater use of advanced techniques like Data Mining (DM). In the retail domain these techniques have typically dominated the fields of Customer Relationship Management (CRM) (Duchessi et al. 2004; Hayashi et al. 2009) and Risk Management (RM) (Apte et al. 2002; Giudici et al. 2009). The proven success of DM in these fields has served as a launching pad for greater interest in applying DM throughout retail organizations. Popular managerial books like “Competing on Analytics” have demonstrated the powerful extensions DM can have on internal and external processes (Davenport et al. 2007). However, barriers remain as to relaying mining discoveries to managerial audiences in value terms that are both easy to understand and realistic in magnitude.

The work of Keen (Keen 1981) provided insight as to managerial decision making processes when evaluating the investments surrounding DSS implementations. His work provided a frame for communicating worth in business terms and championed an iterative approach to value. Numerous articles since Keen’s original publication have considered the efficacy of the VA approach in communicating value to executive audiences (Belcher et al. 1993; Guimaraes et al. 1992; Poon et al. 2001). Given DM models are an output of a DSS it seems Keen’s framework may be an appropriate option to consider in quantifying the financial impact of DM. In order to illustrate the applicability of VA to managerial decision making for DM we will explore a case study through the lens of VA. This approach will focus on contributing a viewpoint of professional relevance while maintaining academic rigor.

2.0 RESEARCH METHODOLOGY

In recognizing the challenges of case study methodology this section describes the validity and reliability of the methodology employed. The case study methodology was selected to help in framing the concept of VA in relation to DM due to its ability to be used to develop and test theory including ethnographic or grounded theory approaches.
(Yin 2009). As described by Eisenhardt (Eisenhardt 1989) this research approach is “Particularly well suited to new research areas or research areas for which existing theory seems inadequate. This type of work is highly complementary to incremental theory building from normal science research. The former is useful in early stages of research on a topic or when a fresh perspective is needed, whilst the latter is useful in later stages of knowledge (pp.548-549).” As this paper focuses on investigating how DM can be better employed throughout organizations by demonstrating value a case study perspective provides insights that establish professional relevance (Arnott et al. 2005; Arnott et al. 2008; Vizecky et al. 2011) and serve as foundations for future research contributions in theory extension.

It is the objective of this case study to present rich, thick descriptions of the operational events relating to the organizational context as well as the potential problems facing the DM team as a sub-set of the Pharmacy Expense Optimization team. The potential for personal assumptions and bias are a risk of case research, specifically when the researcher is embedded in the organization. In recognizing this risk, we will focus on presenting as objective a point of view as possible, while providing tangible demonstration of communication vehicles employed within the organization.

All events described in this paper took place on site at the organizational headquarters. Due to the recent nature of these activities the organization has agreed to publication of the time frame in terms of months, spanning from February to August, the time frame in which management made the decision required to move forward with Scenario 0. Implementation of Scenario 0 took place five months following approval and is being followed for future quantitative and qualitative discussion as to the impact of the DM approach. Therefore this exploratory case study will focus on determining if Keens’ existing Value Analysis theory is adequate or if a fresh perspective is required.

3.0 SITUATION

The organization described in this case study is a retailer based in the United States that includes a pharmacy segment within the retail box. The pharmacy was introduced as a “one size fits all” format as the chain quickly expanded through the late 1990’s and early 2000’s. Prescription growth was significant in these years and the business focused on a strategy of expansion of business hours and physical locations. Business was considered to be good, growing at a greater than expected pace and business partners located at the retailers’ headquarters were pleased with performance.

This trend was abruptly interrupted when the economy in the United States softened significantly for retailers in 2007. Expense management became the prevailing term at the retailers headquarters and the organization was tasked with identifying the greatest expense drivers. A new culture of expense management was ushered into the business as illustrated by the Expense Management Mission posted on the internal company website and Wiki. No business segment was immune from expense scrutiny and thus the pharmacy business was no exception. The growth of the pharmacy business segment had been significant but the expenses supporting the business had also grown and at a pace that met or in some cases exceeded sales. So while the retailer tasked its merchant organizations with increasing margin by lowering expenses, pharmacy was given the largest task of all. Optimize the pharmacy business by driving continued growth in non-discretionary prescription volume while reducing the expenses below current levels.

Figure 1. Expense Management Mission

A supportive, engaged culture where leaders view their performance not in isolation, but with regard to total company profitability and peer opportunities / constraints
The new expense management culture provided the incentive for transformation, but the question around “how” remained. All ideas to deliver results that provided a balanced approach to growing the business and managing expenses were welcome. While the merchant and store operations partners identified numerous opportunities, none delivered upon the financial task necessary to contribute to the overall retailers expense management needs. It was at this time that the pharmacy leadership turned to the experts in DM within the retailers CRM and RM teams to enable data to identify opportunities.

### 3.1 Data Mining Results

The team of specialists assembled to try DM techniques against the pharmacy issue brought with them knowledge of multiple data sources within the company, including the transactional customer warehouse, the credit warehouse and the financial warehouse. This yielded a solution specific dataset developed within the company, bringing together data from the three disparate data warehouses as well as publically available data. This activity was carefully supervised by the legal department to ensure Health Insurance Portability and Accountability Act (HIPAA) compliance. To guarantee there was no question as to HIPAA compliance no personally identifiable guest information was used, nor was any data from the prescription management system. The final solution specific dataset contained aggregated CRM data, Geographic Information Systems (GIS) data, financial performance data, and store operations data.

With the solution specific dataset in place, the DM team began exploring the data, modeling against prescription volume, prescription dollars and profitability. The first win of the DM team was identifying that prescription volume was the best predictor of performance and correlated strongly with profitability. While prescription dollars were adversely impacted by mix of generics versus branded drugs the profitability of a pharmacy was inversely related to the higher dollar value prescription locations. Therefore, the DM team focused all further exploration towards modeling the predictors of prescription volume.

The resulting DM models segmented the pharmacy locations based on prescription volume and provided meaningful insight into the drivers of business performance. However, they also provided information that was counter-intuitive to decision makers, such as the best performing pharmacies were in underperforming store locations, and the worst performing pharmacies were in the highest sales volume stores.

### 3.2 Partnering with Finance

The Pharmacy Expense Optimization teams realized that the DM models in and of themselves were not compelling enough to business leaders to overcome the hurdle of the exigent findings. Knowing that the requirement of the project was to identify expense savings the team enlisted partners in the Finance organization to quantify the ROI resulting from the optimization strategy derived from the DM models. Due to the organizational size, it seems prudent to describe that the Finance organization is comprised of approximately 500 individuals assigned into distinct specialty teams such as merchant finance, financial reporting, financial goals and forecasts, headcount planning etc. each with between 40 and 100 team members. Each team within the Finance pyramid specializes in specific types of financial analysis and are often called upon to consult with other organizational units as they build and evaluate business cases. As such, the merchant finance team, as well as the expense optimization team was determined to have the expertise necessary to prepare a business case that spoke to the impact to the Pharmacy merchants in terms of sales growth or risk, as well as a business case that spoke to expense savings and margin growth. A representative from the merchant finance team as well as the expense optimization team worked together with the DM team to understand the statistical output and DM recommendations.

The output of the statistical analysis found three primary performance clusters as represented as limbs in the decision tree. Pruning of the decision tree was performed to achieve actionable segment sizes as determined by the partners within the stores organization. These store partners would be responsible for implementing the DM recommendations, and therefore every effort was made to find a good statistical fit that yielded three primary
treatments. These treatments reflected the findings of prescription volume and prescription clustering within the course of daily and weekly operations. The three behavior patterns of a pharmacy customer resulted in the recommendation of three primary schedules for hours of operation. The first segment of stores reflected characteristics suggesting a “doctor to drugstore” mentality which in turn allowed for reduced hours of operation with minimal customer impact simply by reflecting clinic office hours. Alternately, stores that showed prescription volume patterns of “convenience trip” or “rest-of-store” required less hours of operation, but more strategically placed during the day. In other words, shoppers who made their prescription visit a combined visit with shopping the rest of the store seemed to prefer a visit that was later in the day, resulting in unproductive morning hours and dissatisfied guests during the high volume afternoon and evening hours. Therefore, a schedule that reduced hours, and placed emphasis on greater staffing during the peak demand was suggested. Lastly, there was a segment of pharmacies where prescription volume required extended hours of operation in order to achieve optimal work flow for the pharmacy team and to deliver on guest satisfaction metrics. These pharmacies retained their current hours of operation and were retrained to better match scheduling to customer demand.

In telling the story of the statistical analysis through a financial lens the analysts from the merchant finance and expense optimization teams developed models that reflected the financial benefit of each treatment tier. These financial models suggested that optimizing each store location to one of the three treatment tiers resulted in an ROI of $120 million dollars of expense savings in the first full year of implementation. The significant scale of the ROI results as well as the lack of transparency to assumptions due to the complicated nature of the calculation led to disbelief of not only the financial analysis, but the underlying statistical analysis. As a result it was clear to both the financial analysts and the DM team that ROI was not the best measure upon which to position the recommendation to leadership, rather value and iterative options for scale were required.

4.0 VALUE ANALYSIS

At this point we have set the stage of organizational context which gives us opportunity to pause and discuss how the case demonstrates the plausibility of Stage 1 of Keen’s VA model to communicating the value of DM. Keen’s model provided two Stages of components that justified a Decision Support System (DSS). In the first stage three components were defined including: 1) Establish Value, 2) Establish Threshold, 3) Build Version 0 as illustrated in greater detail in Figure 2. This theory was originally proposed to demonstrate value of a physical DSS system including capital investment. In the context of this case, and the opportunity for theory application we will look at how VA can also be used to demonstrate the value of a DSS output in the form of DM. In order to do this effectively we will focus on moments during the course of case development that demonstrated theoretical fit focusing on the Stage 1 processes.
4.1 Establish Value

The Keen model focused on establishing value based on discovering financial metrics that would resonate with a management audience. As Figure 2 illustrates, the examples provided include the ability to solve urgent business problems, making data quickly accessible or saving time for ad hoc analysis. From this viewpoint the Pharmacy Expense Optimization team focused on understanding the objectives that instigated the DM project. While expense leverage was clearly articulated, so was prescription growth. Therefore, the team was tasked with determining what metrics best represented a thorough value analysis. Due to the competitive nature of the industry, all documentation regarding the actual metrics was classified as confidential to the organization and was not disclosed for research purposes. However, the four pillars that defined metric measurements were deemed appropriate in the context of defining value statements. Those four pillars included prescription volume, payroll expense, guest loyalty as collected from internally available quantitative measures and guest feedback provided through point of sale surveys. In making explicit the characteristics that defined value to the leadership team, future communication vehicles focused on addressing how the DM model recommendations aligned against the value expectations.
4.2 Establish Threshold

The second component of Keen’s VA model relates to establishing a decision making threshold. The Pharmacy Optimization Team had defined the metrics that would tell the story from a balanced perspective of prescription growth and expense reductions with a nod to minimal impact to brand equity or customer loyalty. However, the scale of value that the retailers’ executive leadership expected was unknown. While a task had been defined from a tops-down perspective, the task number was not shared with the DM team. This left the team to establish an expected expense savings scale that would be seen to deliver upon the desired balance of prescription growth and expense reduction.

As PowerPoint was the primary communication vehicle between members of the DM team and executive leadership we benefit in having a clearly documented lens on the establishment of the decision threshold. Figure 3 was extracted from an executive presentation made three months prior to the recommendation that is equivalent to Keen’s Scenario 0. The team went about establishing the decision making threshold by presenting a series of recommendations that represented a conservative, a moderate and an aggressive interpretation of the three levers based on the DM segmentation. The scenario illustrated in Figure 3 represents the moderate interpretation which corresponded to an estimated profitability impact of $111 million. Minor changes to the interpretation of Keen’s analysis to support a DSS model rather than a DSS system are required, but are reasonable generalizations of the existing theory. It is recognized by the authors that further confirmation of the possibility of generalization beyond DSS systems would need to be validated by additional cases of DSS modeling exercises.

Figure 3. Extracted from Presentation to Executive Decision Makers
4.3 Build Version 0

As the Pharmacy Expense Optimization team moved from exploration of threshold impact, the DM team was challenged to design an appropriate iterative approach to test the validity of their models. Executive leadership was wary of even the moderately aggressive threshold being established. Therefore, it became particularly important to continue to reinforce the objective of delivering upon the expense expectations of the organization. In the three months that ensued between the executive communication vehicles represented in Figure 3 (May) and Figure 4 (August) multiple iterations of Version 0 were created. Each was slightly tailored to make the test of the DM model more palatable to executive decision makers at headquarters and store leaders in the field operations. In order to overcome barriers to implementation, the team proactively addressed concerns and challenges raised during the three months required to propose an acceptable testing strategy. As Figure 4 demonstrates, the communication vehicles presented following much debate resulted in the implementation of 4 statistically derived tests informed by DM.

While Keen’s discussion focused on building Version 0 with the intent of iterating the DSS system, the benefits of the iterative approach were also realized in the testing strategy outlined in Figure 4. Essentially the tests that were recommended were each a Version 0 in that they provided the organization the opportunity to evaluate the impact while reducing risk. In this case, the organization focused on learning the true impact of the four value drivers of prescription growth, expense savings, guest loyalty and guest satisfaction.

Figure 4. Extracted from Presentation to CEO where test of DM recommendations was approved
5.0 REFLECTIONS AND IMPLICATIONS FOR FUTURE RESEARCH

The impact of DM can be significant for an organization. It can uncover hidden trends and as in this case, debunk myths about organizational performance. However, applying DM techniques against large organizational problems can uncover opportunities of a scale where simple Return on Investment (ROI) calculations belie the complexity of decision making required. Understanding the impact of DM against big data and big companies requires a different approach to quantifying success. In this context, describing the opportunity to decision makers to aid in decision making requires greater transparency to the value proposition.

The Stage 1 components of Keens’ VA appear to have a foundational fit that may inform an extension or generalization to address the unique challenges illustrated by this case. Although aversion to implementation was experienced by the organizations decision makers, the alignment created by the VA approach employed enabled strategic testing of the DM model. While applying Keens’ model required a broadening of interpretation of establishing the threshold so as to model the more tangible dollars of a specific solution this interpretation was more in line with focusing on the magnitude of the expected return than the implied precision of ROI calculations. The preliminary indications of the potential use of VA in quantifying DM potential shows promise. However, it is recognized that this is initial research focused on determining if a new perspective on an existing theory fits not only the individual problem set of the case described, but is extensible.

As such, this case illustrates several relevant research streams as well as the potential for a teaching case. The first research stream will be made possible by continued partnership with the organization illustrated in this case to understand the assessment of Scenario 0 and the viability of Stage 2 of Value Analysis as described by Keen as the iteration based on a successful Scenario 0 (Keen 1981). It is recognized that Keen’s VA is well accepted in quantifying the benefit of DSS, and this paper serves only as an introduction into DM. Further understanding the fit of this theory to demonstrating the value of DM will be important to informing a DM audience as to communicating value in alternate ways to ROI. It is recognized that the applicability of VA within multiple organizational settings and DM contexts will be important to determine the extensibility to new DM projects and to negate the potential impact of organizational specific power and political constraints. To build upon these research streams, a teaching case may be appropriate in demonstrating the integrated nature of DM and financial impact analysis using Keen’s VA framework. This case could expose students to the critical thinking skills necessary to tell the story of DM output through multiple lenses including the statistical fit of the model, but also how that statistical output can be translated into a financial outcome. Providing exposure to executive decision making processes relating to DM through the rich context of case study descriptions allows students to engage in and propose extensions to the VA approach to quantifying DM effects.
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